

# Charged-Up

ANALYSIS OF THE JOBS, INVESTMENTS AND COMPANIES  
IN THE ZERO EMISSIONS MEDIUM AND HEAVY DUTY  
VEHICLE SUPPLY-CHAIN ECONOMY

## CALIFORNIA CASE STUDY



October 2021

Environmental Defense Fund is dedicated to protecting the environmental rights of all people, including the right to clean air, clean water, healthy food and flourishing ecosystems. Guided by science, we work to create practical solutions that win lasting political, economic and social support because they are nonpartisan, cost-effective and fair.

This report and the underlying technical analysis were made possible by services provided by Strategy&, a PwC network company. Arian Dehnow, London School of Economics and Political Science\*, and Sarah Ryan, EDF, also contributed significantly to this report and underlying analysis.

Additional information on the national supply-chain analysis is available online at:  
<https://www.edf.org/zero-emission-trucks-generating-jobs-across-us>

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# Executive Summary

California has been a global center of technological innovation and environmental policy for decades. The convergence of these two ideas have created the conditions where many energy-sector companies have started-up in California and grown into major employers and economic growth drivers. One example is seen in the medium and heavy duty zero emissions vehicle (MHD ZEV) transport industry, where many metrics show both that a vibrant industry has already taken hold and is poised to deliver vast amounts of additional economic investments and job generation.

To better understand the present characteristics and future trends of the burgeoning MHD ZEV industry, both in California and nationally, Environmental Defense Fund (EDF) compiled a database of companies involved in every segment of its supply chain. After gathering the extensive list of relevant companies with US operations, EDF staff and consultants collected or developed location-specific data, including information on employment, announced investments, and other key attributes. The project team then organized this information by state and city, and congressional district in an effort to demonstrate the geographic distribution of the industry and motivators of present and future growth.

This supply chain study illustrates a robust and rapidly growing industry: as of September 2021, 375 companies were identified across the MHD ZEV supply chain, with about 1000 locations across the country. Those locations collectively employ more than 333,000 people and have announced over \$53.7 billion in new EV-related investments. Vehicle assembly boasts the largest number of companies and employees, while the majority of announced investments revolve around the battery, from raw material processing to battery cell and pack production. Since September 2021, additional companies have announced new investments, added employees and opened up new business locations – underscoring the dramatic growth present across industry today and the importance of continued tracking and support.

In California, the MHD ZEV industry is far-reaching and can deliver economic and employment benefits as the transition to zero-emissions vehicles continues to occur. Auto industry incumbents are adapting their businesses to provide MHD ZEV products, and new entrants are arriving on the scene to take advantage of the emerging market. California has at least 128 companies operating at 181 locations involved in the MHD ZEV supply chain; 86 of these companies are headquartered within the state. These companies have over 44,000 employees at in-state locations, and announced corporate investments in manufacturing, infrastructure, research and training have exceeded \$3.8 billion over the last seven years. As a result, this study finds California is uniquely positioned to take advantage of growth in electric transport.

There are likely several reasons California is leading the nation in several metrics associated with the MHD ZEV industry. Continued policy and economic support of the MHD ZEV industry is likely one major factor, as is the supportive business environment in places like Silicon Valley and Los Angeles. As additional transportation policies are developed in the state, consideration of the economic and employment benefits that a growing MHD ZEV supply chain in California can provide should be taken into account.

# Introduction

While medium and heavy-duty vehicles (MHD) today are primarily fueled by polluting fuels such as diesel and natural gas, the transition to MHD Zero Emission Vehicles (ZEVs) is well underway. Over the past several years, investments in MHD ZEVs have made them a financially and environmentally sound choice moving forward. By 2050, climate and public health concerns, along with technological and manufacturing advancements, will likely compel all MHD truck and bus fleets to abandon fossil fuels entirely.

Nevertheless, the transition to a zero emissions MHD fleet will require significant growth up and down the vehicle manufacturing and infrastructure supply chain. This growth will also need to be matched by maintenance and resale (also known as midlife) companies, research and development institutions, and training organizations. Many elected officials and policy makers have recognized the opportunity ahead and are acting now to promote a zero-emissions future.

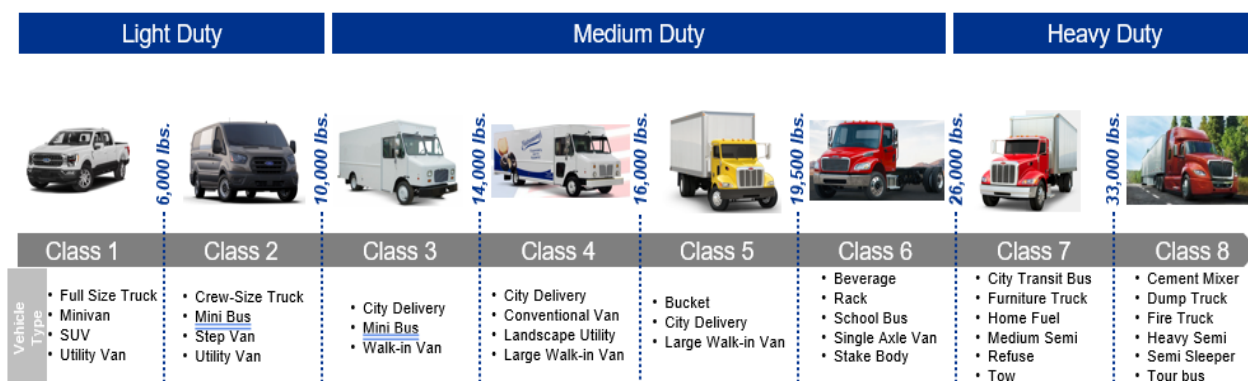
A review of the national MHD ZEV vehicle supply chain shows that with investment in a transition to MHD ZEVs comes the potential for new economic and employment growth, and California has already begun to experience it. This report details the current footprint of the MHD ZEV supply chain in California, as well as the United States as a whole.

# Background

## What are Medium- and Heavy-Duty Vehicles?

Medium- and heavy-duty (MHD) vehicles are those that weigh over 10,000 pounds; the category ranges from vehicles as small as local delivery truck to vehicles as large as an eighteen-wheeler (class 3 and class 7 respectively). These vehicles are at least tangentially involved in all aspects of commercial activity—parcel and goods delivery, public transportation, utility and government services, long distance shipping, construction and more all rely on MHD vehicles.

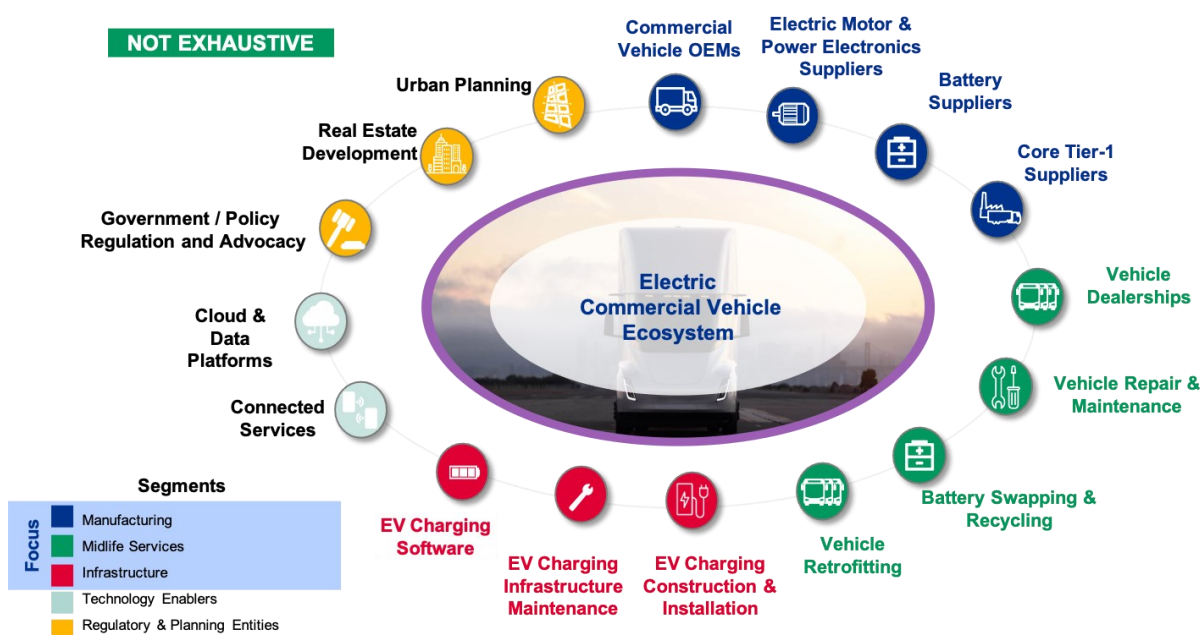
Figure 1: Vehicle Classification and Common Type



Source: Alternative Fuels Data Center

Medium and heavy-duty zero emission vehicles have major cost, operations, and emissions benefits that their fossil fuel-burning, internal combustion engine counterparts do not. That has led vehicle manufacturers, information technology companies, governmental organizations, private fleets, and many more to invest in the transition to zero emission vehicles.

Figure 2: Zero Emissions Vehicle Supply Chain (Market, Regulatory and Development) Segments

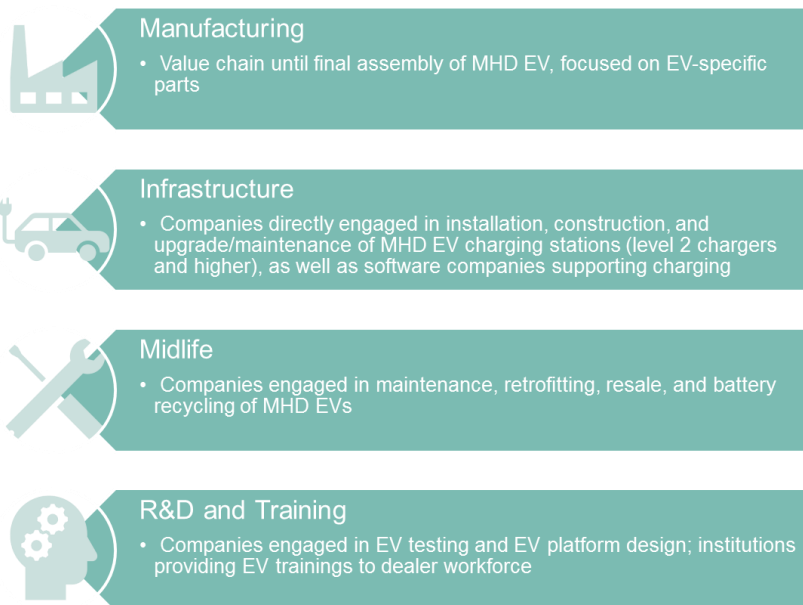


## Methodology for this study

This industry assessment is based on a literature search and data compilation of various companies across the MHD ZEV supply chain segments in the United States. This study is limited to only a certain portion of the ecosystem of activity relevant to the MHD ZEV vehicle supply chain, and evaluates businesses involved in electrification.

With contracted assistance from the consulting firm PwC, EDF compiled a database of incumbent and new entrant companies operating nationwide that are purposefully involved in the manufacturing, infrastructure, midlife, and R&D and training segments of the MHD electric vehicle supply chain.

Definitions of each of these segments are as follows:



This analysis only includes companies that devote a portion of their capacity specifically to MHD ZEVs. In other words, the analysis considers companies that offer at least some products or services that pertain only to MHD ZEVs.

This assessment also identifies each company's specific sub-segment based on the products and services it offers. This study collected general company-wide information, such as financials, announced investments, and ZEV-related announcements from an array of sources (see Appendix 1 for a data source list). Subsequently, the study team gathered specific data for each company, including location/address, number of employees, union information, state agreements, and other key attributes. If not stated publicly, the study team estimated location level data based on a percentage ZEV share of production volumes, percentage share of ZEV products of total portfolio, or by applying a percentage of MHD-vehicle-based revenue or number of employees to each location. If too little information was available to make a reasonable estimate, the field was left blank and was not included in the overall summation. The resulting tool paints a detailed picture of the domestic MHD electric vehicle industry, including its regional variability.



## Limitations of this study

This study focuses only on a portion of the overall ecosystem of activity involved in the zero-emissions transportation transition. Furthermore, this study does not capture companies whose products may incidentally end up in MHD ZEVs but who have not made it their business to do so. This means that companies in adjacent vehicle manufacturing industries or companies that manufacture non-ZEV-specific parts (i.e., bolts, steering wheels, chassis, etc.) were not included in the database if they do not also produce ZEV-specific parts. Additionally, this database and associated economic assessment does not include information of the effects of indirect or induced growth from investment in the zero emissions industries (e.g. effect of having additional money circulating in the economy). Finally, due to limitations inherent to industry-wide data collection, the study does not purport to provide an exhaustive census of all companies, workers, and investments involved in the evaluated industry segments, but rather offer an illustrative survey of those locations to convey a clear impression of the industry at large.

Due to the restrictive criteria and limitations described above, this study presents a conservative assessment of the overall industry.

## MHD ZEV Economy in California

California is one of 44 states in the United States with one or more corporate locations working in the MHD ZEV industry, and is also one of 22 states that boasts over \$100 million in announced corporate investments in the industry. According to this analysis, there are at least 128 companies, operating at 181 locations with over 44,000 employees at relevant locations. Of these companies, 86 have located their US headquarters in California as well. Given the size of the domestic industry, infrastructure and employment base already in place, California is uniquely positioned to take advantage and scale up to meet further growth in the zero emissions transport sector.

*Figure 3: Geographic distribution of companies in California – most companies are located in the major metropolitan regions of the San Francisco Bay Area, the Los Angeles Metropolitan Area and the San Diego region.*

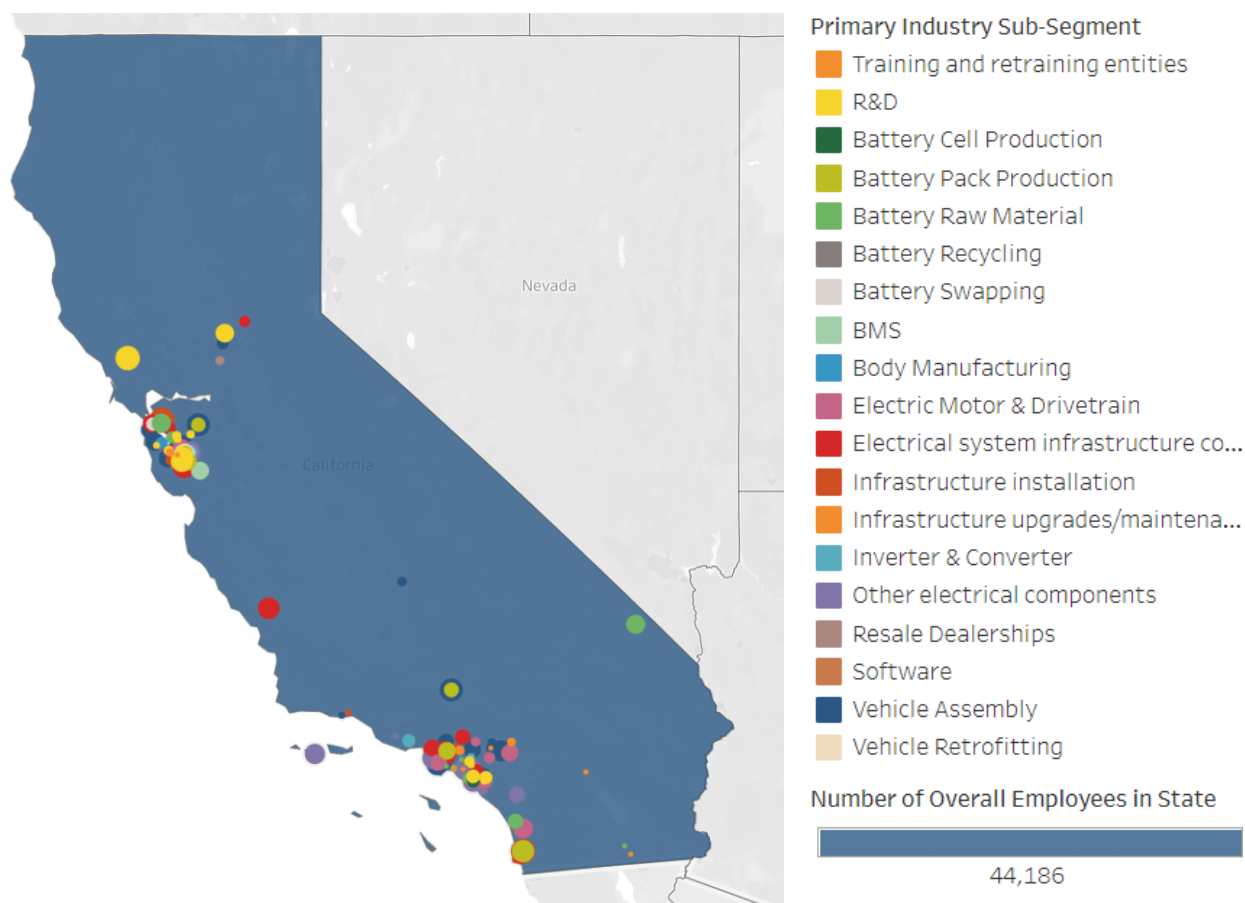


Table 1: Company locations in California as of August 2021 (non-exhaustive)

| Company / Brand                | Main Industry Segment | Primary Industry Sub-Segment                  | HQ? | City                    |
|--------------------------------|-----------------------|-----------------------------------------------|-----|-------------------------|
| AC Propulsion                  | Manufacturing         | Electric Motor & Drivetrain                   | Y   | San Dimas               |
| Alpha Motor Corp.              | Manufacturing         | Vehicle Assembly                              | Y   | Irvine                  |
| Ample                          | Midlife               | Battery Swapping                              | Y   | San Francisco           |
| AmPLY Power                    | Infrastructure        | Software                                      | Y   | Mountain View           |
| AmpUp                          | Infrastructure        | Infrastructure installation                   | Y   | Cupertino               |
| Analog Devices Inc             | Manufacturing         | Inverter & Converter                          |     | Milpitas, Santa Clara   |
| Andromeda Power                | Infrastructure        | Infrastructure installation                   | Y   | Costa Mesa, Long Beach  |
| Aptiv                          | Manufacturing         | Inverter & Converter                          |     | Agoura Hills            |
| AVL (Drivetrain)               | Manufacturing         | Electric Motor & Drivetrain                   |     | Lake Forest, Menlo Park |
| AVL List GmbH                  | R&D and Training      | R&D                                           |     | Lake Forest, Menlo Park |
| A-Z Bus, Inc.                  | Midlife               | Resale Dealerships                            | Y   | Colton, Sacramento      |
| Battle Motors                  | Manufacturing         | Vehicle Assembly                              | Y   | Los Angeles             |
| BattSwap Inc.                  | Midlife               | Battery Swapping                              | Y   | Palo Alto               |
| Bertrandt                      | Manufacturing         | Battery Pack Production                       |     | Sunnyvale               |
| Bidgely                        | Infrastructure        | Software                                      | Y   | Mountain View           |
| Blink                          | Infrastructure        | Electrical system infrastructure construction |     | Various                 |
| Brightdrop                     | Manufacturing         | Vehicle Assembly                              |     | San Francisco           |
| BTCPower                       | Infrastructure        | Electrical system infrastructure construction | Y   | Santa Ana               |
| BYD (Batteries)                | Manufacturing         | Battery Pack Production                       |     | Lancaster, Los Angeles  |
| BYD (Vehicle Man.)             | Manufacturing         | Vehicle Assembly                              |     | Lancaster, Los Angeles  |
| Canoo                          | Manufacturing         | Vehicle Assembly                              | Y   | Torrance                |
| Chanje                         | Manufacturing         | Vehicle Assembly                              | Y   | Los Angeles             |
| Chargenet Holdings             | Infrastructure        | Infrastructure installation                   | Y   | San Diego               |
| Chargepoint                    | Infrastructure        | Electrical system infrastructure construction | Y   | Campbell                |
| Chargeie                       | Infrastructure        | Software                                      | Y   | Culver City             |
| Chevron                        | Infrastructure        | Electrical system infrastructure construction | Y   | San Ramon               |
| Chroma Systems Solutions, Inc. | R&D and Training      | R&D                                           | Y   | Foothill Ranch          |
| CityFreighter                  | Manufacturing         | Vehicle Assembly                              | Y   | Santa Barbara           |
| Clean Tech Institute           | R&D and Training      | Training and retraining entities              | Y   | Moffett Field           |

|                                    |                |                                               |   |                               |
|------------------------------------|----------------|-----------------------------------------------|---|-------------------------------|
| <b>Clipper Creek</b>               | Infrastructure | Electrical system infrastructure construction | Y | Auburn                        |
| <b>Continental Automotive Inc.</b> | Manufacturing  | Inverter & Converter                          |   | San Jose                      |
| <b>CoorsTek</b>                    | Manufacturing  | Battery Raw Material                          |   | Vista                         |
| <b>Delta (Drivetrain)</b>          | Manufacturing  | Electric Motor & Drivetrain                   |   | Eastvale, Fremont, San Diego  |
| <b>Delta (EV Charging)</b>         | Infrastructure | Electrical system infrastructure construction | Y | Fremont                       |
| <b>Dow</b>                         | Manufacturing  | Battery Raw Material                          |   | Hayward, La Mirada            |
| <b>Draexlemaier Components</b>     | Manufacturing  | Battery Pack Production                       |   | Livermore                     |
| <b>Einride</b>                     | Manufacturing  | Vehicle Assembly                              |   | Palo Alto                     |
| <b>Electriphi</b>                  | Infrastructure | Software                                      | Y | San Francisco                 |
| <b>ENC</b>                         | Manufacturing  | Vehicle Assembly                              | Y | Riverside                     |
| <b>Endera Motors</b>               | Manufacturing  | Vehicle Assembly                              | Y | San Diego                     |
| <b>Endera Motors (Charging)</b>    | Infrastructure | Electrical system infrastructure construction | Y | San Diego                     |
| <b>Enevate</b>                     | Manufacturing  | Battery Cell Production                       | Y | Irvine                        |
| <b>EV Connect</b>                  | Infrastructure | Software                                      | Y | El Segundo                    |
| <b>EV Safe Charge</b>              | Infrastructure | Infrastructure installation                   | Y | Los Angeles                   |
| <b>EVBox</b>                       | Infrastructure | Electrical system infrastructure construction |   | Los Angeles, San Francisco    |
| <b>EVGo</b>                        | Infrastructure | Electrical system infrastructure construction | Y | Los Angeles                   |
| <b>EVSolutions</b>                 | Infrastructure | Electrical system infrastructure construction | Y | Monrovia                      |
| <b>EVT Motors</b>                  | Manufacturing  | Vehicle Assembly                              | Y | Newport Beach                 |
| <b>Fluence</b>                     | Manufacturing  | Other electrical components                   |   | San Francisco                 |
| <b>Ford</b>                        | Manufacturing  | Vehicle Assembly                              |   | Palo Alto                     |
| <b>Freewire Technologies</b>       | Infrastructure | Electrical system infrastructure construction | Y | San Leandro                   |
| <b>Garrett</b>                     | Manufacturing  | Electric Motor & Drivetrain                   |   | Torrance                      |
| <b>Gillig</b>                      | Manufacturing  | Vehicle Assembly                              |   | Hayward, Livermore            |
| <b>Green Power</b>                 | Manufacturing  | Vehicle Assembly                              |   | Porterville, Rancho Cucamonga |
| <b>Greenlots</b>                   | Infrastructure | Electrical system infrastructure construction | Y | Los Angeles                   |
| <b>Hummingbird EV</b>              | Manufacturing  | Vehicle Assembly                              | Y | Livermore                     |
| <b>In-Charge Energy</b>            | Infrastructure | Infrastructure installation                   | Y | Santa Monica                  |

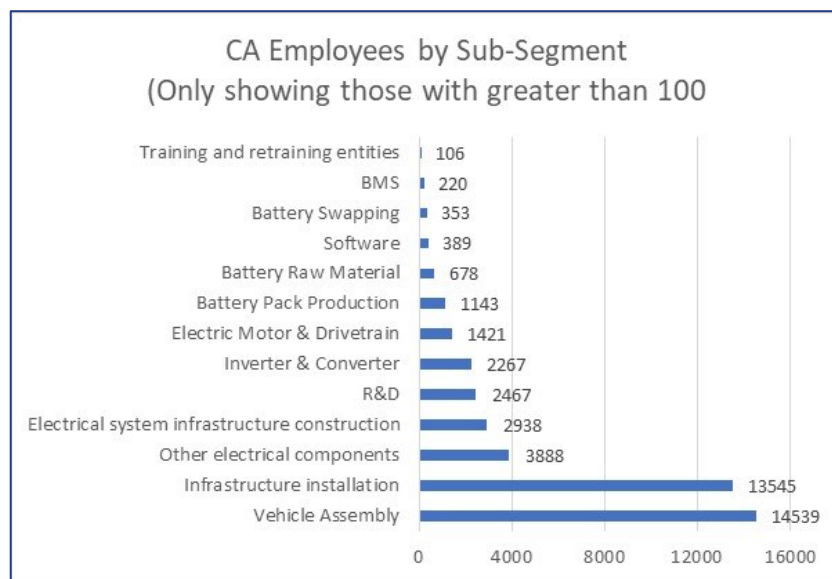
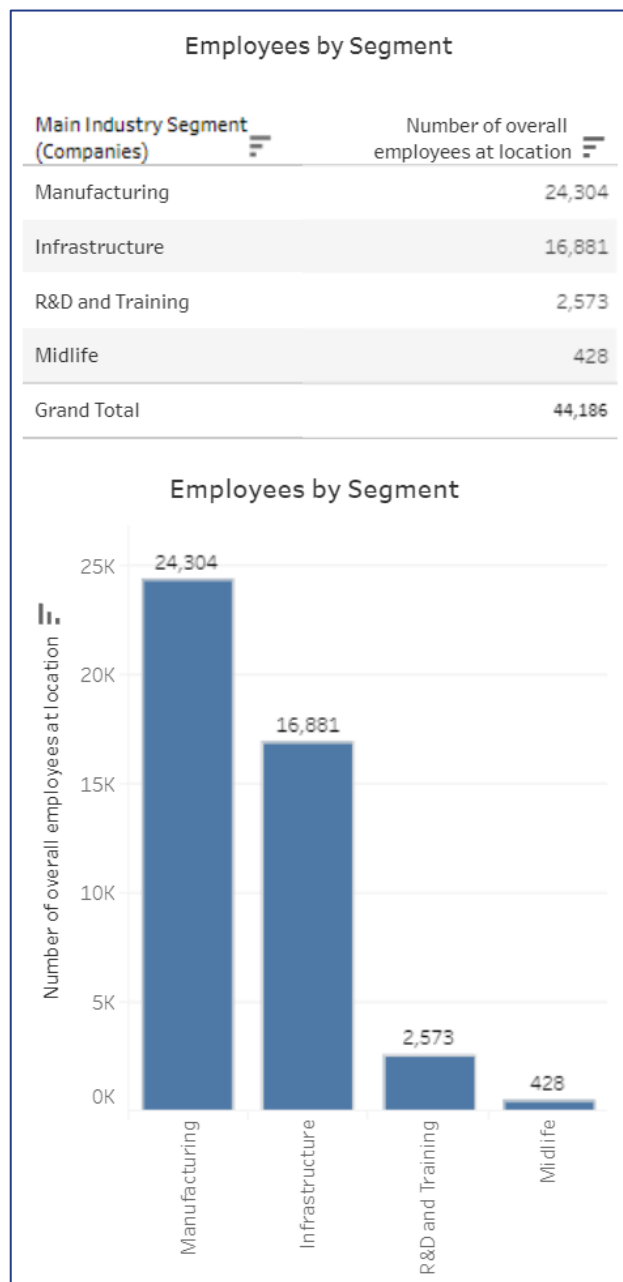
|                                    |                      |                                               |   |                                                                        |
|------------------------------------|----------------------|-----------------------------------------------|---|------------------------------------------------------------------------|
| <b>Infineon Technologies</b>       | Manufacturing        | Other electrical components                   | Y | El Segundo, Milpitas, San Jose, Temecula                               |
| <b>Innogy eMobility</b>            | Infrastructure       | Electrical system infrastructure construction | Y | Irvine                                                                 |
| <b>Keysight Technologies</b>       | R&D and Training     | R&D                                           |   | Roseville, Santa Clara, Santa Rosa                                     |
| <b>Kitu Systems</b>                | Infrastructure       | Software                                      | Y | San Diego                                                              |
| <b>Liberty Access Technologies</b> | Infrastructure       | Infrastructure installation                   | Y | Santa Barbara                                                          |
| <b>Littelfuse</b>                  | Manufacturing        | Other electrical components                   |   | Aliso Viejo, Fremont, Long Beach, Milpitas, Orange                     |
| <b>Mahle</b>                       | Manufacturing        | Electric Motor & Drivetrain                   |   | Bell                                                                   |
| <b>Maxwell</b>                     | Manufacturing        | Battery Pack Production                       | Y | San Diego                                                              |
| <b>Meritor</b>                     | Manufacturing        | Electric Motor & Drivetrain                   |   | Escondido                                                              |
| <b>Metlabs</b>                     | R&D and Training     | R&D                                           |   | Santa Clara, Union City                                                |
| <b>Microchip Technology</b>        | Manufacturing        | Other electrical components                   |   | Aliso Viejo, Garden Grove, Roseville, San Jose, Santa Clara, Sunnyvale |
| <b>Millbrook</b>                   | R&D and Training     | R&D                                           |   | Hayward                                                                |
| <b>Mitsubishi Electric</b>         | Manufacturing        | Other electrical components                   |   | Mountain View                                                          |
| <b>Mitsubishi Materials</b>        | Manufacturing        | Battery Raw Material                          |   | Costa Mesa                                                             |
| <b>Monarch Tractor</b>             | Manufacturing        | Vehicle Assembly                              | Y | Livermore                                                              |
| <b>Motiv Power Systems</b>         | Manufacturing        | Body Manufacturing                            | Y | Foster City, Hayward                                                   |
| <b>MP Materials</b>                | Manufacturing        | Battery Raw Material                          |   | Mountain Pass                                                          |
| <b>National Instruments</b>        | R&D and Training     | R&D                                           |   | Santa Clara                                                            |
| <b>NH Research</b>                 | R&D and Training     | R&D                                           | Y | Irvine                                                                 |
| <b>Nichia</b>                      | Manufacturing        | Battery Raw Material                          |   | Cupertino, Long Beach                                                  |
| <b>Nio</b>                         | Midlife              | Battery Swapping                              |   | San Jose                                                               |
| <b>NTS</b>                         | R&D and Training     | R&D                                           | Y | Anaheim, Fullerton                                                     |
| <b>Nuvve</b>                       | Infrastructure       | Infrastructure installation                   | Y | San Diego                                                              |
| <b>Pacific Gas &amp; Electric</b>  | Infrastructure       | Infrastructure installation                   | Y | Oakland                                                                |
| <b>Penske Corp</b>                 | Midlife and Training | Vehicle leasing and testing                   | N | Ontario                                                                |
| <b>Phihong</b>                     | Infrastructure       | Electrical system infrastructure construction | Y | Fremont                                                                |
| <b>Phoenix Motor Cars</b>          | Manufacturing        | Vehicle Assembly                              | Y | Ontario                                                                |

|                                                    |                  |                                               |   |                                     |
|----------------------------------------------------|------------------|-----------------------------------------------|---|-------------------------------------|
| <b>Plug In America</b>                             | R&D and Training | Training and retraining entities              | Y | Los Angeles                         |
| <b>PowerFlex Systems</b>                           | Infrastructure   | Infrastructure installation                   | Y | Los Altos                           |
| <b>Proterra</b>                                    | Manufacturing    | Vehicle Assembly                              | Y | Burlingame, City of Industry        |
| <b>QuantumScape Corp</b>                           | Manufacturing    | Battery Pack Production                       | Y | San Jose                            |
| <b>Recargo</b>                                     | Infrastructure   | Software                                      | Y | El Segundo                          |
| <b>Renesas</b>                                     | Manufacturing    | Battery Management Systems                    | Y | Milpitas, San Jose                  |
| <b>Retriev Technologies</b>                        | Midlife          | Battery Recycling                             |   | Anaheim                             |
| <b>Rivian</b>                                      | Manufacturing    | Vehicle Assembly                              |   | Carson, Irvine, San Jose            |
| <b>Romeo Power</b>                                 | Manufacturing    | Battery Pack Production                       | Y | Vernon                              |
| <b>SAE International</b>                           | R&D and Training | Training and retraining entities              |   | Palo Alto                           |
| <b>Samsung SDI</b>                                 | Manufacturing    | Battery Pack Production                       |   | San Jose                            |
| <b>San Diego Gas &amp; Electric</b>                | Infrastructure   | Infrastructure installation                   | Y | San Diego                           |
| <b>SEA Electric</b>                                | Manufacturing    | Electric Motor & Drivetrain                   | Y | Torrance                            |
| <b>Sensata</b>                                     | Manufacturing    | Other electrical components                   |   | Carpenteria, Thousand Oaks, Vista   |
| <b>Siemens</b>                                     | Infrastructure   | Electrical system infrastructure construction |   | Los Angeles                         |
| <b>Sila Nanotechnologies</b>                       | Manufacturing    | Battery Raw Material                          | Y | Alameda                             |
| <b>SolecTrac</b>                                   | Manufacturing    | Vehicle Assembly                              | Y | Santa Rosa                          |
| <b>Solvay</b>                                      | Manufacturing    | Battery Raw Material                          |   | Long Beach                          |
| <b>Southern California Edison</b>                  | Infrastructure   | Infrastructure installation                   | Y | Rosemead                            |
| <b>Stable Auto</b>                                 | Infrastructure   | Software                                      | Y | San Francisco                       |
| <b>STMicroelectronics</b>                          | Manufacturing    | Other electrical components                   |   | Laguna Niguel, Santa Clara          |
| <b>Tellus Power Green</b>                          | Infrastructure   | Electrical system infrastructure construction | Y | Irvine, Lake Forest                 |
| <b>Tesla (Trucks)</b>                              | Manufacturing    | Vehicle Assembly                              | Y | Fremont                             |
| <b>The Lion Electric Company</b>                   | Manufacturing    | Vehicle Assembly                              | Y | Sacramento                          |
| <b>TI</b>                                          | Manufacturing    | Inverter & Converter                          |   | Los Angeles, San Diego, Santa Clara |
| <b>Toshiba America Electronic Components, Inc.</b> | Manufacturing    | Other electrical components                   | Y | Irvine, San Jose                    |
| <b>Tritium</b>                                     | Infrastructure   | Electrical system infrastructure construction |   | Los Angeles, Torrance               |

|                                        |                  |                                               |   |                                                   |
|----------------------------------------|------------------|-----------------------------------------------|---|---------------------------------------------------|
| <b>TSMC</b>                            | Manufacturing    | Other electrical components                   |   | San Jose                                          |
| <b>TUV Rheinland</b>                   | R&D and Training | R&D                                           |   | Fremont, Pleasanton                               |
| <b>TXC Technology Inc</b>              | Manufacturing    | Inverter & Converter                          |   | Brea                                              |
| <b>US Hybrid</b>                       | Manufacturing    | Electric Motor & Drivetrain                   | Y | Torrance                                          |
| <b>Valeo</b>                           | Manufacturing    | Electric Motor & Drivetrain                   |   | San Mateo                                         |
| <b>Vector Informatik</b>               | R&D and Training | R&D                                           |   | San Mateo                                         |
| <b>Velocity Vehicle Group</b>          | Midlife          | Resale Dealerships                            | Y | Whittier                                          |
| <b>Video Voice Data Communications</b> | Infrastructure   | Infrastructure upgrades/maintenance           |   | El Centro, Indio, Los Angeles, Ontario, San Diego |
| <b>Volta</b>                           | Infrastructure   | Electrical system infrastructure construction | Y | San Francisco                                     |
| <b>Volvo Lights</b>                    | R&D and Training | Training and retraining entities              |   | San Bernardino, Whittier                          |
| <b>Wallbox</b>                         | Infrastructure   | Electrical system infrastructure construction |   | Mountain View                                     |
| <b>Weavegrid</b>                       | Infrastructure   | Software                                      | Y | San Francisco                                     |
| <b>Wrightspeed</b>                     | Manufacturing    | Electric Motor & Drivetrain                   | Y | Alameda                                           |
| <b>XL Fleet</b>                        | Midlife          | Vehicle Retrofitting                          |   | Foothill Ranch                                    |
| <b>XOS Trucks</b>                      | Manufacturing    | Vehicle Assembly                              | Y | Los Angeles                                       |
| <b>Zero Emission Propulsion System</b> | Manufacturing    | Electric Motor & Drivetrain                   |   | Alameda, Riverside                                |
| <b>Ztractor</b>                        | Manufacturing    | Vehicle Assembly                              | Y | Palo Alto                                         |

Across the 128 unique companies found to be located at 181 distinct sites in California, the study identified more than 44,000 ZEV supply chain employees work in manufacturing and infrastructure, with more than 14,000 workers involved in vehicle assembly and over 13,000 working in infrastructure installation.

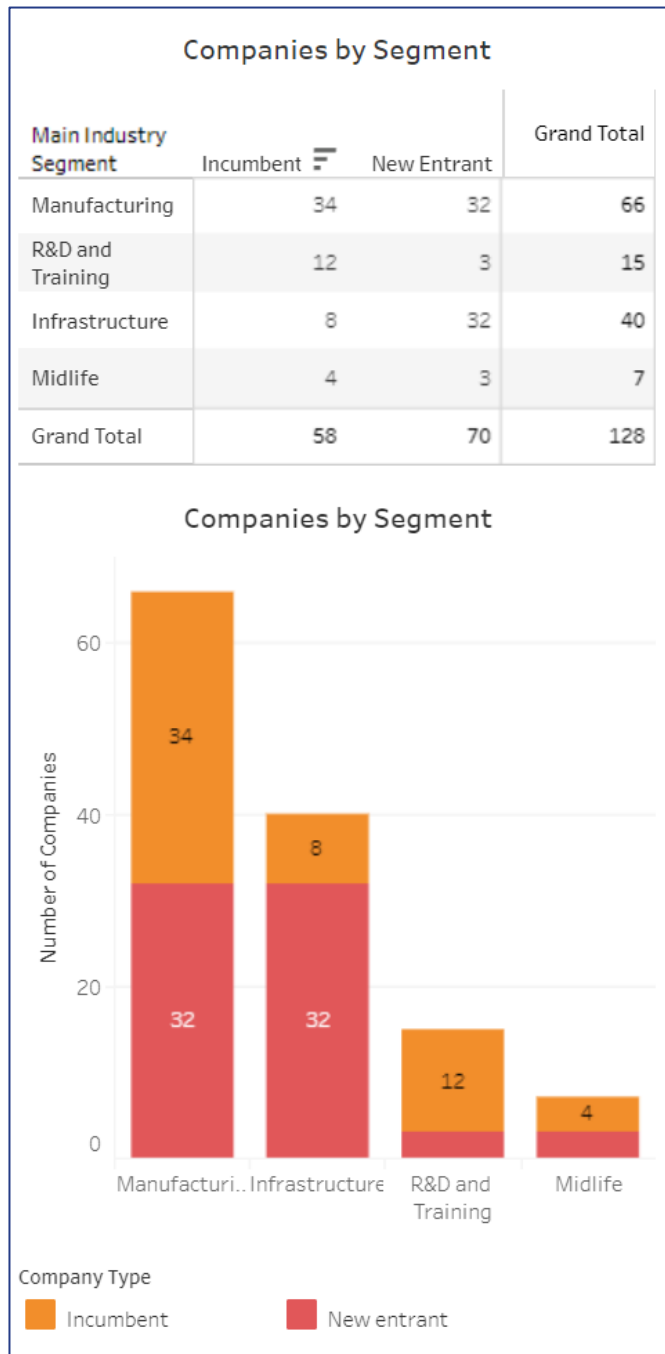
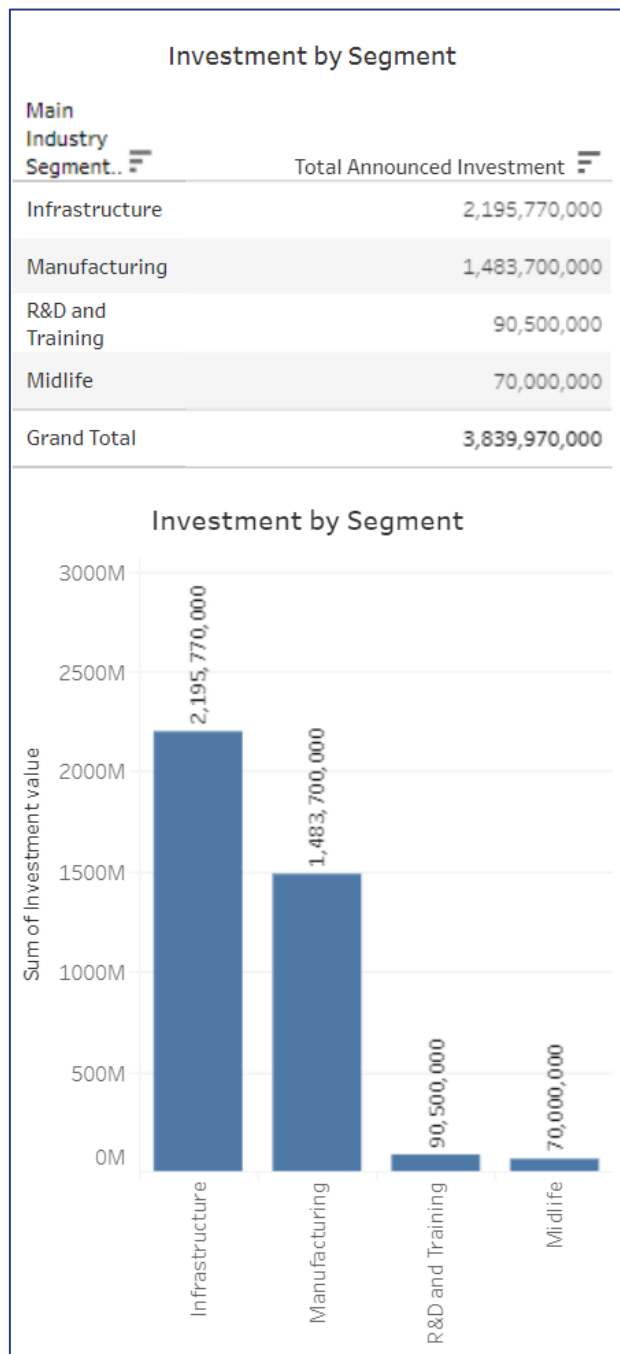
*Figures 4 and 5: Number of Employees in Each Segment (left) and in each Sub-segment with greater than 100 employees (right) in California*



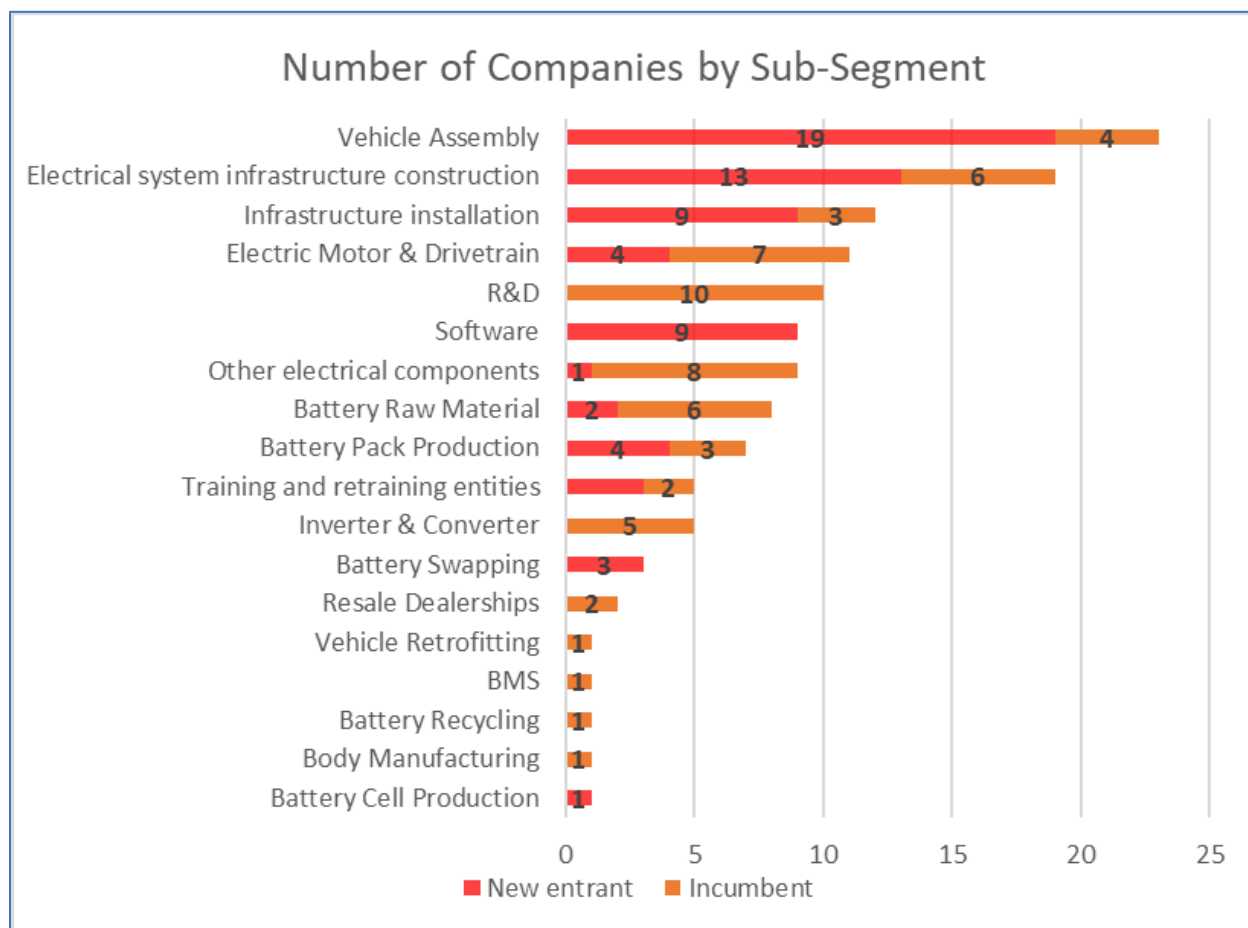


This study identifies over \$3.8 billion in announced investments across the California MHD ZEV industry. Nearly \$2 billion of that total is attributable to infrastructure installation, primarily through the expenditure of money by the state's three investor-owned utilities (IOUs), followed by \$1.5 billion invested in vehicle manufacturing, primarily focused in the vehicle assembly sub-sector.

*Figures 6 and 7: Amount of Announced California Investments and Unique Companies by Industry Segment*



Of the 128 distinct companies with locations in California, the manufacturing sector is evenly split between incumbents (existing companies) and new entrants, and the infrastructure sector is dominated by new entrants. Of the companies identified, over 40 percent are involved in vehicle assembly.

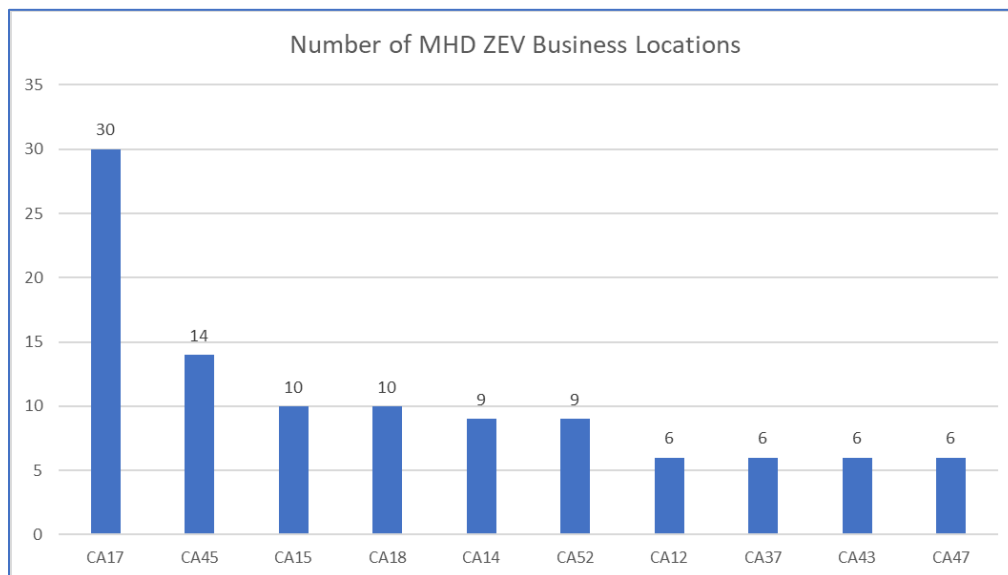


With a strong foundation in vehicle assembly and manufacturing, and ambitious investments in MHD ZEV infrastructure by charging companies and utilities, the MDH ZEV industry in California is well situated to grow as part of the expanding national MHD ZEV economy. The California manufacturing and infrastructure sectors stand ready to capitalize on zero-emission favorable policies that will foster job growth.

## Congressional District Analysis

Below, this study provides an analysis of the 181 business locations identified in this study. The results indicate that MHD ZEV company locations are located in at least 39 different congressional districts across California. Many of the districts with the highest number of locations—CA-17, CA-18, and CA-15—are located in the Bay Area, though Orange County’s CA-45 and San Diego County’s CA-52 are also leaders.

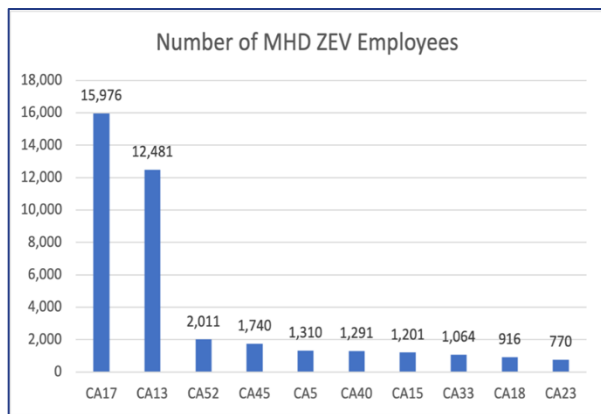
*Figure 9 and Table 2: Number of Business Locations in the top 10 Congressional Districts, with location identifiers*



| CA Congressional District Counties |                                                |
|------------------------------------|------------------------------------------------|
| CA-17                              | Santa Clara and Alameda Counties               |
| CA-45                              | Orange County                                  |
| CA-15                              | Alameda and Contra Costa Counties              |
| CA-18                              | San Mateo, Santa Clara and Santa Cruz Counties |
| CA-14                              | San Francisco and San Mateo Counties           |
| CA-52                              | San Diego County                               |
| CA-12                              | San Francisco County                           |
| CA-37                              | Santa Clara and Alameda Counties               |
| CA-43                              | Los Angeles County                             |
| CA-47                              | Orange County                                  |

The districts with the highest number of employees are also split between the Bay Area, Orange County, and San Diego County.

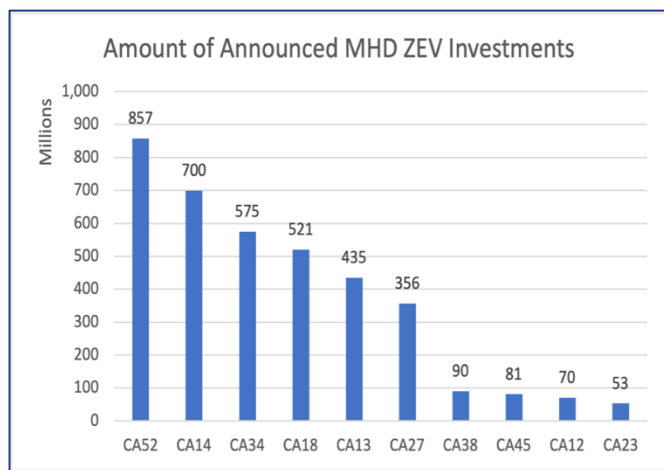
*Figure 10 and Table 3: Number of Employees in the top 10 Congressional Districts, with location identifiers*



| CA Congressional District Counties |                                                |
|------------------------------------|------------------------------------------------|
| CA-17                              | Santa Clara and Alameda Counties               |
| CA-13                              | Alameda County                                 |
| CA-52                              | San Diego County                               |
| CA-45                              | Orange County                                  |
| CA-5                               | Wine Country and East Bay                      |
| CA-40                              | Los Angeles County                             |
| CA-15                              | Alameda and Contra Costa Counties              |
| CA-33                              | Los Angeles County                             |
| CA-18                              | San Mateo, Santa Clara and Santa Cruz Counties |
| CA-23                              | Kern and Tulare Counties                       |

Most announced MHD ZEV investment is concentrated in districts in San Diego, Los Angeles, and the Bay Area.

*Figure 11 and Table 4: Amount of Announced Investment (in Millions) in the top 10 Congressional Districts, with location identifiers*



| CA Congressional District Counties |                                                |
|------------------------------------|------------------------------------------------|
| CA-52                              | San Diego County                               |
| CA-14                              | San Francisco and San Mateo Counties           |
| CA-34                              | Los Angeles County                             |
| CA-18                              | San Mateo, Santa Clara and Santa Cruz Counties |
| CA-13                              | Alameda County                                 |
| CA-27                              | Los Angeles and San Bernardino Counties        |
| CA-38                              | Los Angeles and Orange Counties                |
| CA-45                              | Orange County                                  |
| CA-12                              | San Francisco County                           |
| CA-23                              | Kern and Tulare Counties                       |

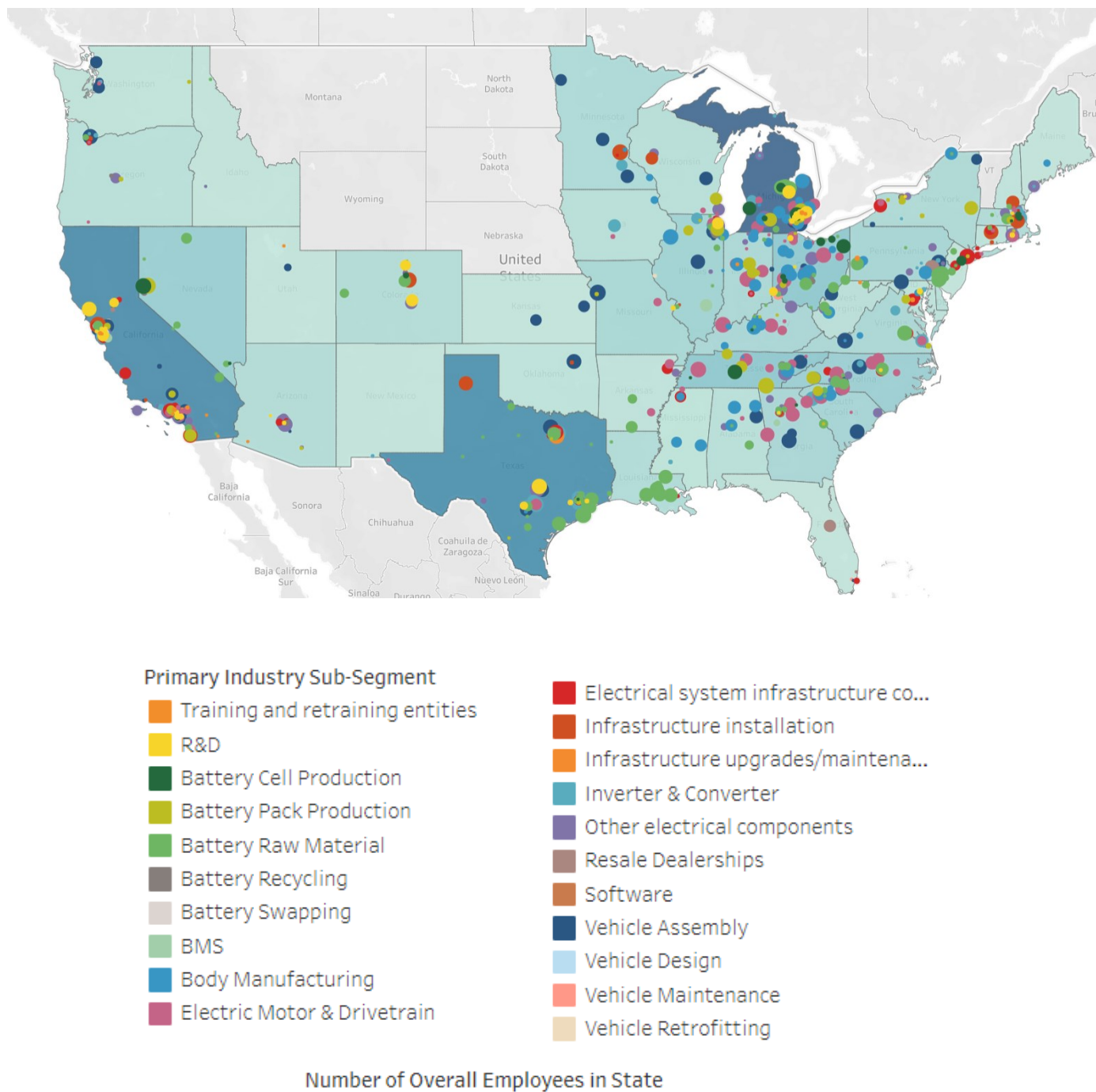
# State of the National Market

This study provides evidence that significant investment and growth in the MHD ZEV industry is already taking place. New entrant companies are materializing and competing with incumbents, who are also shifting their manufacturing priorities to focus on ZEVs. As the data captured herein on investments, employment, and corporate locations is viewed alongside the regular release of information announcing rapid technological developments and commitments to electrify major fleets, the pace of change in the industry must be viewed as dramatic, with a large potential for economic gain across the landscape.

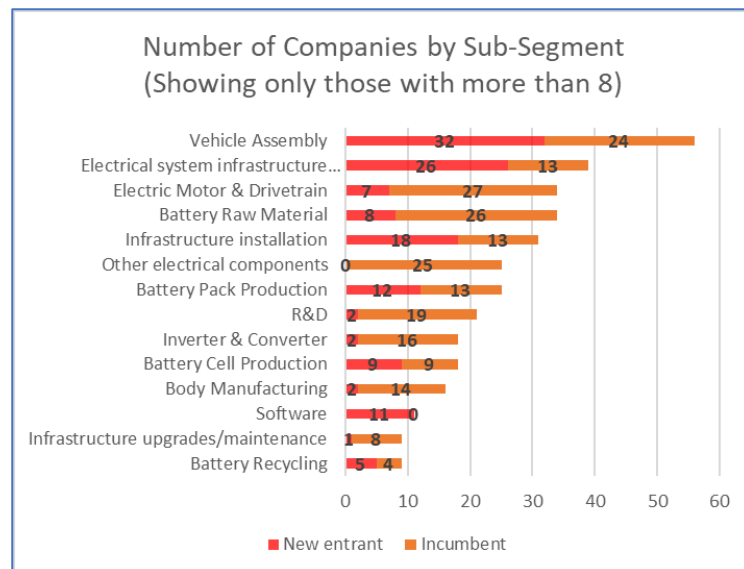
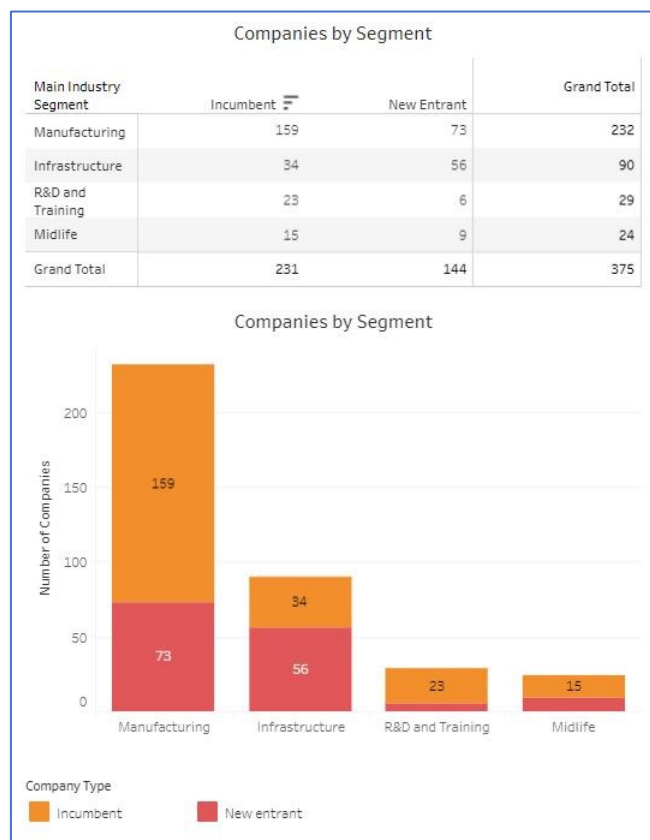
## National assessment of companies and locations

At least forty-four states have companies involved in the MHD ZEV market. This analysis identifies at least 375 distinct companies linked to commercial MHD ZEV manufacturing, infrastructure, and midlife operating at over 996 locations nationwide. Of the 375 companies identified, 232 (62%) percent are involved in manufacturing, 90 (24%) percent in infrastructure, 29 (8%) percent in R&D and training, and 24 (6%) percent offer midlife services such as maintenance and recycling. The largest sub-segment of companies is those involved in vehicle assembly, an arena equally crowded by incumbents and new entrants.

Figure 12: Map of all companies found in the study



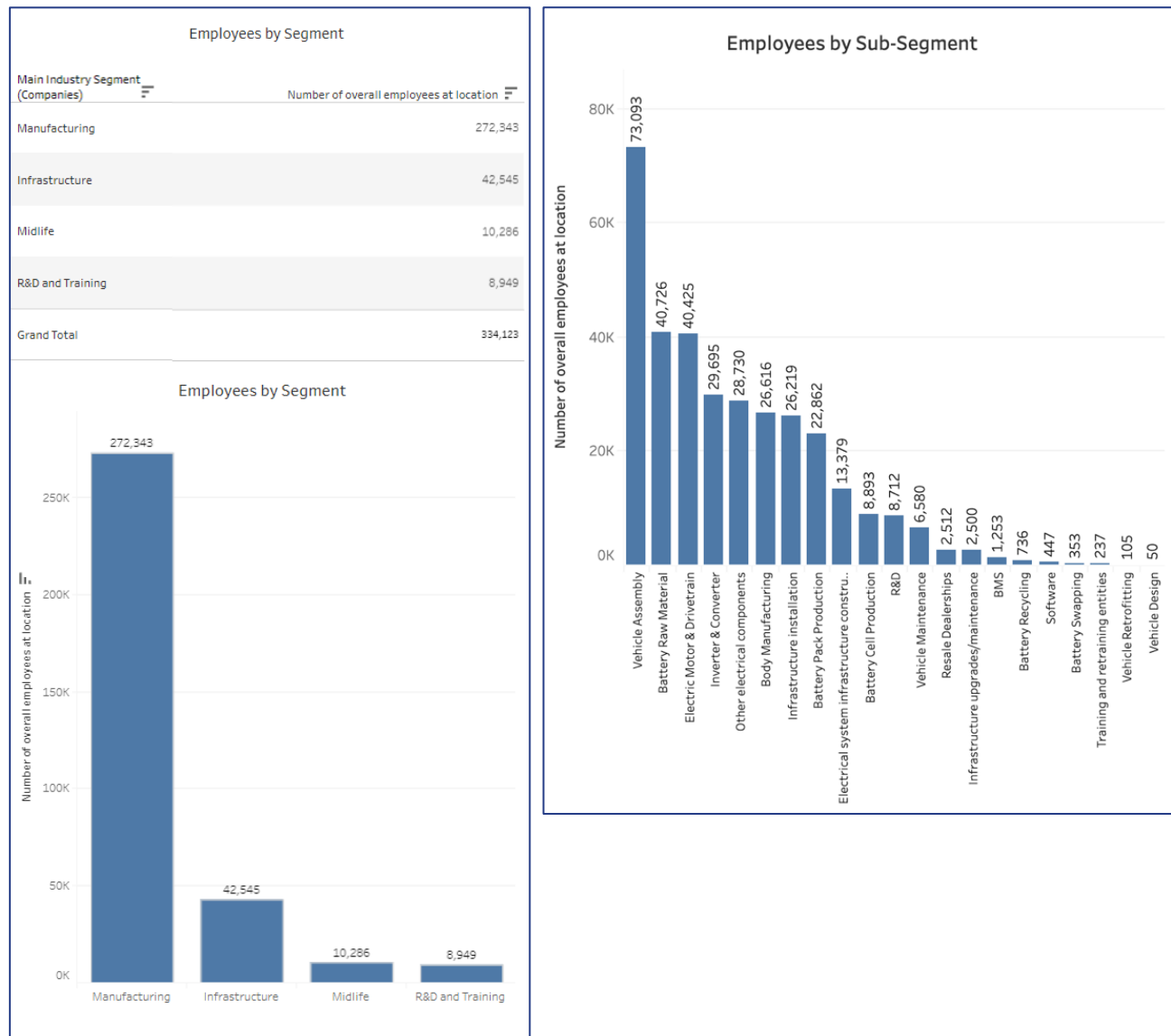
Figures 13 and 14: Nationwide Number of Companies in Each Segment (left) and Each Sub-segment with 8 or more companies(right)



## Assessment of MHD ZEV Employees Throughout the Supply Chain

Companies operating in the MHD ZEV supply chain currently support a large number of jobs, many of which are well-paying, and that number is expected to rise. Nationwide, this study found over 334,000 employees working at US locations involved in the MHD ZEV supply chain. Most employees work at companies involved in manufacturing. Once again, vehicle assembly holds the largest share of employees of any sub-segment.

*Figures 15 and 16: Nationwide Number of Employees by Segment (Left) and Sub-segment (Right)*



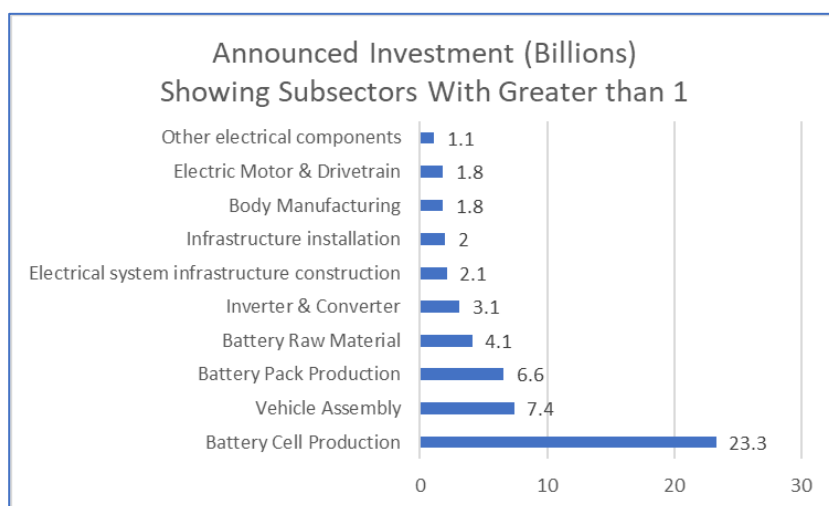
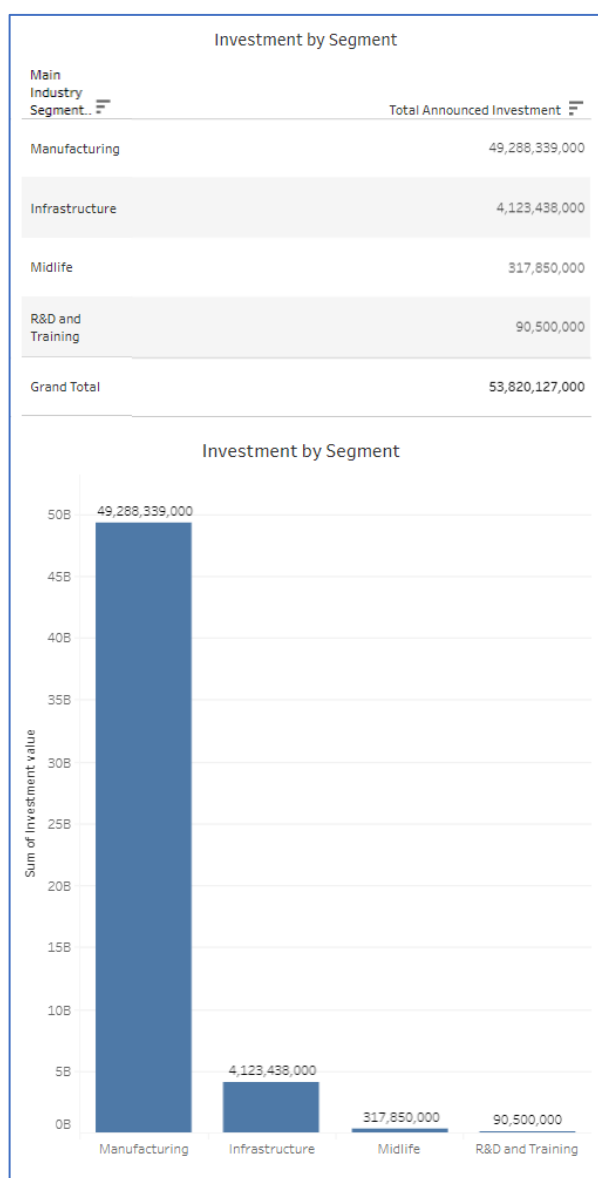


## Assessment of Announced Investments in MHD ZEVs

Across the sectors evaluated, this study found the transition to MHD ZEV, primarily associated with electrification of the MHD market, has come by way of 53.8 billion in announced investments, with likely much more being made without announcements.

The manufacturing segment leads all others in investment value by far, with over \$ 49 billion announced. Most investment is related to battery manufacturing and vehicle assembly. 22 of the 44 total states identified as having companies in the MDV ZEV supply chain feature over 100 million in announced corporate investments.

*Figures 17 and 18: Nationwide Announced Investments by Segment (Left) and Sub-segment For Those With Greater Than \$1 billion (Right)*



## National Supply Chain Profiles

The segments of the supply chain on which this analysis focuses are manufacturing, infrastructure, midlife, and research and development (R&D) and employee training (see definitions below). These segments are broken down further into sub-segments wherein companies are identified and employee numbers and investments are quantified across the states.

**Manufacturing:** companies responsible for creating various components of a MHD ZEV.

**Infrastructure:** companies that not only create ZEV charging infrastructure, but also directly engage in installation, construction, and upgrade/maintenance of MHD ZEV charging stations (level 2 chargers and higher), as well as software companies supporting charging.

**Midlife:** companies that engage in maintenance, retrofitting, resale, and battery recycling of MHD ZEVs.

**R&D:** companies engage in ZEV testing and EV platform design.

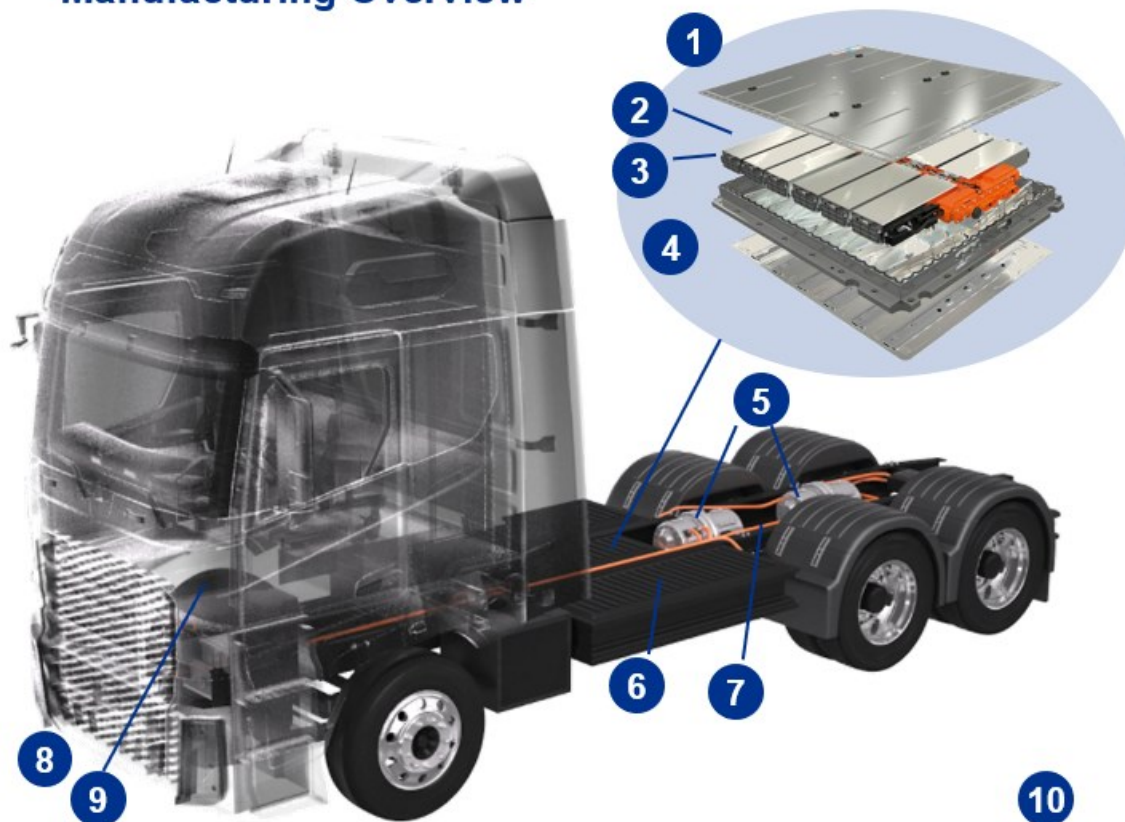
**Training:** institutions that provide EV job manufacturing trainings to dealer workforce

## Manufacturing

Many of the components that make up an MHD internal combustion engine (ICE) vehicle are the same as a ZEV. However, the key components that differentiate a ZEV that uses electric drive technology are the battery packs, the electric motor, the inverters and converters, along with other electrical parts. These various components make up the long list of sub-segments within the ZEV manufacturing segment of the supply chain.

Figure 19: Key Elements of an Electric Truck

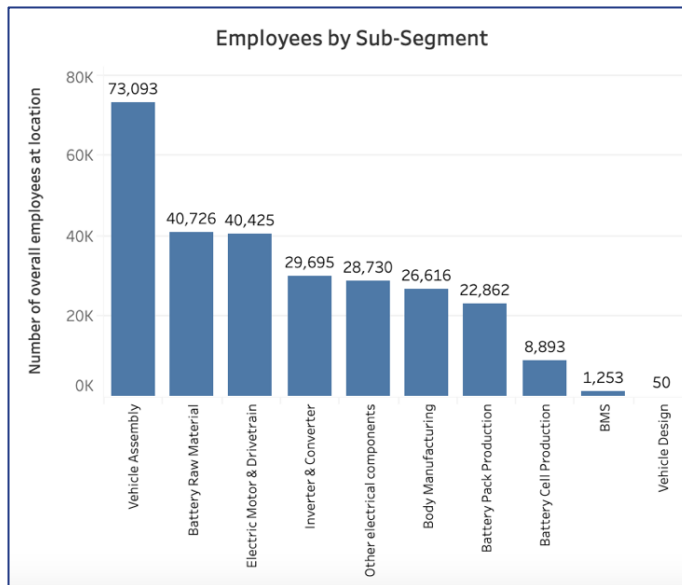
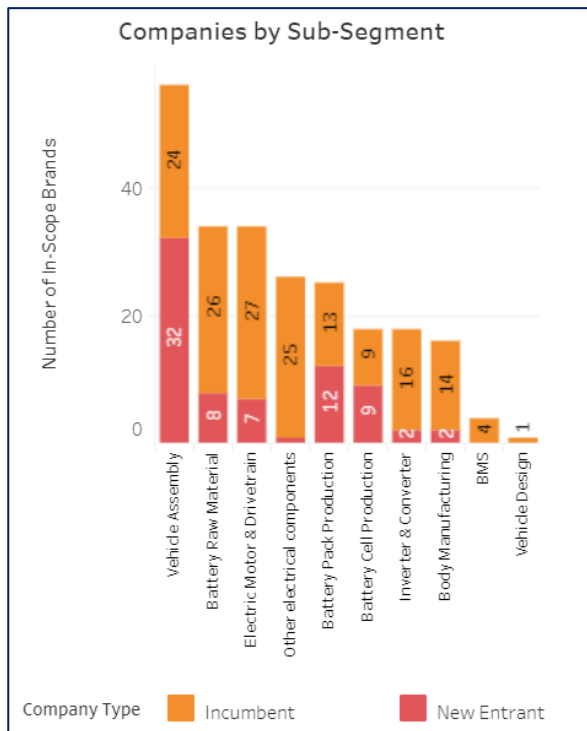
### Manufacturing Overview



| Sub-Segment                    | Description                                                                                                                                                            |
|--------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>1 Battery Packs</b>         | Battery pack through sorting of cells, assembly of modules and pack and BMS integration                                                                                |
| <b>2 Battery Raw Materials</b> | Base materials for cathodes, anodes and other components and refined metal chemicals                                                                                   |
| <b>3 Battery Cells</b>         | Cells made from manufacturing electrodes, assembling and finishing cells                                                                                               |
| <b>4 BMS</b>                   | Battery management system – controls battery and optimizes performance (circuit board, I/O software, control algorithms)                                               |
| <b>5 Electric motor</b>        | Electric traction motor or powertrain (incl. axles) for propulsion as well as regeneration (while breaking)                                                            |
| <b>6 Inverters/Converters</b>  | Inverters for DC to AC (for electric motor) and AC to DC for regenerative braking, Converters convert high-voltage DC power to lower voltage for other vehicle systems |
| <b>7 Other electrical</b>      | Controllers (regulating energy and thereby speed), onboard computers, chips, and high voltage harnesses                                                                |
| <b>8 Vehicle Design</b>        | Commercial ZEV design                                                                                                                                                  |
| <b>9 Body Manufacturing</b>    | Body structures and assemblies (e.g. frames, cab, hood, side rails, cross-members)                                                                                     |
| <b>10 Vehicle Assembly</b>     | Commercial ZEV assembly combining all systems                                                                                                                          |

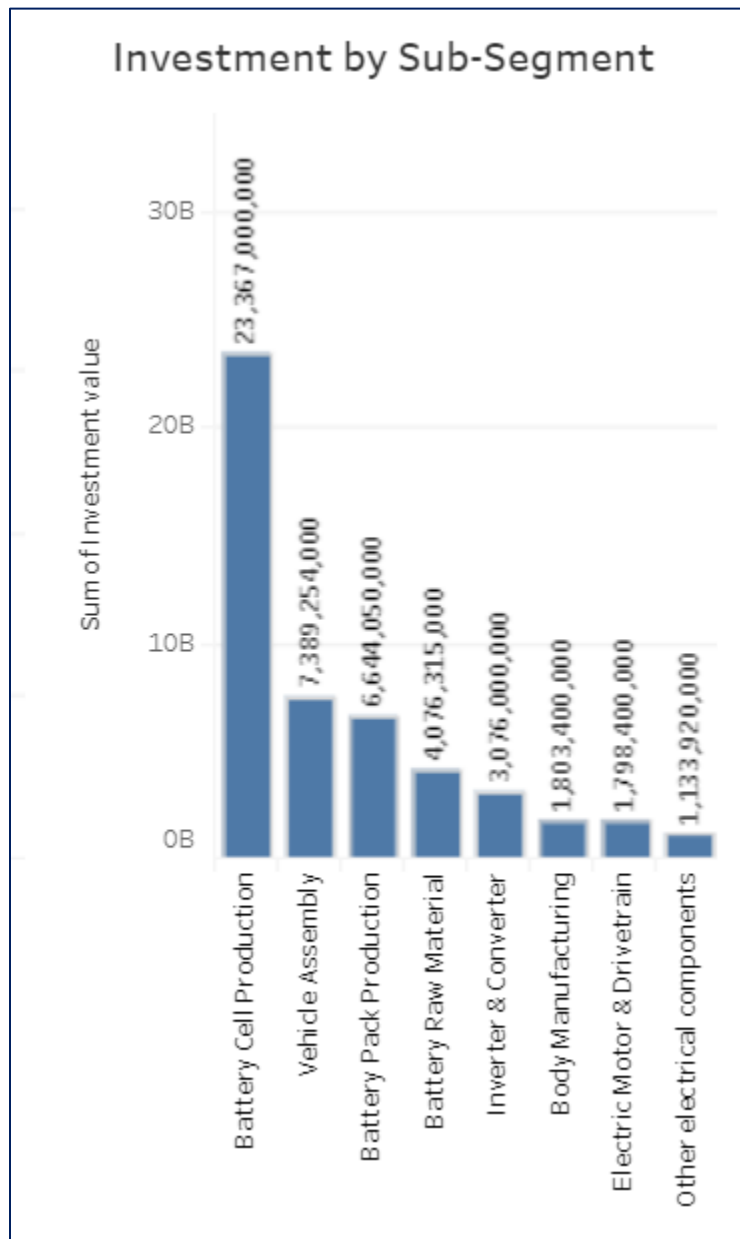
The MHD ZEV manufacturing segment is growing rapidly with 231 companies driven by 73 new entrants. These companies are estimated to employ approximately 272,000 employees to work on the manufacturing of MHD ZEVs. Most of this growth is occurring in the vehicle assembly, battery cell, and battery pack subsegments.

*Figures 20 and 21: Companies in Each Manufacturing Sub-segment (left) and Associated Employees (right)*



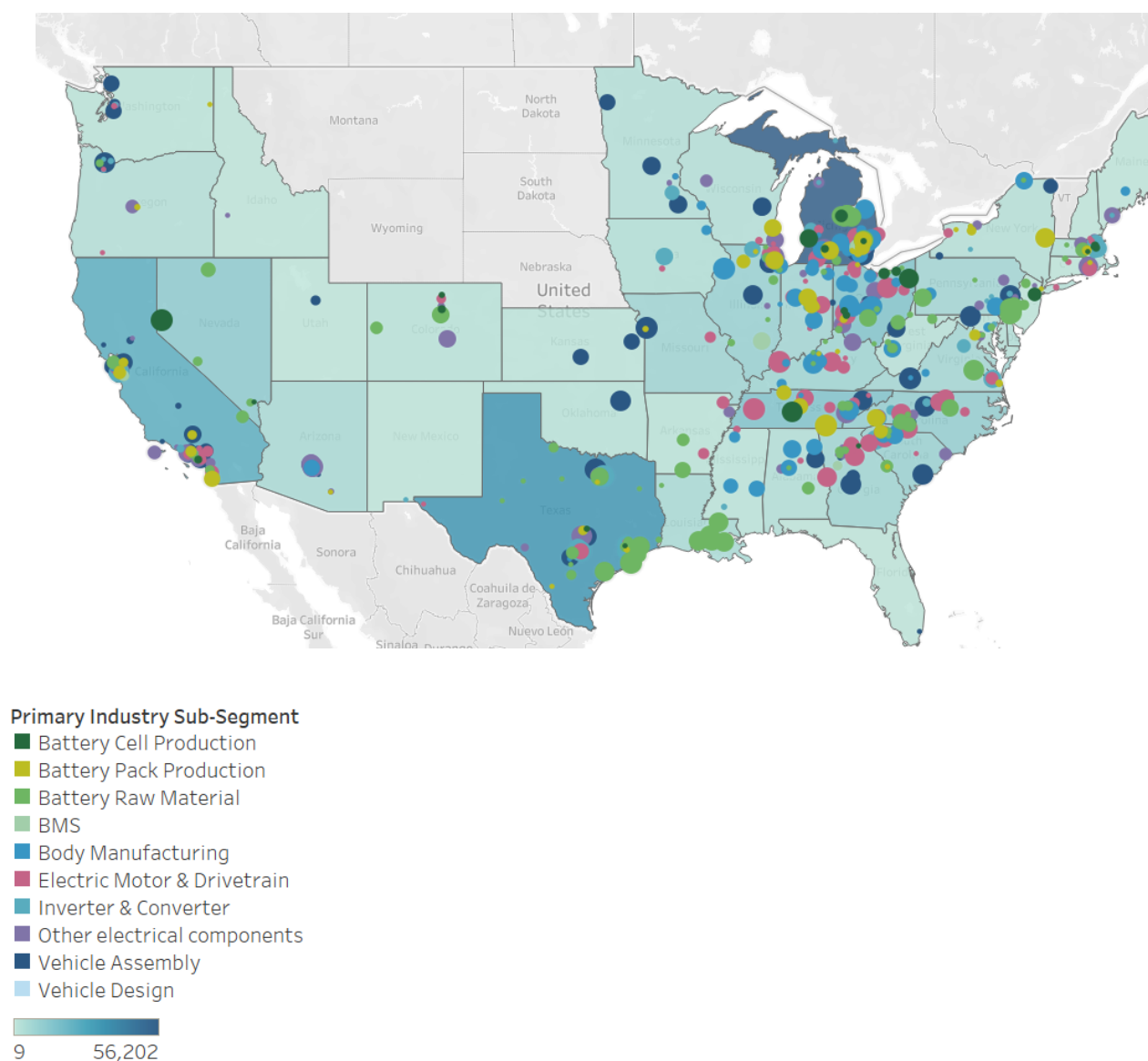
Driven by the companies involved in the sector, investments are taking place mainly in battery cell production at a level of \$23.3 billion, vehicle assembly at a level of \$7.4 billion, and battery pack production at a level of \$6.6 billion.

Figure 22: Announced Investment by Manufacturing Sub-segment



Most manufacturing employment is currently in California, Texas, and Michigan, with these three states covering 65 percent of the total manufacturing workforce. Based on the data collected, the high number of employees in the Midwest is driven by incumbents shifting their portfolio to support MHD ZEVs.

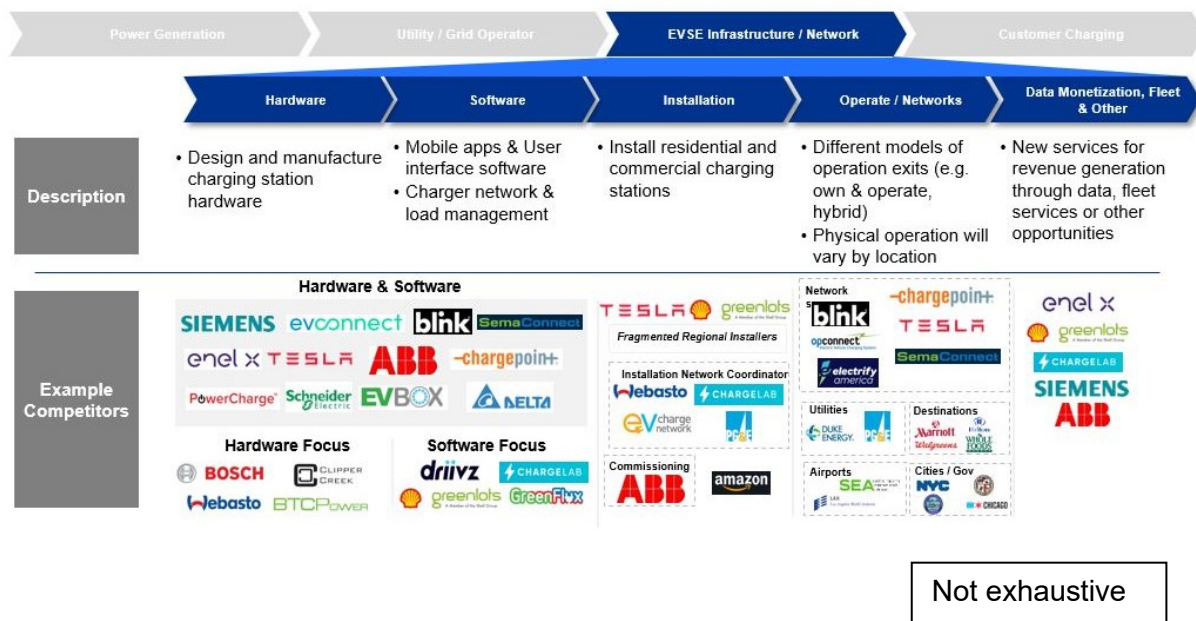
*Figure 23: Manufacturing Employment by State*



## Infrastructure

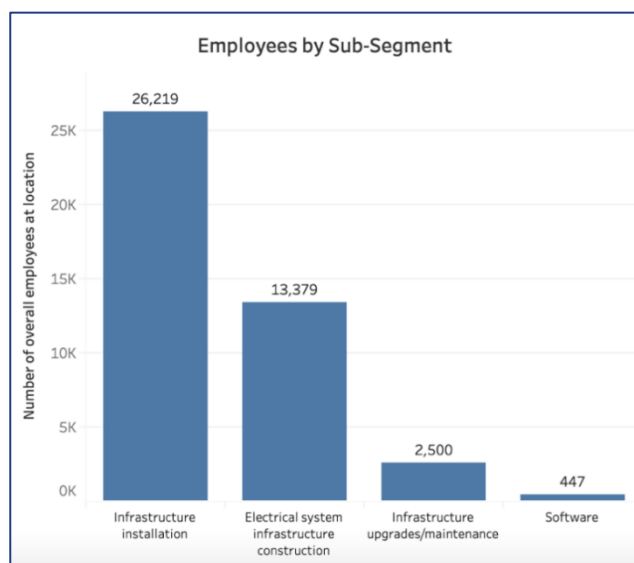
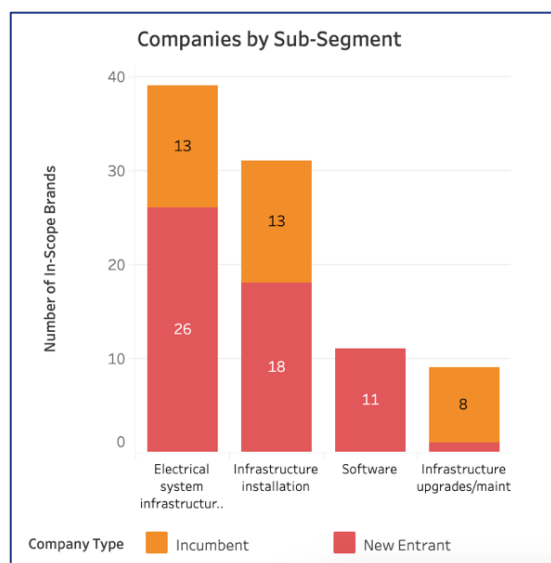
The MHD ZEV market cannot thrive without a robust infrastructure ecosystem to support electrification, and a spectrum of entities have been investing in the charging network. The electric vehicle supply equipment (EVSE) infrastructure can be broken down into five value chain segments, including hardware, software, installation, network operation, and new services (e.g., data monetization and fleet services).

Figure 24: EVSE Industry Description



Although the ZEV infrastructure segment is still in nascent stages, 90 companies are already participating in the space with a majority classified as new entrants - indicating that a widening array of companies are bringing new investments and solutions to charging to market at a quickening pace. Both utilities and electronics companies are some of the entities that are emerging as new entrants in the space. Overall, the study found employment of over 42,000 people in the U.S across the sector.

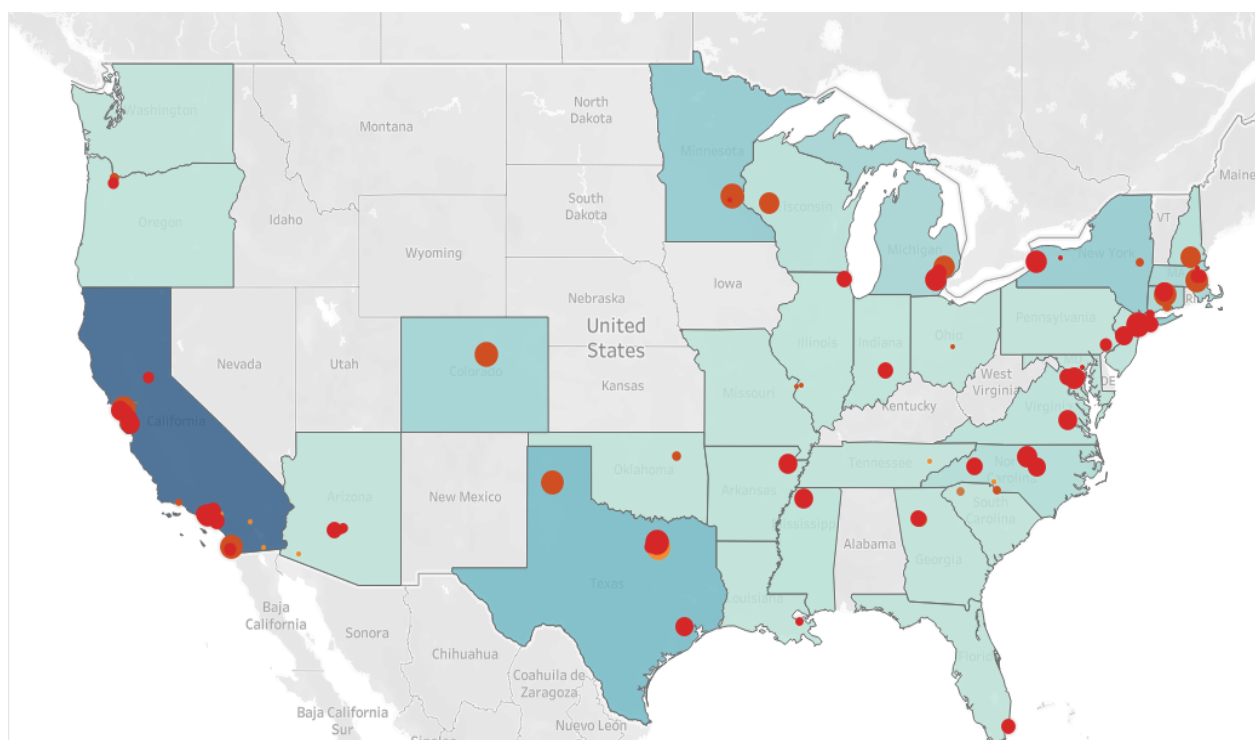
*Figures 25 and 26: Infrastructure Companies in Each Sub-Segment (left) and Associated Employees (right)*





Approximately 80 percent of entities in the space are domestic to the U.S., with the majority of employment located in California, and an array of companies along the Eastern Coast and Texas.

*Figure 27 Infrastructure Employment by State*



**Primary Industry Sub-Segment**

- Electrical system infrastructure construction
- Infrastructure installation
- Infrastructure upgrades/maintenance
- Software

**Number of Overall Employees in State**

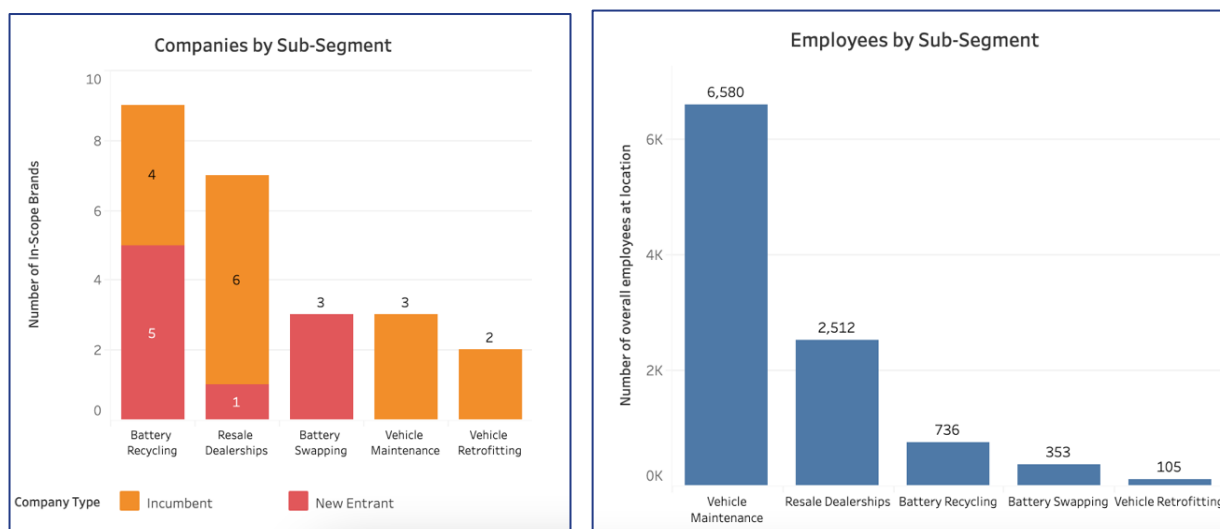


## Midlife

The midlife segment of the supply chain is comprised of companies engaged in maintenance, retrofitting, resale, and battery recycling of MHD ZEVs. As commercial ZEVs are just starting to enter the market, limited dedicated midlife locations exist, but major players including truck leasing companies are building up capabilities.

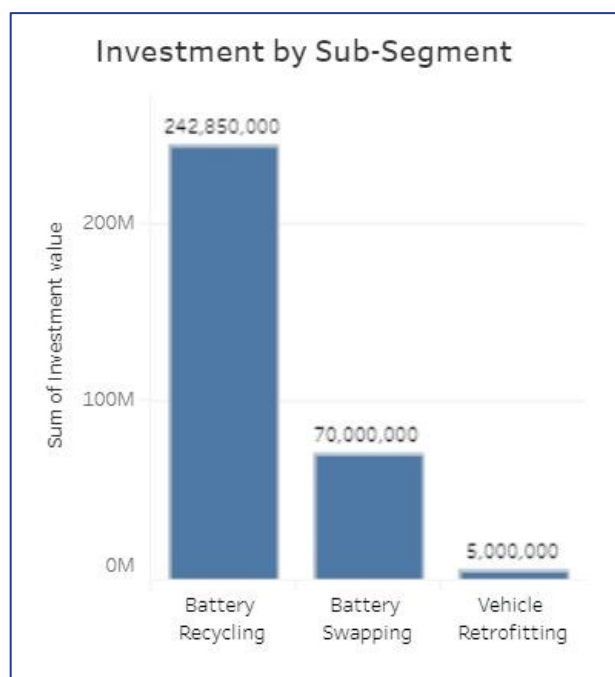
In addition to established battery manufacturers advancing their recycling capabilities (e.g. LG Chem, BASF, SK Innovation, Tesla, CATL), this segment includes major US recycling incumbent Retrieval Technologies and a few startups like Redwood Materials and Li-Cycle. Over 10,000 people are employed in this field in the U.S., and that number is expected rise as the ZEV industry grows.

*Figures 28 and 29: Midlife Companies in Each Sub-Segment (left) and Associated Employees (right)*



As more ZEVs hit the road, more investments will be made by dealers/OEMs and fleet managers, therefore improving the capabilities and possibilities for midlife, resale, and recycling. Major known investments currently total over \$267 million.

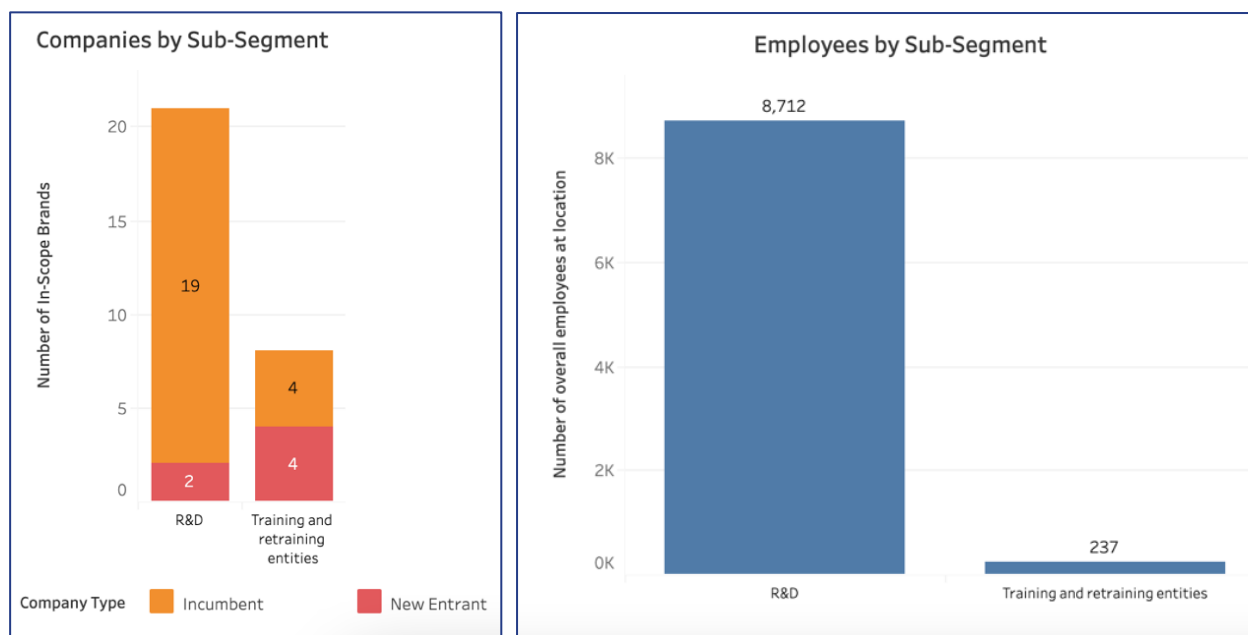
*Figure 30: Midlife Investment by Sub-segment*



## R&D and Employee Training

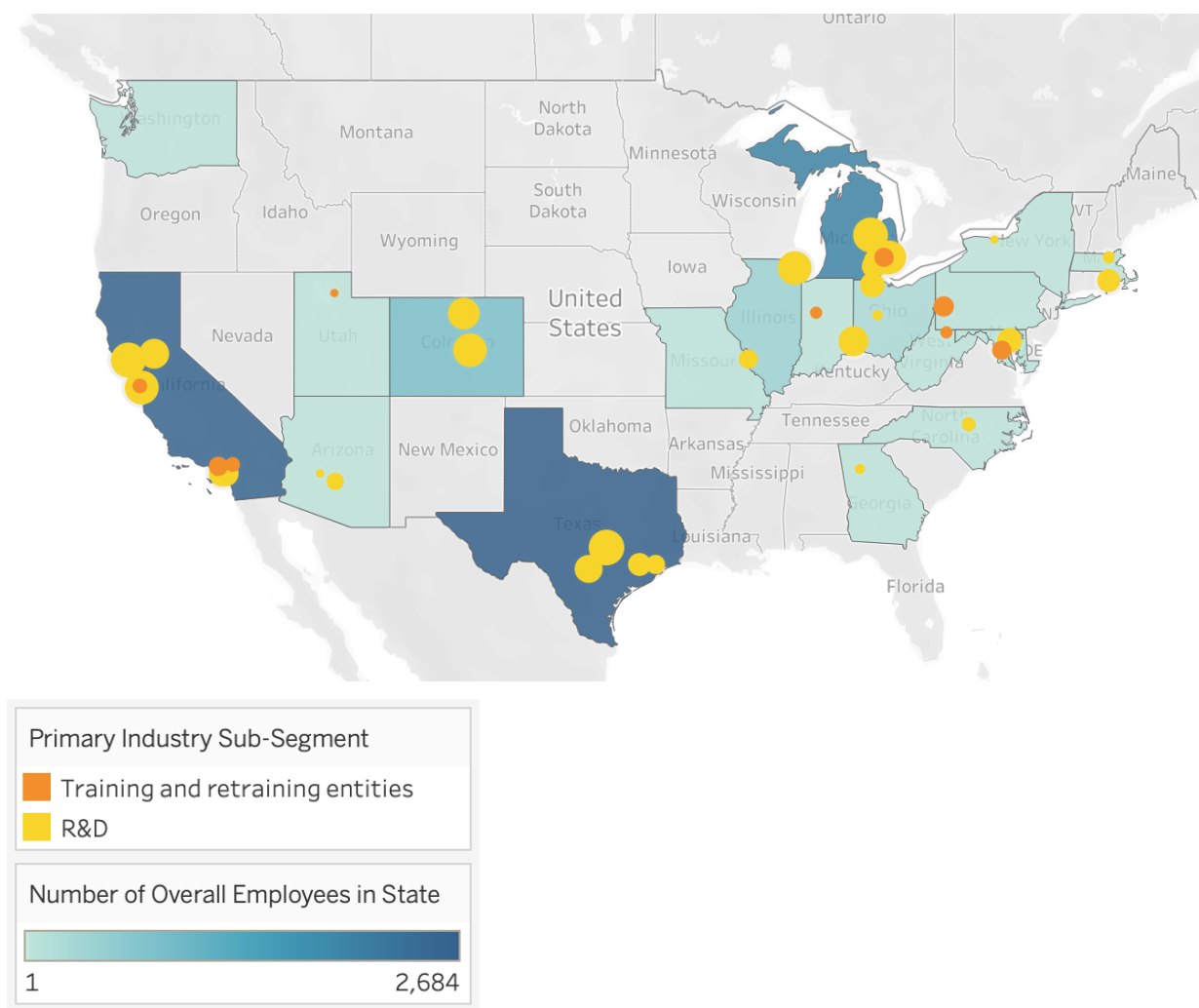
R&D companies are the behind-the-scenes innovators quietly leading the charge on vehicle electrification. These companies, many of them engineering firms, are engaged in EV testing (electric motor testing, battery testing, charging simulation, EMC, etc.) and ZEV platform design. Employee training companies are the entities ensuring that the transition happens as smoothly as possible, providing ZEV trainings to the dealer workforce. These trainings equip technicians with the skills to repair and maintain EVs and focus heavily on technology. There are almost 9,000 currently employed in the space in the U.S at 29 companies.

*Figures 32 and 33: Number of R&D and Employee Training Companies in Each Sub-Segment (left) and Associated Employees (right)*



R&D and testing facilities are located in California, Texas, Colorado, and the Midwest. Dedicated ZEV training and education is limited but gradually growing in California.

*Figure 34: R&D and Training Employment by State*



# The Way Forward

Companies in the zero-emission supply chain are present across the United States, and in over half of the U.S. Congressional Districts. California, a state that has extensive policies on zero emissions vehicle transportation and technological hubs in places like Silicon Valley and Los Angeles is leading in several metrics, such as number of companies and corporate headquarters.

To continue this rapid growth, a continued focus on durable state and federal public policy signals to

1. promote additional corporate investments,
2. ease the process of buying and operating vehicles, and
3. ensure that infrastructure can support swift development will be crucial for the sector moving forward.

Supply chain businesses were found in 44 separate states, with California and Michigan having the most. Furthermore, the analysis found over \$53 billion in announced investments across identified companies.

Widespread and sizeable announced investments are a clear signal of where the MHD ZEV industry is heading, and there is more to be gained from a market share and an employment perspective. This industry has the potential to increase both the number and geographical distribution of domestic EV jobs. Under the umbrella of ZEV manufacturing, there are already many different rapidly growing subfields such as battery cells, vehicle assembly, and vehicle design. Moreover, the jobs are being created across the entire country. As investment into domestic ZEV manufacturing increases, the distribution of these jobs will also spread more widely around the nation, leading to increases in job equity and equality.

In addition to economic and employment benefits, the electrification of MHD vehicles offers a plethora of environmental, public health, and economic benefits. Over their lifetime, ZEVs produce fewer emissions than vehicles powered by internal combustion engines, and as nations worldwide transition their electricity grids from fossil-fuels to renewables, the environmental benefits of ZEVs will only increase.

## Appendix

The following is a list of data sources used to assemble and analyze the data for this analysis

| Title (Linked if available)                                                 | Publisher               | Year | Segment(s) Covered            | Comment                                                                               |
|-----------------------------------------------------------------------------|-------------------------|------|-------------------------------|---------------------------------------------------------------------------------------|
| Automotive Supplier Consolidation Study 2020                                | PwC (Internal)          | 2021 | Manufacturing                 | Long list of automotive manufacturing suppliers; key data points (revenue, employees) |
| Economic potential of growing electric transportation in CA, NY, IL markets | AEE, BW Research        | 2021 | All                           | Select CA, NY, IL companies from each segment noted                                   |
| <a href="#">Battery Critical Materials Supply Chain</a>                     | US DoE                  | 2020 | Manufacturing                 | Sector overview                                                                       |
| Next-generation Battery Technology Report                                   | IHS Markit              | 2020 | Manufacturing                 | Battery cell and battery pack manufacturers                                           |
| <a href="#">Mineral Commodity Survey 2021</a>                               | U.S. Geological Survey  | 2021 | Manufacturing                 | Battery raw materials suppliers                                                       |
| <a href="#">State of the EV lithium-ion battery market</a>                  | Prescouter              | 2020 | Manufacturing                 | Battery raw materials suppliers, Battery cell and battery pack manufacturers          |
| <a href="#">EV Powertrain Market Research Report</a>                        | Market Research Future  | 2021 | Manufacturing                 | Electric motor and drivetrain players                                                 |
| <a href="#">Electric Motors for Electric Vehicle Market</a>                 | Mordor Intelligence     | 2020 | Manufacturing                 | Electric motor players                                                                |
| <a href="#">Electric Vehicle Power Inverter Market</a>                      | Mordor Intelligence     | 2020 | Manufacturing                 | EV Inverter players                                                                   |
| <a href="#">EV Market Status report</a>                                     | EDF / MJ Bradley        | 2021 | Manufacturing                 | Vehicle Assembly                                                                      |
| <a href="#">Top 71 Electric Car Startups</a>                                | Energy Startups dot Org | 2021 | Manufacturing, Infrastructure | Vehicle Assembly, EV Charging infrastructure players                                  |
| <a href="#">ZEV Bus &amp; Truck Market in US &amp; Canada</a>               | ICCT                    | 2021 | Manufacturing, Infrastructure | Vehicle Assembly, EV Charging infrastructure players                                  |
| <a href="#">Top 10 EV Tech Solution Companies</a>                           | Auto Tech Outlook       | 2020 | Infrastructure                | Key EV charging infrastructure players identified                                     |

|                                                                                                          |                         |      |                |                                                                            |
|----------------------------------------------------------------------------------------------------------|-------------------------|------|----------------|----------------------------------------------------------------------------|
| <a href="#">Top 7 EV Stocks and Battery Companies</a>                                                    | US News                 | 2021 | Manufacturing  | Vehicle Assembly                                                           |
| Sustainability Market Assessment                                                                         | PwC (Internal)          | 2020 | Infrastructure | EV Charging infrastructure players                                         |
| <a href="#">California Energy Commission announces new incentive program for ZEV truck and bus infra</a> | Charged EV Magazine     | 2021 | Infrastructure | Key investments, state grants in CA EV Infrastructure segment; Key players |
| <a href="#">San-Francisco EV Infrastructure Working Paper</a>                                            | ICCT                    | 2020 | Infrastructure | Sector overview                                                            |
| <a href="#">EV Stations Map by PlugShare</a>                                                             | PlugShare               | Live | Infrastructure | Key EV charging infrastructure players identified                          |
| <a href="#">US EV Infrastructure Market</a>                                                              | Grand View Research     | 2021 | Infrastructure | Key EV charging infrastructure players identified                          |
| <a href="#">Electric Vehicle Charging Infrastructure Trends</a>                                          | NREL                    | 2020 | Infrastructure | Key EV charging infrastructure players identified                          |
| <a href="#">PG&amp;E's Approved EV Charge Network vendors</a>                                            | PG&E                    | Live | Infrastructure | Key EV charging infrastructure players identified                          |
| <a href="#">Electric Vehicle Charging Station Market</a>                                                 | Research and Markets    | 2020 | Infrastructure | Key EV charging infrastructure players identified                          |
| <a href="#">Top 20 electric charging station companies</a>                                               | News article            | 2019 | Infrastructure | Key EV charging infrastructure players identified                          |
| <a href="#">Top Electric Vehicle Charging Startups</a>                                                   | Tracxn                  | 2021 | Infrastructure | Key EV charging infrastructure players identified                          |
| <a href="#">EV charging infrastructure: Rising role of utilities</a>                                     | ADI Analytics           | -    | Infrastructure | Key EV charging infrastructure players identified                          |
| <a href="#">Electric Vehicle Battery Swapping Market</a>                                                 | Allied Market Research  | 2021 | Midlife        | Battery swapping players                                                   |
| <a href="#">Top 10 international truck dealers in US</a>                                                 | Fue Loyal               | 2017 | Midlife        | Only 1 sells/services EV trucks                                            |
| <a href="#">Dealers prepping for the inevitable shift toward electric vehicle service</a>                | Transport Topics (News) | 2021 | Midlife        | Only 1 sells/services EV trucks                                            |
| <a href="#">Bus Dealers Distributors &amp; Sales</a>                                                     | Metro Online Directory  | Live | Midlife        | Some EV bus dealers and maintenance players                                |



|                                                                                     |                        |      |                  |                                                            |
|-------------------------------------------------------------------------------------|------------------------|------|------------------|------------------------------------------------------------|
| <a href="#">North American Commercial Vehicle Contract Maintenance Market, 2020</a> | Research and Markets   | 2020 | Midlife          | Vehicle Maintenance players (EV specific selected)         |
| <a href="#">EV Test Equipment Market - Forecast to 2026</a>                         | Research & Markets     | 2021 | R&D and Training | Key EV Testing players; EV Testing equipment manufacturers |
| <a href="#">EV Charging Systems Testing Market</a>                                  | Allied Market Research | 2021 | R&D and Training | Report yet to be published; sourced key player names       |

| Generic Sources Used                                    | Publisher        | Year | Segment(s) Covered | Comment                                                                 |
|---------------------------------------------------------|------------------|------|--------------------|-------------------------------------------------------------------------|
| <a href="#">Capital IQ (Licensed Database)</a>          | S&P Global       | Live | All                | Key company data (revenues, geography, employees, business description) |
| <a href="#">Dun &amp; Bradstreet Business Directory</a> | Dun & Bradstreet | Live | All                | Key company data (revenues, employees, business description)            |
| LinkedIn                                                | Microsoft        | Live | All                | Key company data (employees, business description, HQ, geographies)     |
| <a href="#">SEC Edgar</a>                               | SEC              | Live | All                | Key company data (revenues, geography, employees, business description) |
| Monster                                                 | -                | Live | All                | Key company data (employees, business description, jobs, salaries)      |
| Glassdoor                                               | -                | Live | All                | Key company data (employees, business description, jobs, salaries)      |
| Investor Reports, Annual Reports                        | Company websites | Live | All                | Key company data (revenues, geography, employees, business description) |
| Misc. News Articles on EV                               | -                | Live | All                | Smaller players, JVs, partnerships, etc. (Eg: Volvo & Mack trucks)      |
| Google Ads                                              | -                | Live | All                | Direct leads on segment players from Google Sponsored Ads               |