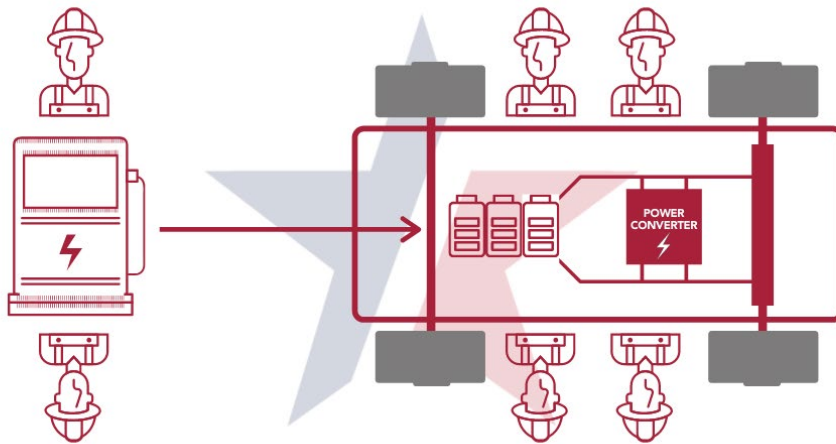


ELECTRIC TRANSPORTATION SUPPLY CHAIN IN TEXAS

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



Prepared by BW Research Partnership

[bw] RESEARCH PARTNERSHIP

December 2020

ABOUT 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.

ABOUT TEXAS ADVANCED ENERGY BUSINESS ALLIANCE

Texas Advanced Energy Business Alliance (TAEBA) includes local and national advanced energy companies seeking to make Texas's energy system secure, clean, reliable, and affordable. TAEBA's mission is to raise awareness among policymakers and the general public about the opportunity offered by all forms of advanced energy for cost savings, electric system reliability and resiliency, and economic growth in the state of Texas. Learn more at texasadvancedenergy.org and follow our latest news [@TXAdvEnergyBiz](https://twitter.com/TXAdvEnergyBiz).



EXECUTIVE SUMMARY

The Texas Advanced Energy Business Alliance (TAEBA) engaged BW Research Partnership to analyze the Electric Transportation (ET) supply chain in Texas. The economic turbulence resulting from the coronavirus pandemic has highlighted the increased need for a diversified economy that provides well-paying jobs with long term growth potential. The findings of this report show that ET already has a substantial footprint in the Texas economy representing a solid foundation for robust growth as global, national, and statewide demand for electric vehicles grows.

This study includes an overview of the current ET supply chain, including the current number of jobs and businesses involved in ET, historic growth rates, and projections of near-term growth. As the ET market is still relatively nascent (e.g., electric vehicles accounted for roughly 2% of light-duty vehicle sales in the United States in 2019), the analysis also includes so-called “Adjacent Industries and Occupations,” which are firms and workers that are not currently working with ET goods or services but have characteristics similar to those that are. Examining Adjacent Industries is useful for identifying existing companies and workforce that could transition to one industry from another with relative ease. In addition to evaluating the current size and scope of the ET sector in Texas, this report identifies strengths and opportunities in the underlying Texas economy that could facilitate rapid growth in ET activities.

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).

For this project, BW Research developed a database of 21,147 Texas businesses potentially involved in the ET supply chain and then closely examined 3,780 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 electrical component, motor, and generator manufacturers an opportunity to expand their product lines. BW Research was able to use the analysis to develop an understanding of the ET supply chain in Texas today.



Key findings:

- ◉ **7,100 Texas workers** currently participate in ET-related activities, most in manufacturing, working in **1,234 businesses in 203 counties throughout the state.**
- ◉ **By 2024, a projected 13,500 workers in Texas will be involved in ET,** including the Tesla factory currently under construction outside of Austin, which will add an estimated 5,000 ET jobs to the state.
- ◉ While population centers have the greatest number of ET workers, **ET workers make up a greater share of the labor force in some suburban and rural counties, including Titus, Cook, Lamar, Calhoun, and Dallam Counties.**
- ◉ ET activity contributed nearly **\$690 million to Gross State Product (GSP)** in 2019. This is equivalent to the GSP contributions of Convenience Stores and more than twice that of Guided Missile and Space Vehicle Manufacturing.
- ◉ There are more than **29,000 workers in 789 companies** that are part of industries requiring similar skill sets and equipment to those needed for ET manufacturing. These industries lost 900 jobs statewide between 2014 and 2019. As such, there is a substantial workforce, which has seen some recent struggles, that could support a growing ET sector with relatively little reskilling or training and find new opportunities.
- ◉ Another **89,000 workers employed in 512 companies** that are part of industries that would require only short-term training or reskilling to transition to ET manufacturing roles.
- ◉ Some existing innovation industries in Texas, such as **Semiconductor and Related Device Manufacturing and Switchgear and Switchboard Apparatus Manufacturing,** could see a boost in growth as ET demands these products in greater quantities than traditional transportation.
- ◉ **More than a quarter of a million (275,800) workers and 4,020 companies** are part of industries that support ET manufacturing. Demand for workers in these industries will grow as ET business activity increases. This robust collection of industries also suggests that there are strong supply chains that could readily scale to meet ET demand for goods and services.
- ◉ Counting the 33,400 people now working in traditional auto and auto-parts manufacturing, many of whom would continue to participate in electric vehicle (EV) production, **more than 5,000 companies and over 400,000 Texans total are currently part of industries that could directly benefit from ET growth.**

These findings demonstrate that the Texas economy is well-positioned to expand its ET sector, which is currently small but poised to grow. Expanding the Texas ET sector will help diversify the regional economy and provide thousands of well-paying jobs across a range of occupations throughout the state. Growth in the ET sector will also bolster the regional economy as established industries supply goods and services to ET firms. Fostering a robust ET sector helps ensure that Texas – and Texans – will be leaders in the innovation economy of the future.



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I. INTRODUCTION

Texas Advanced Energy Business Alliance (TAEBA) commissioned BW Research Partnership to determine the scale and geographic concentration of the companies and employees currently working in Texas’s Electric Transportation (ET) supply chain. This research also examines industry growth trends and the economic opportunities that ET offers in Texas. 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).

BW Research developed a comprehensive database of 21,147 businesses in industries most likely to conduct ET work. Within that dataset, and primarily focused on manufacturing firms, the team closely examined 3,780 companies, confirming 134 companies with 299 unique locations involved in ET work. Based on this sample, BW Research estimates that there are 1,234 businesses involved in some form of ET across the state.¹ This includes manufacturers, distributors, automotive repair shops, and sales representatives.

While the ET sector in Texas is still in its infancy, its potential for growth and opportunity make it critical to understand the industrial infrastructure in place and the skilled workforce available within the state that could ultimately serve this sector. This research included an examination of “Adjacent” Industries and Occupations, which include the industries, companies, and workers that could readily transition to—and benefit from—an expanding ET market. Adjacent Industries provide similar goods or services and have workers who, along with Adjacent Occupations, have knowledge, skills, and abilities that are similar or complementary to those currently involved in ET.

In many industries, such as service centers, dealerships, and parts wholesalers and distributors, non-ET employment is expected to transition to ET-related employment rather than generate new and additional

Select Electric Transportation Firms in Texas

Bird Electric
Britt Rice Electric
Dana Incorporated
Flextronics
Hyllion
Linear Labs
Manheim
Momentum Motors
Navistar
Nidec Corporation
Orange EV
Oncor
Peterbilt
VAHLE Inc.

¹ These figures are based on statistical extrapolations that use the same methodology as the United States Energy Employment Report (USEER), which has been reviewed by the Bureau of Labor Statistics and the Department of Energy. Please see Appendix B for information on the methodology.



roles. This is not the case among some manufacturing industries. Some of Texas's 33,400-strong workforce in traditional automobile and automobile parts manufacturing² has the opportunity to expand as the demand for ET rises. The state is already seeing some of this trend; Tesla has begun construction on its 4 million to 5 million square foot factory, which will allow up to 5,000 new workers to build out Tesla's electric fleet. Given the potential for additional employment in Texas, the Adjacent Industry and Occupational analyses are centered on manufacturing industries and occupations.

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,³ Motor and Generator Manufacturing, and Other Electronic Component Manufacturing.

Secondary Adjacent Manufacturing Industries include companies 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; Aircraft Parts and Auxiliary Equipment Manufacturing; and Power, Distribution, and Specialty Transformer Manufacturing.

Support Industries include companies that are upstream suppliers to companies in Adjacent Industries.⁴ 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. As such, these Support Industries are expected to benefit from growth of the Texas ET supply chain. Examples include Plate Work Manufacturing, Iron and Steel Mills and Ferroalloy Manufacturing, and Machine Shops.

² These include NAICS Motor Vehicle Parts Manufacturing (336300), Motor Vehicle Body Manufacturing (336211), and Automobile Manufacturing (336111)

³ 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.

⁴ 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 in Texas

Electric vehicle (EV) adoption rates are accelerating in Texas, reflecting global trends. Of all of the advances in EV technology over the past decade, perhaps none have been more important than advances to lithium-ion batteries, which make up a large part of the cost of an EV. The 85% decline in cost of lithium ion batteries between 2010 and 2018⁵ has lowered upfront costs and increased range to more than 200 miles today. As the technology has evolved, consumers increasingly recognize the array of benefits associated with these vehicles, from faster acceleration and a quieter ride to lower maintenance and fueling costs. In Texas, light-duty EV sales – including both Battery Electric Vehicles (BEVs) and Plug-in Hybrid Electric vehicles (PHEVs) – more than doubled between 2017 and 2018, when the year’s EV sales surpassed 11,700. BEVs account for a rising share of the total, reaching 70% of 2018 EV sales, up from 52% in 2016 and 47% in 2011.⁶ Tesla, currently constructing a vehicle and battery factory in Travis County, holds the largest share of the national EV market (40% in 2018) and the Texas EV market (54%).⁷

While the electrification of light-duty passenger vehicles may immediately come to mind in a discussion of EV adoption, the medium- and heavy-duty EV markets are also growing. These include public transportation (e.g., transit and school buses, and trains), trucking and freight, and mobile machinery such as warehouse (e.g., forklifts) and agricultural equipment (e.g., tractors, combines, etc.). Austin’s public transit authority has added 12 battery electric buses to its fleet and hopes to begin purchasing EVs exclusively starting in 2022. The transit authority has designed and is now constructing a bus yard exclusively for these buses which will have charging infrastructure to support charging capacity for 187 battery electric buses.⁸ Using a grant from the Federal Transit Administration’s Low or No Emission Vehicle Deployment Program, the Dallas Area Rapid

Company Snapshot

Orange EV Ellis County

Orange EV is a Missouri-based electric truck company that has grown from 35 to 80 employees over the course of the 2020 calendar year. The company produces 100% electric turnkey trucks and charging systems for shipping yards and terminals. While the trucks are produced in Kansas City, Orange EV has an expanding footprint and customer base in Texas. The company currently has one sales manager based in Waxahachie, Texas, and plans to hire a service worker in San Antonio who will be able to provide maintenance and repair on the trucks’ electric components.

The need for a service worker in the area stems from the anticipated growth in demand for Orange EV trucks in Texas. By the end of 2020, the company is expected to have 7-8 Orange EV trucks at various shipping yards and terminals in Texas. By the end of 2021, the number of Orange EV trucks in Texas is expected to reach 25 to 35 across the state. Orange EV’s growth provides a glimpse of the future of ET in Texas as corporations and individuals increasingly transition to ET.

⁵ Behind the Scenes Take on Lithium-ion Battery Prices, Bloomberg New Energy Finance (March 5, 2019).

<https://about.bnef.com/blog/behind-scenes-take-lithium-ion-battery-prices/>

⁶ Advanced Technology Vehicle Sales Dashboard, Auto Alliance (2019). <https://autoalliance.org/energy-environment/advanced-technology-vehicle-sales-dashboard/>

⁷ Expanding Electric-Vehicle Adoption Despite Early Growing Pains, McKinsey & Company (August 2019).

<https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/expanding-electric-vehicle-adoption-despite-early-growing-pains>

⁸ Electric Fleet, Capitol Metro. <https://www.capmetro.org/electricbus>

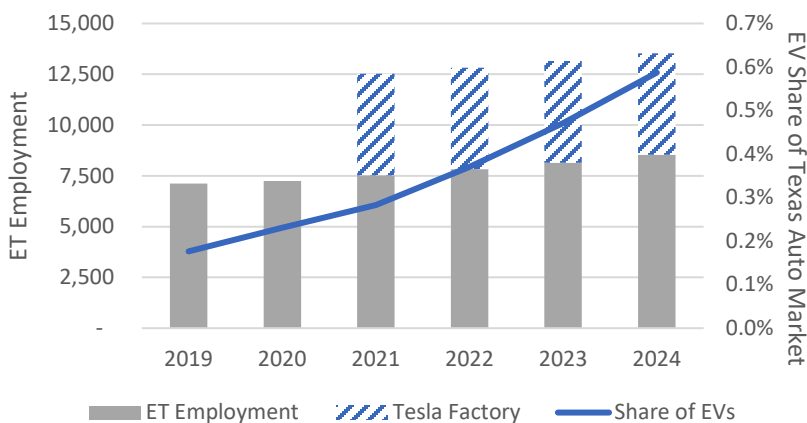


Transit (DART) purchased seven electric buses and the infrastructure to charge and maintain them.⁹ Texas’s Emissions Reduction Incentive Grants (ERIG) Program and Rebate Grants Program – under the Texas Emissions Reduction Plan (TERP) administered by the Texas Commission on Environmental Quality (TCEQ) – provide grants for various types of clean air projects, including those that involve the replacement, retrofit, repower, lease, or purchase of new heavy-duty vehicles, alternative fuel dispensing infrastructure, idle reduction and electrification infrastructure, and alternative fuel use. Other TCEQ initiatives include grants specifically for the replacement of school buses, diesel-fueled vehicle fleets, and other medium- and heavy-duty vehicles.¹⁰

II. THE TEXAS ELECTRIC TRANSPORTATION WORKFORCE

Currently, 7,100 jobs in Texas are involved in some part of the ET supply chain.¹¹ Between 2019 and 2024, the number of workers involved in ET is expected to grow from 7,100 to 8,500 workers, not including workers at the Tesla factory now under construction.¹² The Tesla factory is expected to nearly double the number of ET workers in the state as it is expected to employ nearly 5,000 workers once construction is completed by mid-2021. This brings the estimated number of ET workers in Texas by 2024 to be about 13,500 (Figure 1).

Figure 1: Projected ET Employment and EV Market Share¹³

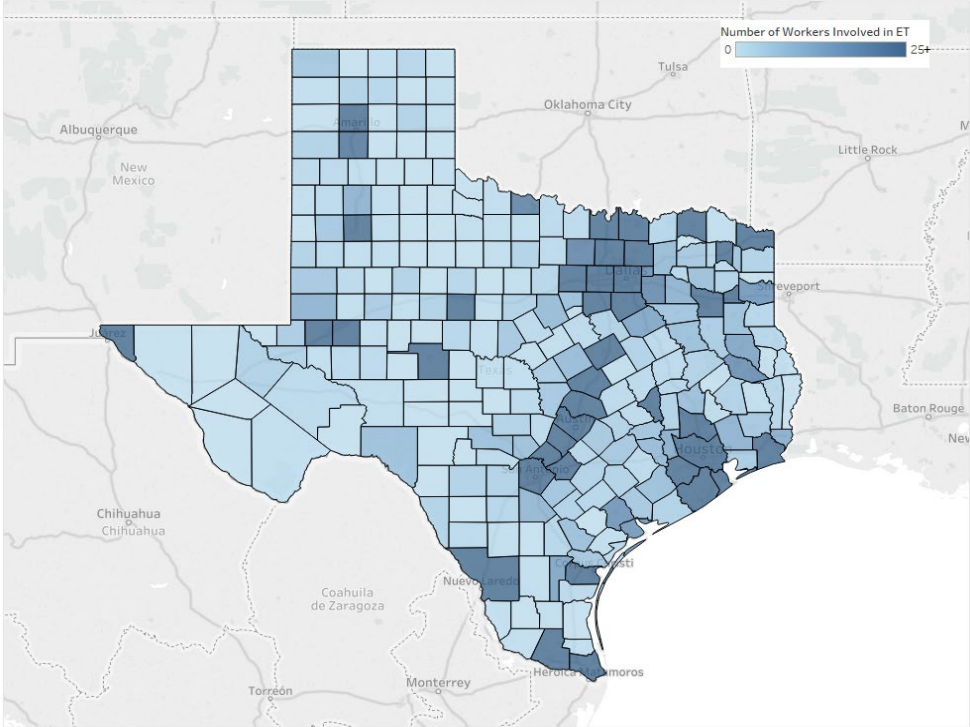


⁹ The Official Newsletter of the Dallas Area Rapid Transit. (Fall 2018). <https://www.dart.org/about/inmotion/fall18/2.asp>
¹⁰ Texas Emissions Reduction Plan (TERP) grant programs. <https://www.tceq.texas.gov/airquality/terp>
¹¹ This definition is based on a worker spending any time on electric transportation goods or services.
¹² These projections are based on data from the 2019 United States Energy and Employment Report and BLS QCEW.
¹³ Share of EVs is based on data from the Texas DMV.



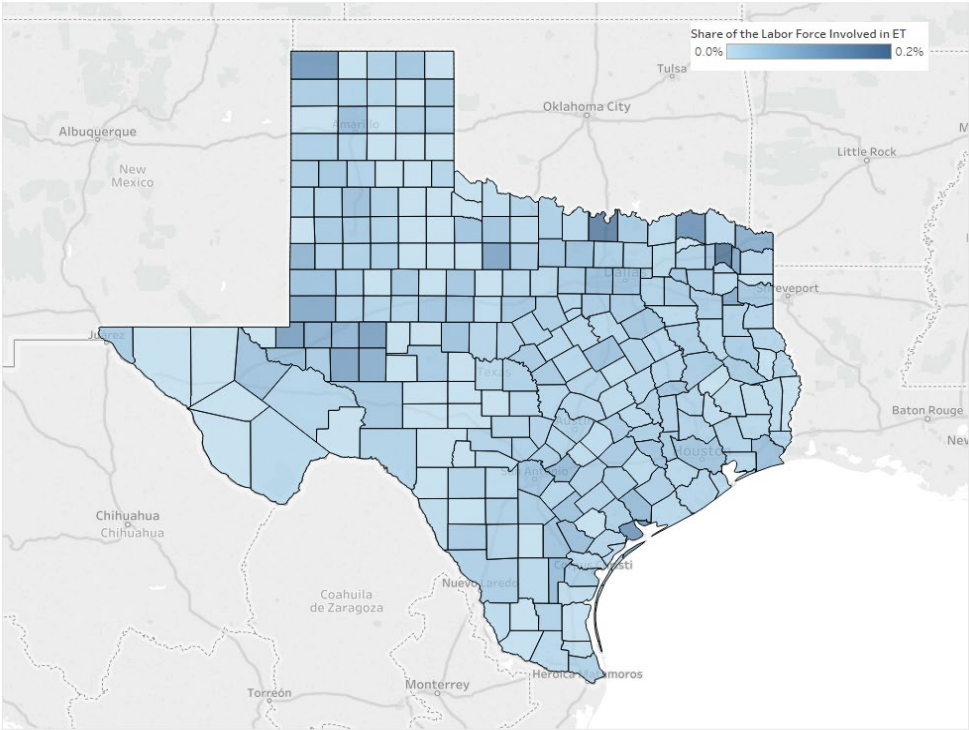
ET jobs can be found in 203 of the 254 counties in Texas. The majority of counties have some ET employment, with the highest numbers found in population centers, including Harris County (1,400 jobs), Dallas County (900 jobs), Tarrant County (700 jobs), and Bexar County (600 jobs). (Figure 2).

Figure 2: ET-Related Employment, 2019



When the relative size of the labor force is considered, the counties with the greatest proportion of ET workers are outside of the large population centers. The counties with the greatest concentration of ET workers are Titus, Cooke, and Lamar (all North-Northeast of Dallas-Fort Worth), Calhoun (North of Corpus Christi), and Dallam (the very Northwest tip of Texas) (Figure 3).

Figure 3. Share of Labor Force Involved in ET¹⁴



Texas Gross State Product (GSP) driven by ET activity was estimated to be nearly \$690 million in 2019. This is about equivalent to the GSP of Convenience Stores within the state. Manufacturing was the primary driver of GSP, accounting for almost two-thirds (65%) of the total ET-driven activity.

¹⁴ Labor Force Estimates from United States Census Bureau, 5-Year Estimates 2018.



Manufacturing also comprises the greatest share of employment in the ET value chain in Texas, with nearly 2,300 jobs. Wholesale Trade and Distribution is the second-largest facet of the ET value chain, with just under 2,000 workers involved in some type of ET activity. (Table 1).

Table 1: ET-Related Employment by Value Chain

	Employment	Share of Employment
MANUFACTURING	2,272	32%
WHOLESALE TRADE AND DISTRIBUTION	1,936	27%
REPAIR AND MAINTENANCE	1,515	21%
PROFESSIONAL SERVICES	772	11%
INSTALLATION	405	6%
RETAIL TRADE	223	3%

The key ET occupations highlighted in Table 2 are estimated to grow an average of 19% between 2019 and 2024. Many of these roles also offer robust wages without requiring a four-year degree. Six of the eight occupations have average hourly earnings above \$20 an hour. (Table 2).

Table 2: Key ET Occupations

<i>Key Occupations¹⁵</i>	<i>2019 Jobs</i>	<i>Projected 2024 Jobs¹⁶</i>	<i>Average Hourly Earnings</i>
<i>Automotive Service Technicians and Mechanics (including ASE certified technicians and mechanics)</i>	582	694	\$20.87
<i>Sales Representatives, Wholesale and Manufacturing, Except Technical and Scientific Products</i>	403	483	\$28.75
<i>Automotive Body and Related Repairers</i>	339	411	\$20.15
<i>Assemblers and Fabricators, All Other, Including Team Assemblers</i>	283	322	\$13.90
<i>First-Line Supervisors of Mechanics, Installers, and Repairers</i>	190	230	\$31.62
<i>Welders, Cutters, Solderers, and Brazers</i>	108	130	\$21.23
<i>Parts Salespersons</i>	82	97	\$13.27
<i>First-Line Supervisors of Production and Operating Workers</i>	70	83	\$29.89

¹⁵ Key occupations were identified based on total current employment within ET.

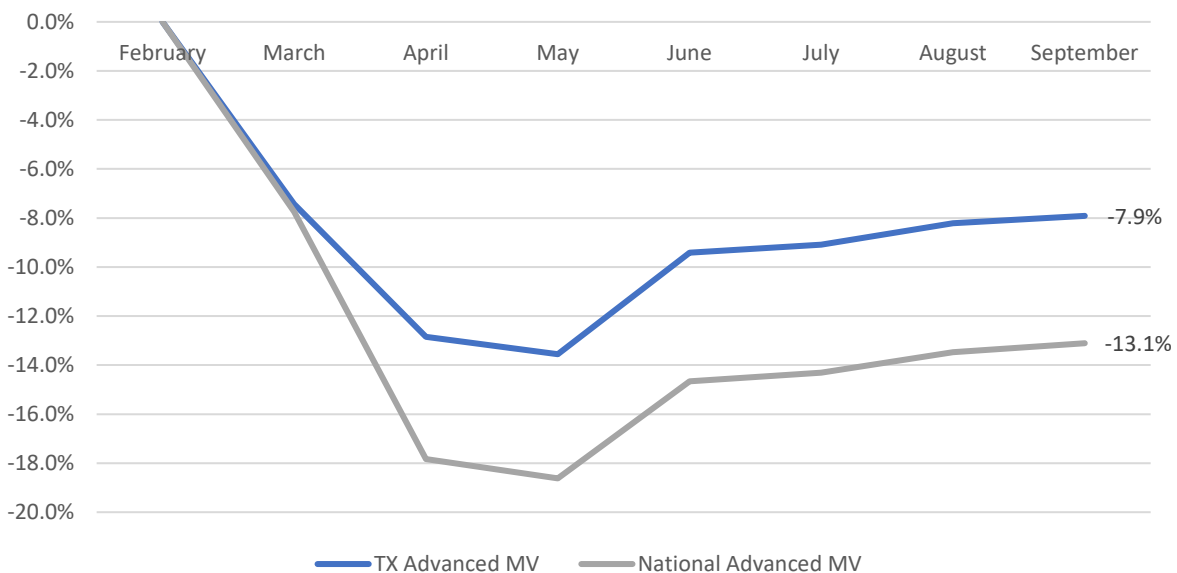
¹⁶ Projected jobs are extrapolated from BLS OES occupational projections through 2024 and ET industry projections developed using data from the 2019 United States Energy and Employment Report and BLS QCEW.



Impacts of COVID-19

BW Research has been tracking changes in advanced energy employment across the U.S. since the beginning of the COVID-19 pandemic.¹⁷ The models developed by BW Research suggest that Texas employment in advanced vehicles,¹⁸ which includes EVs, declined 7.9% between the start of the pandemic and September 2020 (Figure 4). This is lower than the losses seen in advanced vehicle employment nationally (13.1%), but substantial, nonetheless. This came after a jump of 16% in advanced vehicle employment from 2017 to 2018, before a slight decline nationally and in Texas in 2019.¹⁹ Generally, jobs in advanced vehicles – the foundation of the ET sector – have established a solid foothold in Texas.

Figure 4. COVID-19-Related Employment Losses in Advanced Energy²⁰



¹⁷ Clean Energy Employment Initial Impacts from the COVID-19 Economic Crisis, July 2020, Revised, BW Research (September 11, 2020).

https://bwresearch.com/covid/docs/BWResearch_CleanEnergyJobsCOVID-19Memo_July2020rev.pdf

¹⁸ This definition includes hybrid electric vehicles, plug-in hybrid vehicles, electric vehicles, natural gas vehicles, hydrogen vehicles, and fuel cell vehicles.

¹⁹ "More Texans Work in Advanced Energy than Real Estate; Triple Those in Chemical Manufacturing, with Growth Expected Prior to COVID-19." Texas Advanced Energy Business Alliance Press Release. July 30, 2020.

²⁰ Clean Energy Employment Initial Impacts from the COVID-19 Economic Crisis, July 2020, Revised, BW Research (September 11, 2020).

https://bwresearch.com/covid/docs/BWResearch_CleanEnergyJobsCOVID-19Memo_July2020rev.pdf

Company Snapshot

Peterbilt

Denton County

The Peterbilt campus in Denton, has about 1,400 assembly specialists and a team of engineers building Peterbilt trucks as part of a two-shift workday. The development of zero-emission Peterbilt electric trucks started in 2016, and now includes three trucks covering a wide range of trucking applications.

- The Model 579EV is a conventional tractor with a range of 150 miles and is ideal for regional haul, drayage, pickup and delivery and last-mile operations.
- The Model 520EV is a refuse truck that can quietly navigate urban environments and leverages its stop-and-go duty cycle to regenerate its batteries. Its range is 80 miles, as part of its job is to pick up 900 trash bins a day.
- The Model 220EV is a Class 6 Medium duty non-CDL truck, used for deliveries and local distribution with a range of 150 miles.

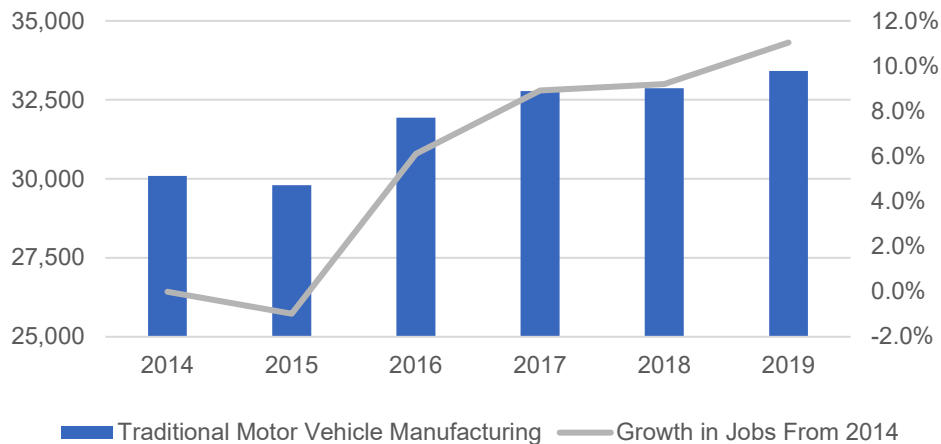
There are more than 41 Peterbilt electric trucks on the road today as part of the Peterbilt EV test fleet. With both the Model 220EV and Model 579EV open for customer orders, the number of zero-emission battery electric Peterbilt trucks on the road will continue to grow into the future. Peterbilt has a team of assembly specialists certified to work on these trucks, and engineers working to design, test, and improve them.



Key Trends in Texas

Texas has a robust and growing workforce in traditional automobile and automobile parts manufacturing. There are 33,400 workers across the state who work in industries involved in traditional automobile manufacturing (Figure 5) and earn an average of \$90,769 per year, including benefits.

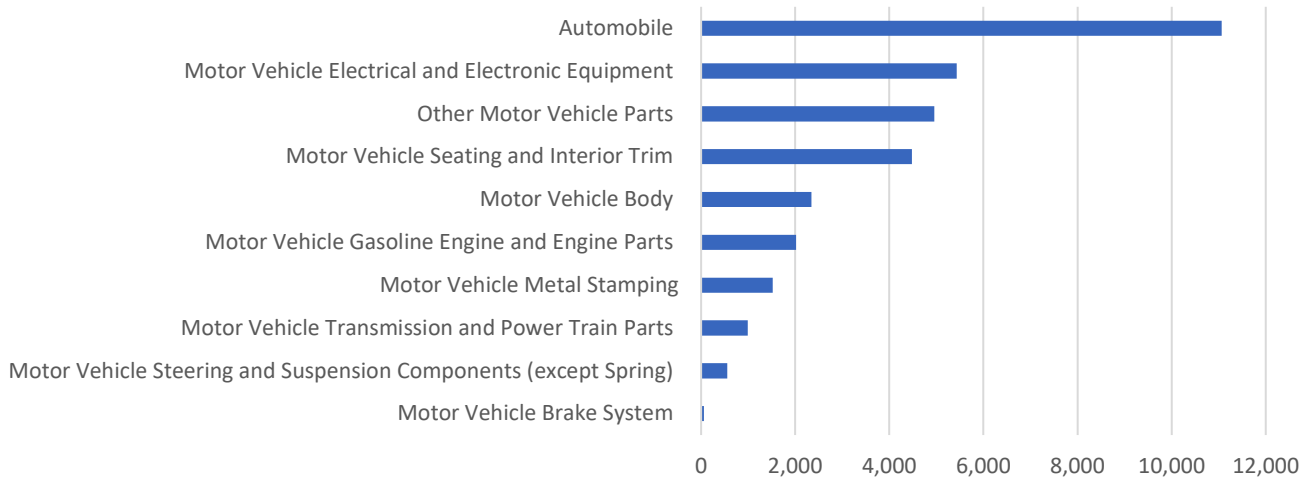
Figure 5. Traditional Auto Manufacturing Employment in Texas²¹



Many of these workers are already well-positioned for a growing market for EVs and EV components. As the ET sector grows globally, it will create net new jobs for some segments of the traditional automobile and automobile parts manufacturing sector, while other sectors will see job replacement and others will see a transition of duties required for those jobs. Amongst the segments that are poised to grow are Automobile Manufacturing, narrowly defined, which employs 11,000 people across the state, and Motor Vehicle Electrical and Electronic Equipment Manufacturing that employs another 5,400 (Figure 6). The 2,000 workers involved in Motor Vehicle Gasoline Engine and Engine Parts Manufacturing may have to undergo some reskilling to adjust to a transition to EVs, though their fundamental knowledge and skills should ease the transition. Other industries that produce components needed in greater quantities among electric transportation compared to traditional transportation, such as Switchgear and Switchboard Apparatus Manufacturing (about 4,100 workers) and Semiconductor and Related Device Manufacturing (29,200 workers), will see growth in employment as the demand for ET increases.

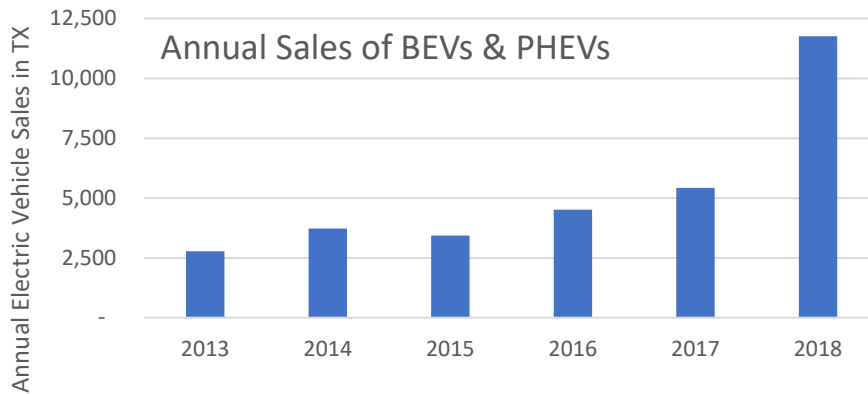
²¹ This includes 10 NAICS centered around traditional automobile manufacturing. These NAICS codes are: 336111, 336211, 336310, 336320, 336330, 336340, 336350, 336360, 336370, 336390

Figure 6. Traditional Auto Manufacturing Jobs by Specific Industry, 2019²²



The EV market in Texas is on the rise. Between 2013 and 2018, sales of EVs in Texas have increased by over 300%. In 2018 alone, more EVs were sold than in 2016 and 2017 combined (Figure 7).

Figure 7. Annual Sales and Market Share of EVs in Texas²³



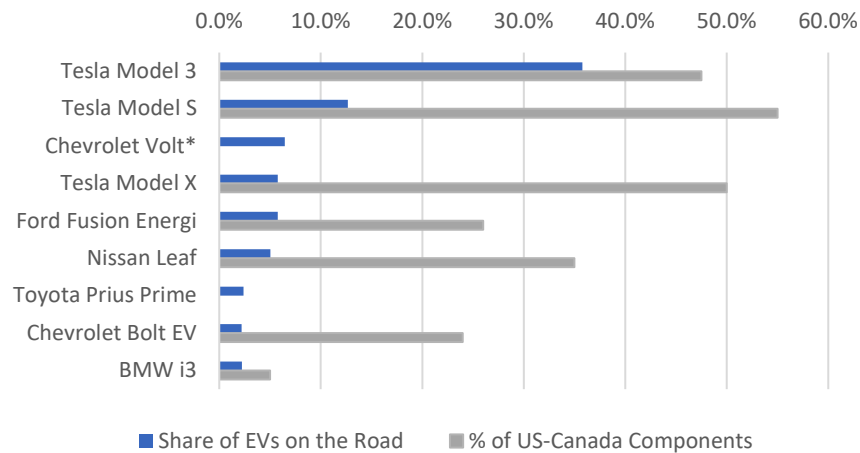
²² Sub-industry by six-digit NAICS code. Emsi 2020.2

²³ 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



A majority of EVs on the road in Texas are made from components primarily sourced from the United States and Canada. Of the 32,897 EVs on the street in Texas, more than half (54%) are Teslas. The three most common models – the Model 3, the Model S, and the Model X – are 48%, 55%, and 50% U.S.-Canada produced components, respectively (Figure 8).

Figure 8. Texas EVs²⁴ and Percentage of US-Canada Content^{25*}



While Tesla presently holds the largest share of the current EV market, other car manufacturers are rapidly producing EV lines; 400 new EV models are projected to be in the market by 2023.²⁶ Many of these new models include electrified versions of former models, including the GMC Hummer EV, Ford’s F-150, the number one selling truck in the U.S. for over 40 years,²⁷ and the Mustang Mach-E. Harley-Davidson recently introduced the LiveWire, an electric motorcycle that can go 0-60mph in three seconds.²⁸ These new electric models present promising opportunities for ET production in Texas at existing facilities like GM in Arlington and Toyota in San Antonio.

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 November 11, 2020 from <https://autoalliance.org/energy-environment/advanced-technology-vehicle-sales-dashboard/>

²⁴ Data from Atlas Public Policy’s EV Hub. <https://www.atlasevhub.com/materials/state-ev-registration-data/>. Definition includes Battery Electric Vehicles (BEVs) and Plug-in Hybrid Vehicles (PHEVs).

²⁵ Data from American University’s Made in America 2020 Auto Index. U.S. and Canada components reported jointly. <https://www.american.edu/kogod/research/autoindex/2020-auto-index.cfm>

* No component source data for Chevrolet Volt.

²⁶ Expanding Electric-Vehicle Adoption Despite Early Growing Pains, McKinsey & Company (August 2019). <https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/expanding-electric-vehicle-adoption-despite-early-growing-pains>

²⁷ The glorious history of the Ford F-Series truck, America’s best-selling vehicle for 36 years, Business Insider (November 2018). <https://www.businessinsider.com/ford-f-series-f150-truck-sales-record-history-2017-1>

²⁸ <https://www.cbsnews.com/news/harley-livewire-electric-motorcycle-0-60-in-3-seconds-and-30000/>



Company Snapshot

Oncor

Dallas County

Oncor is an electric transmission and distribution utility whose service area encompasses 98 counties in Texas, including Dallas, Fort Worth, Round Rock, Midland, and Odessa. Oncor currently has at least 15 employees who are deeply involved in Electric Transportation-related projects. These employees work on a range of issues, including planning for charging infrastructure, managing key customers interested in electrification of their fleet, and infrastructure design.

The Oncor Strategy and Emerging Issues (SEI) Team is working to ensure that adequate utility infrastructure is available to logistics centers as they seek to transition to electric fleets. The Oncor service area has nearly 22,000 fleets that support logistics centers. These fleets are ripe for electrification, but electric fleets require a substantial amount of electric power, potentially requiring charging infrastructure additions that can take 18 months to complete. To proactively plan and prepare for the greater electrical infrastructure needed to meet this demand, the SEI team developed a custom tool using data from the Texas Demographics Center that allows them to map current and anticipated electric demand. As David Treichler, Director of the SEI team, stated, the tool allows the SEI team “to better estimate the size, shape, and speed of the approaching tidal wave of electric trucks.”

III. ADJACENT INDUSTRY ANALYSIS

The ET sector is intertwined with many existing industries within the state of Texas. To understand how increased ET activity could impact jobs in Texas, the research team identified “Adjacent Industries” that have similar workforce competencies, supply chains, and activities to current ET firms. The Adjacent Industry analysis identifies talent with similar or complementary skillsets that could easily transition from one industry to another.

The businesses within these Adjacent Industries currently have little or no involvement in ET production. Their importance lies in the workers, who have skill sets that would allow them and the companies that employ them to move into the ET supply chain with relatively little training and transition. Identifying these industries and their workers highlights a potential workforce that increased ET demand could support or grow, in some cases offsetting recent job losses.

For the purposes of this study, the research team segmented Adjacent Industries into three categories: Immediate Adjacent Manufacturing Industries, Secondary Adjacent Manufacturing Industries, and Support Industries. The three Adjacent Industry categories distinguish industries in the same industry group and progression of the supply chain and those that provide raw materials to the other identified industries.

- **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 these companies. Examples include: Automobile Manufacturing; Motor and Generator Manufacturing; and Other Electronic Component Manufacturing.



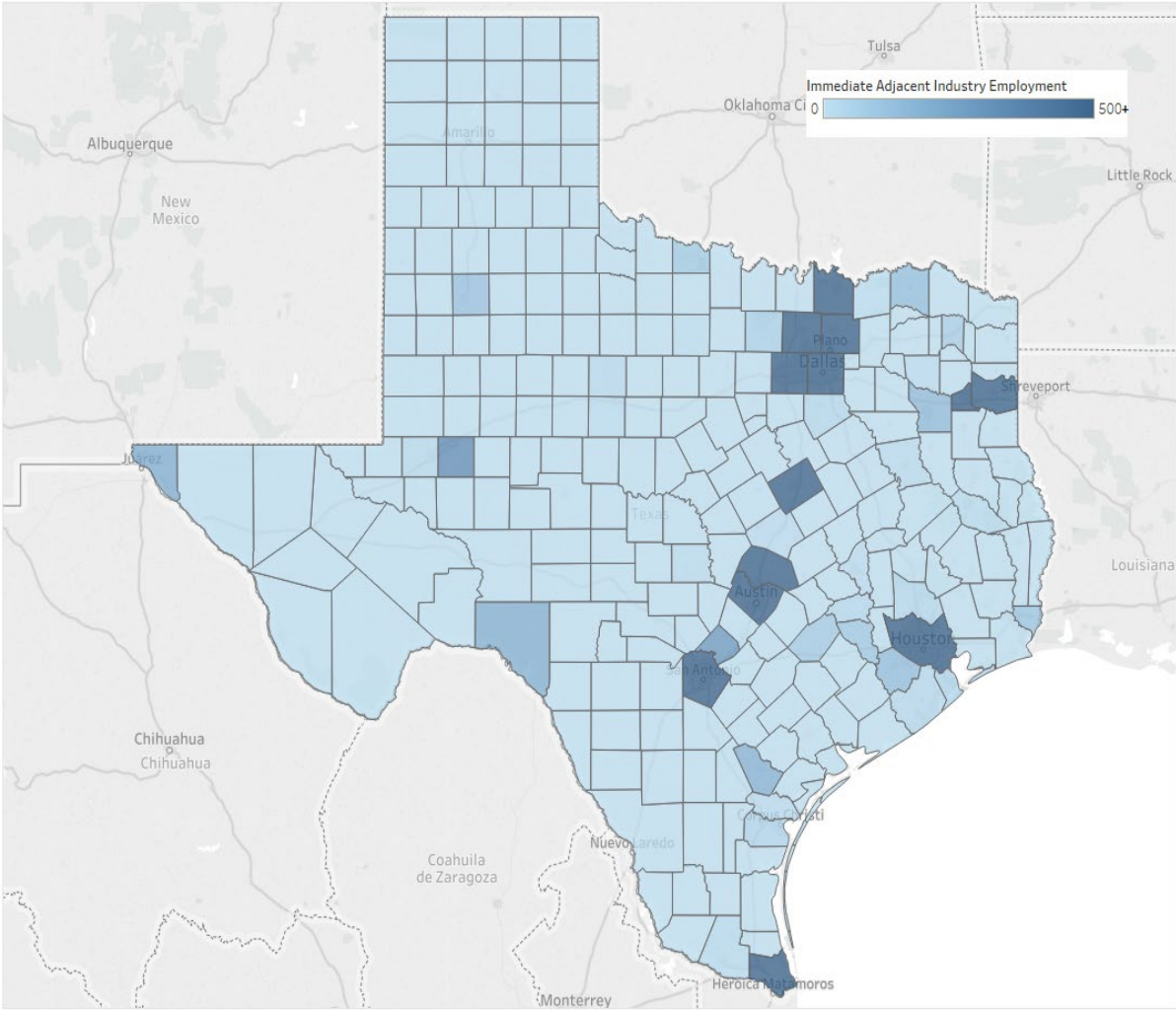
- ◉ **Secondary Adjacent Manufacturing Industries** This category includes industries in the same general industry classifications (four-digit NAICS codes) but differ at the more granular level (six-digit NAICS codes). These industries conduct similar activities as firms in ET manufacturing, but their transition to ET work would take more investment and time than Immediate Adjacent Manufacturing Industries. Examples include: Relay and Industrial Control Manufacturing; Aircraft Parts and Auxiliary Equipment Manufacturing; and Switchgear and Switchboard Apparatus 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 as these companies tend to focus on raw materials and upstream components, those changes are likely to be minimal. These industries are expected to strongly benefit from the growth of the Texas ET industry. Examples include: Plate Work Manufacturing; Iron and Steel Mills and Ferroalloy Manufacturing; and Machine Shops.



Immediate Adjacent Manufacturing

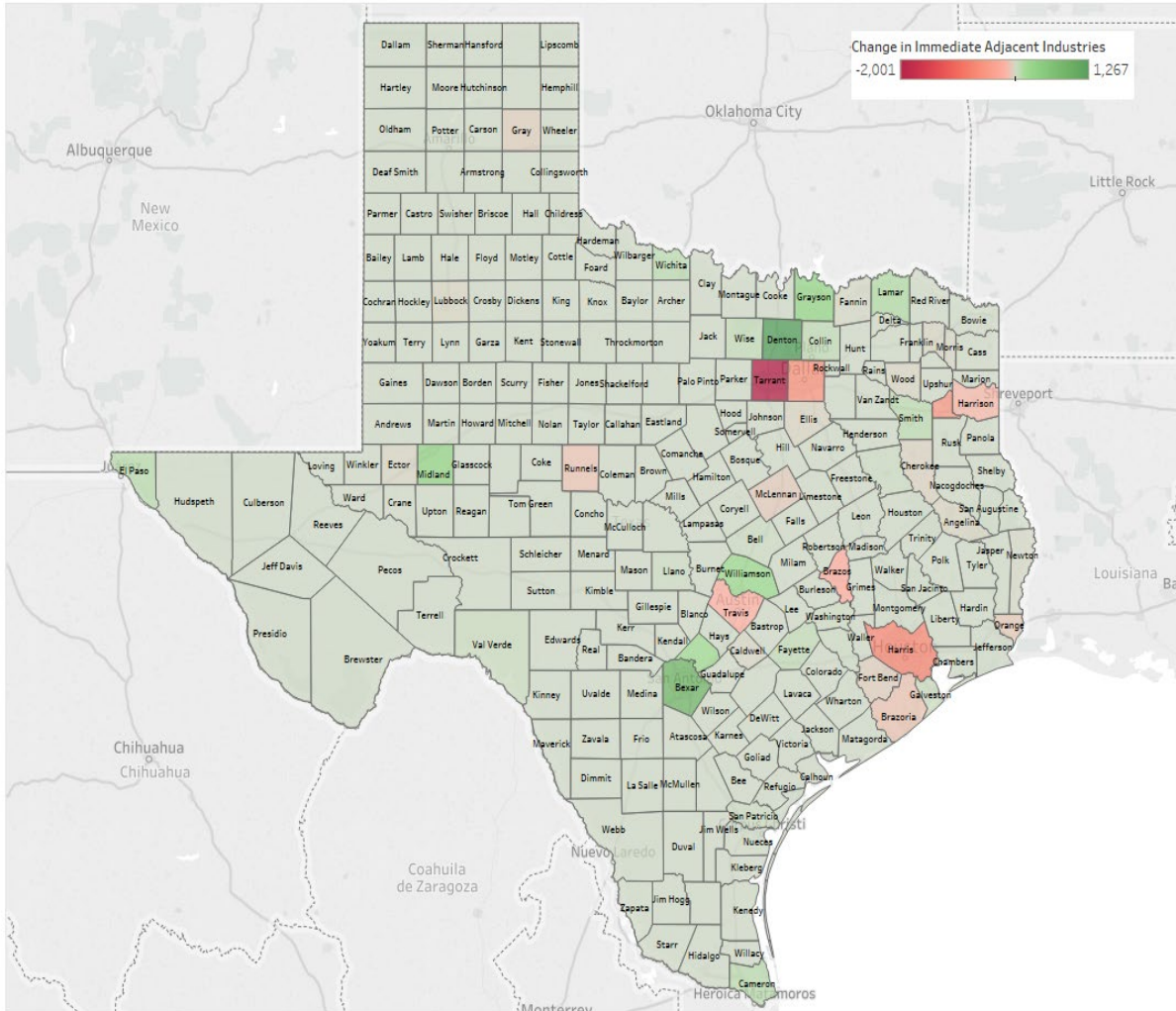
There are more than 29,000 people who work in Immediate Adjacent Manufacturing Industries in Texas. The counties that make up and surround Dallas and San Antonio have the greatest number of workers, including Tarrant County (6,100 workers), Denton County (4,800), and Bexar County (4,200). In total, six counties have more than 1,000 workers in Immediate Adjacent Manufacturing Industries (Figure 9).

Figure 9. Immediate Adjacent Manufacturing Industry Employment, 2019



Immediate Adjacent Manufacturing Industries across Texas lost about 900 jobs between 2014 and 2019. Tarrant County saw the largest decline (-2,000) in these jobs during this time. Harris, Dallas, and Gregg Counties also saw notable declines in these industries, losing 450 or more jobs (Figure 10). Workers who lost jobs in these industries could transition to ET-related work relatively easily since many of the skillsets required in these industries are needed in ET fields.

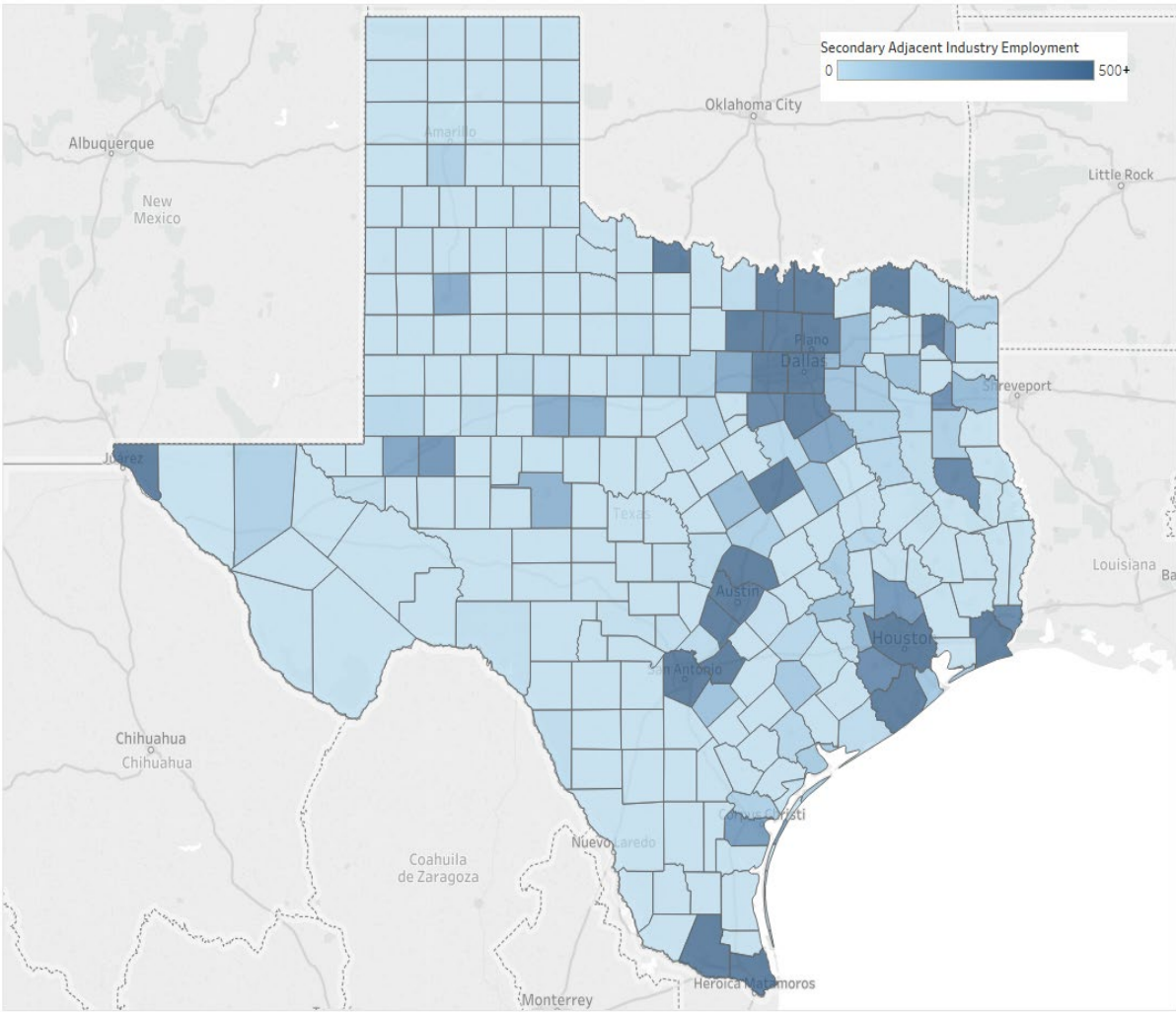
Figure 10. Change in Immediate Adjacent Manufacturing Industry Employment, 2014-19



Secondary Adjacent Manufacturing

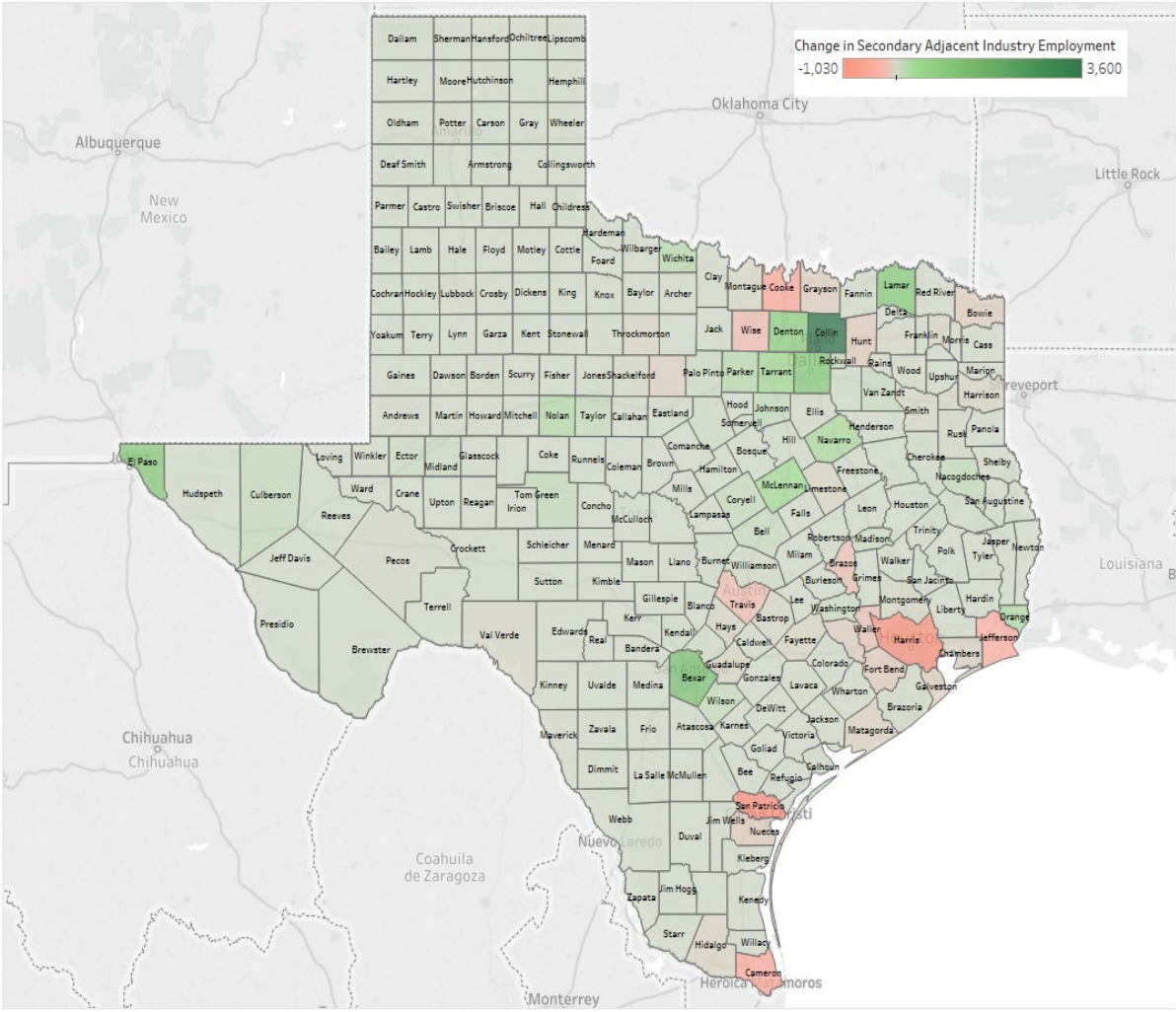
There are more than 89,000 jobs in Secondary Adjacent Manufacturing Industries (SAMI) in Texas. Nearly two-thirds of these jobs can be found in the five counties with the greatest number of SAMI jobs. These are Dallas County (22,200 jobs), Travis County (13,400), Collin County (7,400), Tarrant County (7,000), and Harris County (6,600). It is also notable that 14,800 jobs can be found in 78 counties across the state that are not in the top 15 counties for SAMI employment (Figure 11).

Figure 11. Secondary Adjacent Manufacturing Industry Employment, 2019



Texas gained nearly 5,800 jobs in Secondary Adjacent Manufacturing Industries between 2014-2019. However, these employment gains have not been even across the state. Collin (+3,600 jobs), Bexar (+1,100), and El Paso (+900) counties saw the greatest gains in SAMI jobs during this time (Figure 12). But some other counties saw declines in SAMI employment, notably San Patricio (-1,000 jobs), Harris (-1,000), and Cooke (-500) counties. Workers who lost their jobs in SAMI industries may be able to transition to ET-related work with minimal to moderate training and upskilling.

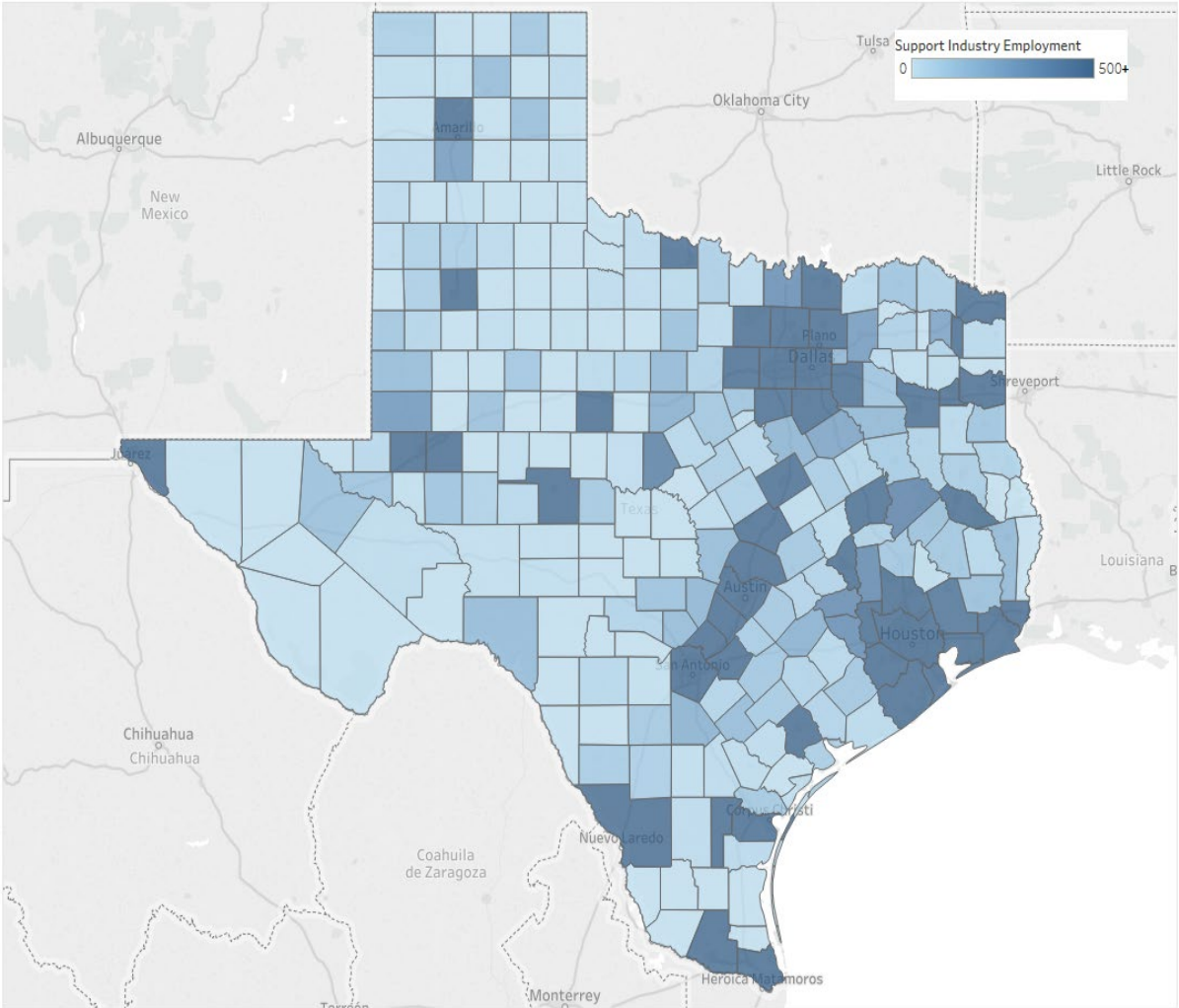
Figure 12. Change in Secondary Adjacent Manufacturing Industry Employment, 2014-19



Support Industries

Support Industries (SI) employ about 275,800 workers across Texas. While Harris (75,500) and Dallas (50,200) counties account for nearly half (46%) of all these jobs, less populated counties also account for a substantial number. In fact, when the 10 counties with the most SI employment are excluded, the remaining 177 counties account for 73,000 jobs across the state (Figure 13).

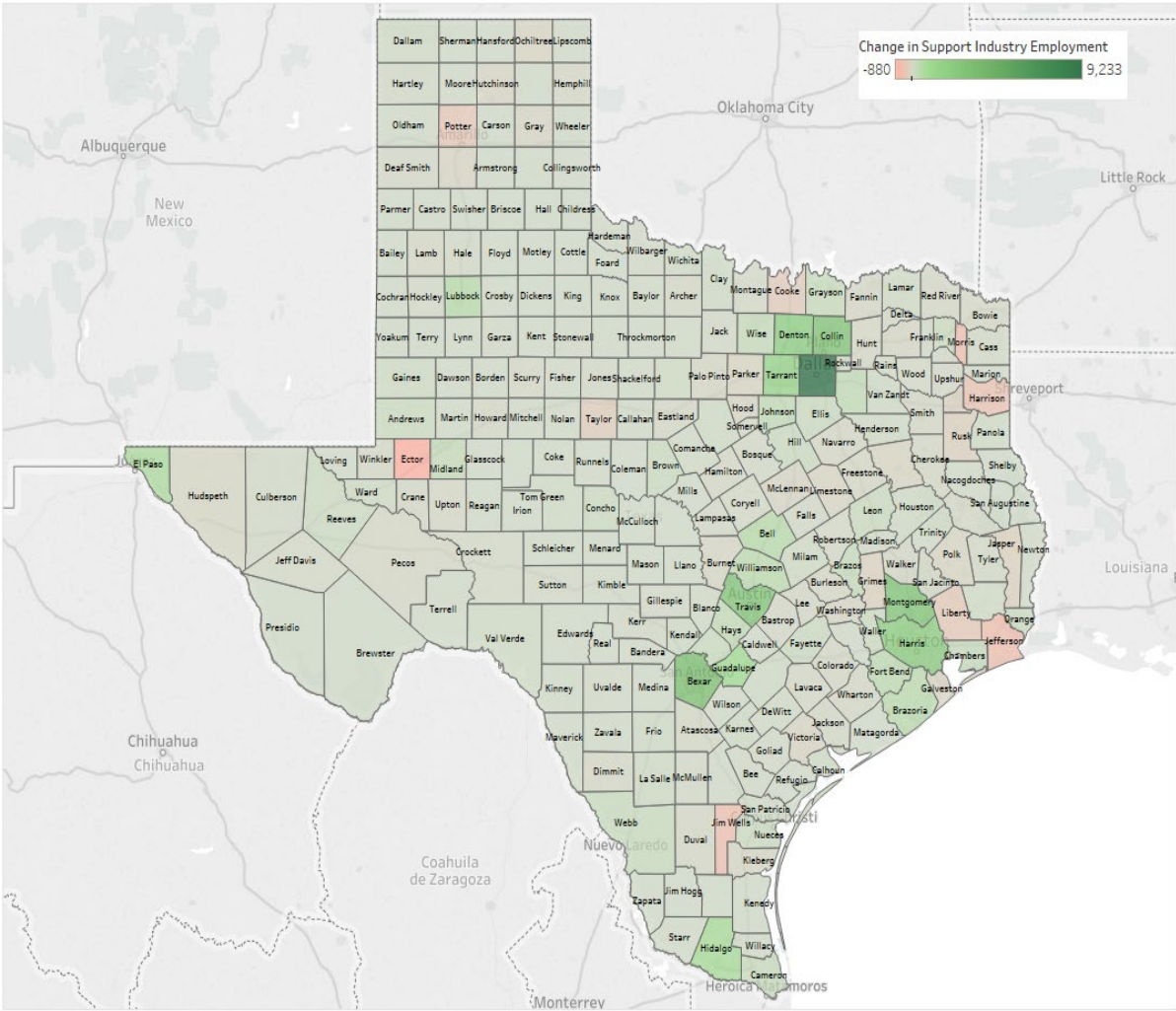
Figure 13. Support Industry Employment, 2019



Between 2014 and 2019, Texas gained 30,100 jobs in Support Industries. Dallas County saw the biggest increase in employment, gaining 9,200 jobs during this time. This substantial growth highlights that the industries that support ET activity are robust within the state, and the growth of ET presents a pathway for the continued expansion of these industries as the demand for materials and services increases.

It is also worth noting that employment in SI declined in 95 counties across the state (Figure 14). Increased ET activity and subsequent demand for materials and services from SI may help mitigate some employment losses in these areas.

Figure 14. Change in Support Industry Employment, 2014-19



IV. ADJACENT OCCUPATION ANALYSIS

Adjacent Occupational analysis complements Adjacent Industry analysis. This type of analysis identifies key occupations within Adjacent Industries with similar knowledge, skills, abilities, tasks, and other work activities, and examines these key occupations across all industries. In doing so, it captures additional workers with relevant skillsets and backgrounds that are currently employed industries outside of the ET and adjacent industries. This reveals a significant Texas workforce in occupations commonly found in Adjacent Industries, and therefore well suited for transition to an ET-related job with a minimum of additional training.

The most common occupations in Immediate Adjacent Manufacturing Industries account for more than half a million workers (545,000) in Texas across all Industries, suggesting a robust talent pipeline and labor pool already available within the state. These occupations offer a range of career opportunities; eight of these 10 occupations offer median hourly earnings that exceed \$15 per hour, and four offer more than \$20 per hour (Table 3).

Table 3. Texas Employment in Top Occupations Found in Immediate Adjacent Manufacturing Industries

	Employed in 2014	Employed in 2019	Employed in 2024	Median Hourly Earnings
Laborers and Freight, Stock, and Material Movers, Hand	170,677	208,561	229,987	\$13.61
Miscellaneous Assemblers and Fabricators	88,760	82,674	82,679	\$13.90
Inspectors, Testers, Sorters, Samplers, and Weighers	45,761	53,285	52,033	\$18.70
Welders, Cutters, Solderers, and Brazers	48,759	51,245	54,998	\$21.23
First-Line Supervisors of Production and Operating Workers	48,783	50,855	53,633	\$29.89
Machinists	32,621	28,873	30,550	\$21.54
Electrical, Electronic, and Electromechanical Assemblers, Except Coil Winders, Tapers, and Finishers	21,954	23,461	23,993	\$16.31
Industrial Engineers	17,607	20,070	21,996	\$48.11
Coating, Painting, and Spraying Machine Setters, Operators, and Tenders	13,542	13,886	14,750	\$18.18
Multiple Machine Tool Setters, Operators, and Tenders, Metal and Plastic	8,265	12,101	12,706	\$15.12



Texas has a large workforce in occupations that are most common among Secondary Adjacent Manufacturing Industries. About 440,000 people are already working in these occupations across Texas (Table 4). Additional ET activity in Texas would also provide new working opportunities for occupations that have seen recent employment declines, including Machinists, Miscellaneous Assemblers and Fabricators, and Electronics Engineers.

Table 4. Texas Employment in Top Occupations Found in Secondary Adjacent Manufacturing Industries

	Employed in 2014	Employed in 2019	Employed in 2024	Median Hourly Earnings
Software Developers and Software Quality Assurance Analysts and Testers	81,136	112,971	135,264	\$51.44
Miscellaneous Assemblers and Fabricators	88,760	82,674	82,679	\$13.90
Inspectors, Testers, Sorters, Samplers, and Weighers	45,761	53,285	52,033	\$18.70
Welders, Cutters, Solderers, and Brazers	48,759	51,245	54,998	\$21.23
First-Line Supervisors of Production and Operating Workers	48,783	50,855	53,633	\$29.89
Machinists	32,621	28,873	30,550	\$21.54
Electrical, Electronic, and Electromechanical Assemblers, Except Coil Winders, Tapers, and Finishers	21,954	23,461	23,993	\$16.31
Industrial Engineers	17,607	20,070	21,996	\$48.11
Electronics Engineers, Except Computer	12,844	12,512	13,152	\$54.48
Semiconductor Processing Technicians	3,366	4,143	4,058	\$16.48

Nearly 1.7 million Texans now work in occupations that are among the most relevant to the Support Industries. The strong pool of existing workers suggests that as ET activity increases and the demand for goods and services that support ET increases, there is a skilled workforce and talent pipeline in place to support additional growth. Increased ET activity will also support some occupations that saw employment declines between 2014 and 2019, including Machinists and Sales Representatives (Table 5).

Table 5. Texas Employment in Top Occupations Found in Support Industries

	Employed in 2014	Employed in 2019	Employed in 2024	Median Hourly Earnings
Office Clerks, General	325,274	344,049	356,728	\$16.53
Customer Service Representatives	243,576	295,958	310,910	\$15.75
General and Operations Managers	186,908	224,359	247,461	\$47.63
Laborers and Freight, Stock, and Material Movers, Hand	170,677	208,561	229,987	\$13.61
Bookkeeping, Accounting, and Auditing Clerks	142,538	142,530	149,574	\$19.54
Project Management Specialists and Business Operations Specialists, All Other	83,639	122,551	134,361	\$36.46
Sales Representatives, Wholesale and Manufacturing, Except Technical and Scientific Products	125,905	121,706	128,835	\$28.75
Accountants and Auditors	105,196	119,934	132,312	\$35.08
Welders, Cutters, Solderers, and Brazers	48,759	51,245	54,998	\$21.23
Machinists	32,621	28,873	30,550	\$21.54

V. FINAL OBSERVATIONS

The findings of this research highlight the ways in which Texas is well positioned to tap the growing demand for ET for a boost to its economy. Fostering and supporting the ET economy in Texas can potentially lead to thousands of stable, well-paying jobs throughout the state. An economy with a substantial ET sector is also well prepared for the future. Growth in the ET sector can also drive growth in other innovative industries, such as manufacturers of semiconductors and switchgears. This report shows three ways Texas can benefit by propelling an ET economy:

Texas already has ET jobs, and they are growing. The current ET workforce in Texas is about 7,100 workers, with projections of growth to 8,500 by 2024. That is without counting the new Tesla factory, now under construction outside Austin, which is expected to open in 2021 and employ about 5,000 workers. This means that by 2024 an estimated 13,500 workers will be employed in ET in Texas.

Texas's strong manufacturing workforce and infrastructure will allow ET firms, related industries, and their workers to gain from ET growth. The Lone Star State already has more than 33,000 workers involved in the manufacturing of automobiles and automobile parts. There are another 118,000 workers in Adjacent Industries—industries that could easily transition to ET manufacturing. The strong presence of these manufacturing industries also highlights the strength of the supply chains, talent pipelines, and infrastructure within the state. Support Industries that could supply and support ET manufacturing currently employ 275,000 workers. Altogether, Texas has already in place a workforce more than 400,000 strong poised to benefit from ET growth.

Texas workers previously displaced in specific industries and occupations will see opportunities from ET growth. Between 2014 and 2019, Immediate Adjacent Manufacturing industries lost 900 jobs statewide. Those workers have the knowledge, skills, and abilities that would allow them to take on ET manufacturing roles with little or no reskilling or training.

Electric Transportation will continue to grow across the globe. Texas, with its robust manufacturing economy, has the workforce and industrial foundations to capitalize on this growth. Efforts to foster the supply chain for the ET industry will help Texas's economy to grow at the forefront of technology and innovation.



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 21,147 businesses in the assembled potential database, 3,780 businesses were examined closely by the research team. Of these, 528 were contacted via telephone at least once.

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)

APPENDIX B: 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 C: 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.

