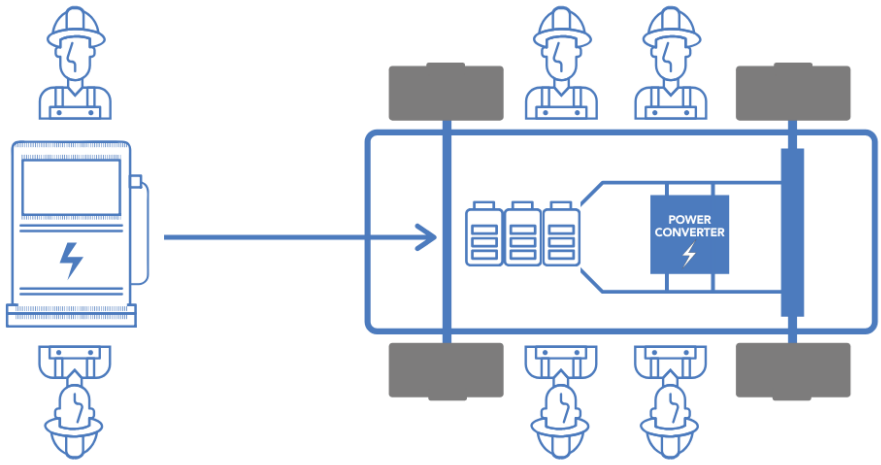
ELECTRIC TRANSPORTATION SUPPLY CHAIN IN PENNSYLVANIA

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



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ADVANCED ENERGY ECONOMY

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

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

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EXECUTIVE SUMMARY

Advanced Energy Economy engaged BW Research Partnership to analyze the Electric Transportation (ET) supply-chain in Pennsylvania. This study includes an overview of the current ET supply chain, including the current number and location of companies and jobs, historic growth rates, and projected short-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 or labor 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 Pennsylvania, this report identifies strengths and opportunities in the underlying Pennsylvania economy that would facilitate such efficient and rapid transition to ET activities.

For the purposes of this report, the ET supply chain is defined as involvement in the manufacturing, wholesale distribution, retail sale, installation, research and development, and maintenance 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 component parts).

For this project, BW Research developed a database of more than 12,000 Pennsylvania firms potentially involved in the ET supply chain. BW Research then closely examined more than 6,100 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 providing existing electrical component, motor, and generator manufacturers an opportunity to expand their product lines.

Key Findings

Even at this early stage in the market's history, ET currently accounts for nearly 4,400 jobs across the state of Pennsylvania. This workforce is about equivalent to the number of natural gas extraction workers within the state. Jobs in ET are particularly abundant in Allegheny, Montgomery, Philadelphia, Bucks, and Lancaster counties. The research team identified 151 firms with 177 unique locations within the state that are involved in ET in some capacity.

ET-related activity is estimated to account for more than $434 million, about 0.6%, of Pennsylvania's Gross State Product (GSP) in 2019. This is about equivalent to the GSP of Sporting Goods Stores within the state. Motor Vehicle Manufacturing[1] was the greatest contributor to ET GSP, accounting for more than $120 million of GSP.

[1] This industry includes manufacturing of vehicle component parts.

ET jobs are projected to grow faster than the overall economy. ET jobs are projected to grow 24% between 2019 and 2024[2], while statewide employment is expected to grow 3%[3] over the same period. The growth in ET employment tracks closely to the expected 400% growth in electric vehicles in Pennsylvania between 2019 and 2024.[4]

About four in 10 (1,800) current ET-related jobs are in repair and maintenance. Manufacturing accounts for almost another 1,000 jobs, or about one fifth (21%) of all ET-related employment in Pennsylvania, while the wholesale trade and distribution segment of the supply chain accounts for 18% of ET-related employment.

Growth in ET is expected to strongly support a number of key industries in Pennsylvania. The Keystone State boasts a diverse industrial base, with 351 companies that could be immediately retooled and retrofitted to supply the ET market, and an additional 190 firms that could transition to ET activity with slightly more time and investment.[5] These companies are not currently conducting ET-related work but are closely related to ET companies in their activities, products, supply chains, and labor profiles and competencies. The rise of ET-related activity in Pennsylvania is expected to support some industries that have experienced recent declines, including: Railroad Rolling Stock Manufacturing and Automobile Merchant Wholesalers, and occupations such as: Assemblers and Fabricators and Cutting, Punching, and Press Machine Setters, Operators, and Tenders.[6]

In Pennsylvania, ET growth should create additional jobs, not just replacement jobs. For service centers, dealerships, and some parts wholesalers and distributors, non-ET employment is expected to transition to ET-related employment rather than generate new and additional roles. However, Pennsylvania's supply chain is particularly strong in electronic component, motor, and generator manufacturing industries; these industries are poised to grow with ET and will be relatively unaffected by declining sales of traditional vehicles, resulting in net job creation.

Erie, Berks, Chester, and Allegheny counties could especially benefit from the growth associated with greater adoption of ET vehicles and equipment. Employment declines in Adjacent and Support Industries between 2014 to 2019 were concentrated in those counties. A growing ET industry presents an opportunity for many of these other industries and their workers to regain their footing.

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[2] These projections are based on data from the Pennsylvania Department of Environmental Protection, the 2019 United States Energy Employment Report, and BLS QCEW.

[3] EMSI 2020.1

[4] Estimates come from the "Pennsylvania Electric Vehicle Roadmap" by the Pennsylvania Department of Environmental Protection (2019).

[5] Based on the analysis of Adjacent Industries.

[6] For definitions of these industries and occupations, please see the Glossary in Appendix D.

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INTRODUCTION

Advanced Energy Economy commissioned BW Research Partnership to quantify the number of companies and employees currently working in Pennsylvania's Electric Transportation (ET) supply chain, as well as to understand growth trends and opportunities for broader economic impact across the Commonwealth. For the purposes of this study, the ET sector is defined as any firms involved in the manufacturing, wholesale distribution, retail sale, installation, research and development, maintenance and repair of ET vehicles and equipment (including automobiles, light and heavy duty trucks, buses, industrial equipment, agricultural equipment, rail, recreational vehicles, and other ET), component parts (including battery, motor controller, electric engine, regenerative braking, and drive system components), and the infrastructure necessary for ET (including charging stations and associated storage and their component parts).

To perform this analysis, BW Research developed a comprehensive database of 12,496 firms that were potentially involved in ET work. Within this dataset, BW Research closely examined over 6,100 companies, prioritizing manufacturing operations. BW Research confirmed 151 firms with 177 unique locations with current involvement in the ET sector.

Because the ET sector is nascent and emerging, it is critically important to understand the opportunities for growth, the industrial infrastructure in place, and the skill profiles of the workforce in Pennsylvania. This information identifies the industries, companies, and workers that could readily transition to and benefit from an expanding ET market; in other words, "Adjacent" Industries and Occupations. Adjacent Industries are industries that provide similar goods or services and have workers who, along with Adjacent Occupations, often have overlapping knowledge, skills, and abilities to those currently involved in ET.

Sample of ET Companies in Pennsylvania

- Eaton
- LORD Corporation
- Accurate Control & Design Co.
- Siemens
- Mars Electric Inc.
- Mitsubishi Electric Power Products
- Choctaw Kaul
- Momentum Dynamics
- DURYEA Technologies
- Morgan Advanced Materials
- Burns Industrial Equipment
- Clipper Creek
- ABB
- Vivint Solar
- C.H. Waltz Sons Inc.
- Lion Electric Company

The growth of the ET market is expected to primarily transition, rather than expand, the transportation market. As a result, for service centers, dealerships, and some parts wholesalers and distributors, non-ET employment is expected to transition to ET-related employment rather than generate new and additional roles. However, Pennsylvania's supply chain is particularly strong in electronic component, motor, and generator manufacturing industries; these industries are poised to grow with ET but are relatively unaffected by declining sales of traditional transportation, as most of these firms are not involved in traditional transportation. This analysis therefore prioritizes these Adjacent Manufacturing Industries because they represent the most potential for net job creation in Pennsylvania.

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, in fact, 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[7], Motor and Generator Manufacturing, and Other Electronic Component Manufacturing.

Secondary Adjacent Manufacturing Industries include companies that are similar to existing ET companies, but less so than Immediate Adjacent Manufacturing Industries. These companies engage in the same general family of activities, but their transition to ET work would take more investment and time than for the Immediate Adjacent Manufacturing Industries. Examples of Secondary Adjacent Manufacturing Industries include Relay and Industrial Control Manufacturing; 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.[8] These include manufacturers as well as distributors and wholesalers. Growth in the ET market might require changes in operations, but as these firms tend to focus on raw materials and upstream components, those changes are likely to be minimal. These Support Industries are expected to strongly benefit from growth of the Pennsylvania ET supply chain. Examples include Plate Work Manufacturing, Iron and Steel Mills and Ferroalloy Manufacturing, and Machine Shops.

Company Snapshot

Momentum Dynamics
Chester County

Momentum Dynamics was founded in 2009 and has established itself as the global leader in high-power automatic wireless electric motor vehicle charging. The technology – which is similar to wireless phone charging but on a much more powerful scale – is mostly intended for fleets of buses and taxis but can also be used by consumer vehicles. The charging stations have the potential to improve the range of electric bus routes, allowing deeper commutes into the suburbs and local communities.

Founder Andy Daga started the firm in his home state of Pennsylvania, and the firm now plans to move into a building seven times larger than its current building, as Momentum Dynamic seeks to double its workforce to over 100 employees in the near future. The firm prides itself in locally sourcing the majority of its engineers.

[7] 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.
[8] Support industries do provide some raw materials to existing ET firms, but the small size of the current market has minimal relative impact.

ELECTRIC TRANSPORTATION AND PENNSYLVANIA

Around the nation, electric vehicle (EV) adoption rates are accelerating. Over the last decade, there have been many advances in EV technology – especially lithium-ion batteries, which make up a large part of the cost of an EV – leading to falling upfront costs and increased range. The cost of lithium-ion batteries fell 85% from 2010 to 2018[9] and many of today's vehicles offer a 200+ mile range. As the technology has evolved, consumers are increasingly recognizing the range of benefits associated with these vehicles, from faster acceleration and a quieter ride, to lower maintenance and fueling costs. Light-duty EV sales – including both Battery Electric Vehicles (BEVs) and Plug-in Hybrid Electric vehicles (PHEVs) – have grown a compound annual growth rate of 44% from 2011 to 2019.[10] While Tesla presently holds the largest share of the current EV market (40%), other car manufacturers are rapidly producing electric vehicle lines; 400 new EV models are projected to be in the market by 2023.[11] The automotive industry has historically been essential to the American economy, so the rise in global demand for EVs is an important trend for both national and individual state economic planning and analysis.

While the electrification of light-duty passenger vehicles may immediately come to mind, the medium- and heavy-duty EV markets are also growing. These include public transportation (e.g., buses and trains), trucking and freight, and mobile machinery such as warehouse (e.g., forklifts) and agricultural equipment (e.g., tractors, combines, etc.).

The growth in EV sales is a global phenomenon with roughly 2.2 million light-duty vehicles sold (roughly 330,000 were sold in the United States[12]) in 2019, with several key international markets (e.g., China, which is the world's largest vehicle market) leading the way.[13] As a state that is already a major supplier of ET parts and equipment, and is home to a number of adjacent industries with skillsets that could be applied to the ET market in the future, Pennsylvania is poised to see an important employment expansion as EV sales accelerate.

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[9] 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/

[10] FINAL UPDATE: Quarterly Plug-In EV Sales Scorecard (January 17, 2020). https://insideevs.com/news/343998/monthly-plug-in-ev-sales-scorecard/

[11] 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

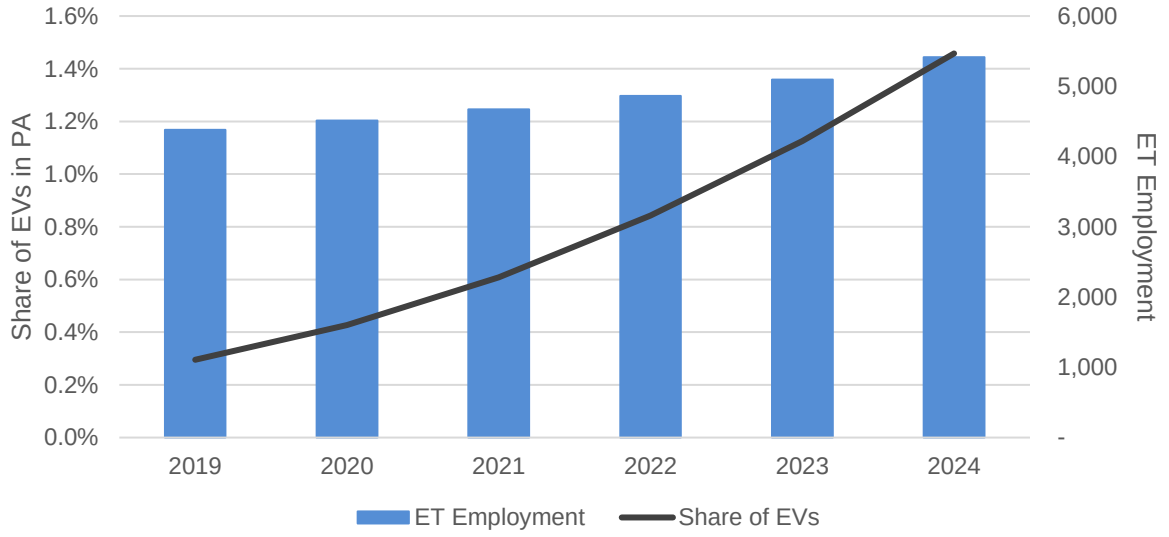
[12] FINAL UPDATE: Quarterly Plug-In EV Sales Scorecard (January 17, 2020). https://insideevs.com/news/343998/monthly-plug-in-ev-sales-scorecard/

[13] Global EV Sales For 2019 Now In, InsideEVs (February 2, 2020). https://insideevs.com/news/396177/global-ev-sales-december-2019/

THE PENNSYLVANIA ELECTRIC TRANSPORTATION WORKFORCE

Even at this early stage in market development, Pennsylvania boasts 4,400 jobs currently involved in the ET supply chain.[14] The sector has experienced 3.5% growth since 2017, but is expected to grow 24% between 2019 and 2024.[15] Figure 1 illustrates the projected growth in ET jobs in relation to the projected growth in share of EVs on the road in Pennsylvania. Since passenger vehicles make up a large share of the transportation sector, as the proportion of EVs on the road increases, the number of ET-related jobs rises as well.

Figure 1: Projected ET Employment and Share of Electric Vehicles (EVs)[16]



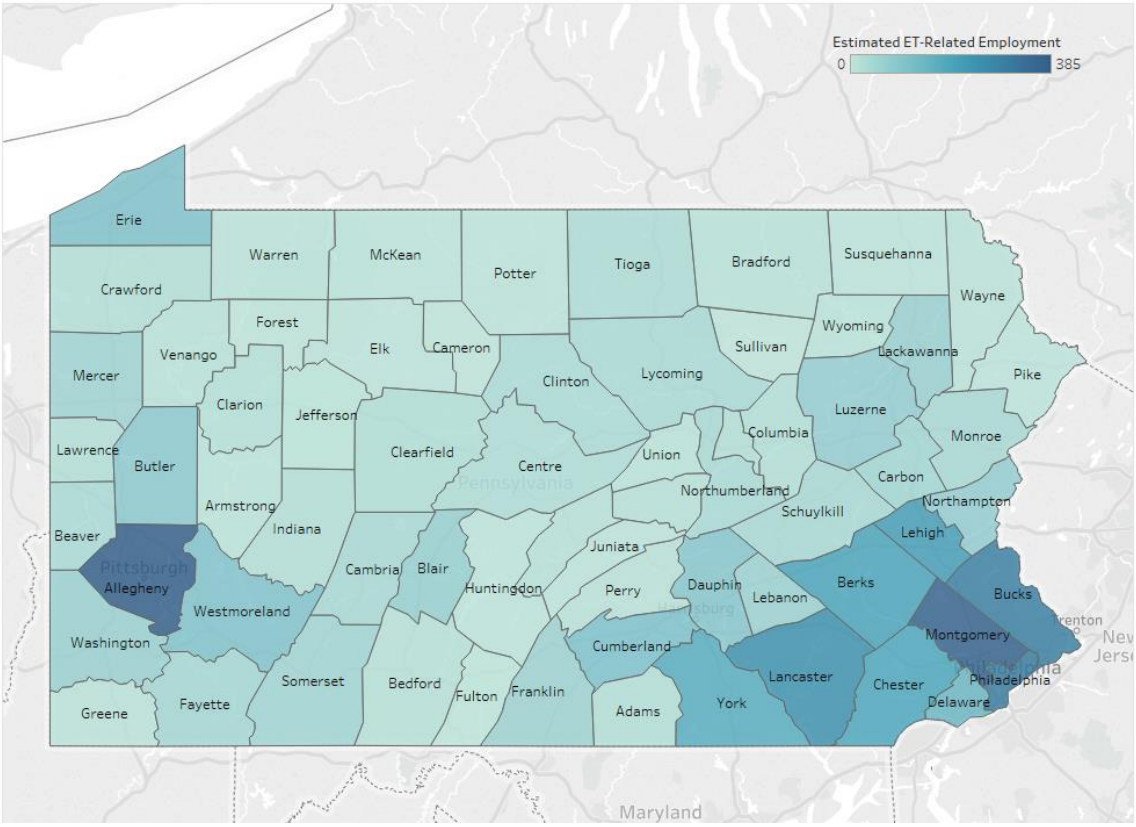
[14] This definition is based on a worker spending any time on electric transportation goods or services.

[15] These projections are based on data from the Pennsylvania Department of Environmental Protection, 2019 United States Energy and Employment Report, and BLS QCEW.

[16] Share of EVs is based on data from the Pennsylvania DMV.

ET jobs are in nearly every county in Pennsylvania. Allegheny, Montgomery, Philadelphia, Bucks, and Lancaster counties have the greatest number of ET-related workers (Figure 2).

Figure 2: ET-Related Employment, 2019



ET-related Gross State Product (GSP) was estimated to be more than $434 million in 2019, equivalent to Sporting Goods Stores within the Commonwealth. Motor Vehicle Manufacturing[17] was the greatest contributing factor to GSP, accounting for more than $120 million in revenues. Non-ferrous Foundries brought in more than $65 million in statewide revenues. Electronic and Electrical Goods Wholesale accounted for nearly $38 million in statewide revenues.

[17] This industry includes manufacturing of vehicle component parts.

Firms involved in repair and maintenance account for the greatest number of employees across the ET supply chain. These firms account for 42% of all ET-related employment in the state. Manufacturing accounts for one-fifth (21%) of ET-related employment, and wholesale trade and distribution accounts for 18% of employment in the ET value chain (Table 1).

Table 1: ET-Related Employment by Value Chain

Supply Chain	Employment	Share of Employment
Repair and Maintenance	1,842	42%
Manufacturing	936	21%
Wholesale Trade and Distribution	801	18%
Retail Trade	580	13%
Professional Services	220	5%
Construction	58	1%

Company Snapshot

Entropy Racing
Schuylkill County

Entropy Racing has been racing cars since the late 1980s but developed their first all-electric racecar in 2013. The car, EVSR, has proven competitive with its gas-powered counterparts, participating in many events across the nation. With the success of EVSR, Entropy pivoted toward electric vehicle development. In 2019, the firm hired a Chief of EV Development with the intention of expanding EV services. Today, the firm continues to develop and race EVSR but also performs EV consultation, electric conversion of classic cars, and resale of EV components. Of the firm's three mechanics hired over the past year, two are solely tasked with electric vehicles. The firm's mechanic shop is located 45-minutes north of Harrisburg in rural Schuylkill County.

Entropy continues to innovate in the electric vehicle field, looking into options for improving driveline capabilities. This year, the firm intends for their 2nd generation electric racecar, EVSR II, to become the first EV to compete in a series of endurance races. Education is central to Entropy Racing's mission as they recognize room for the Commonwealth's citizens to learn more about the benefits of electric cars, including minimal maintenance costs relative to traditional vehicles. Entropy Racing currently partners with Alfred State College (NY) and the Girl Scouts of America's FIRST Robotics Patrol.

Key ET occupations have high growth potential. The eight most numerous ET occupations listed in Table 2 account for about one-third of current ET employment in Pennsylvania. Automotive Service Technicians make up the greatest share of ET-related occupations and are expected to add about 120 ET jobs over five years. Half of these eight occupations have average hourly earnings above $20 an hour.

Table 2: Key ET Occupations

Key Occupations[18]	*2019 Jobs*	*Projected 2024 Jobs*[19]	*Average Hourly Earnings*
Automotive Service Technicians and Mechanics (including ASE certified technicians and mechanics)	590	718	$18.72
Assemblers and Fabricators, All Other, Including Team Assemblers	265	332	$15.72
Automotive Body and Related Repairers	259	306	$20.72
First-Line Supervisors of Mechanics, Installers, and Repairers	99	116	$32.37
Sales Representatives, Wholesale and Manufacturing, Except Technical and Scientific Products	96	106	$29.52
Welders, Cutters, Solderers, and Brazers	62	77	$19.59
Parts Salespersons	56	62	$14.91
First-Line Supervisors of Production and Operating Workers	42	53	$29.00

[18] Key occupations were identified based on total current employment within ET.

[19] Projected jobs are extrapolated from BLS OES occupational projections through 2024 and ET industry projections developed using data from the Pennsylvania Department of Environmental Protection, 2019 United States Energy and Employment Report, and BLS QCEW.

It is important to note that ET-related growth creates net new jobs in some segments of the economy, while other growth will replace non-ET activity. Current manufacturing industries in Pennsylvania that are well-positioned to support and supply the ET market are generally more focused on electric components as opposed to traditional automotive and other transportation goods. As a result, it is unlikely that there will be significant job replacement or elimination from growth in ET manufacturing in Pennsylvania, suggesting that most of the growth in these industries will produce notable net job growth. Conversely, among occupations in sales, service, and other downstream jobs, new ET activity is more likely to replace work currently focused on non-ET, resulting in fewer net new jobs than will be created in manufacturing. The same is likely to be true with wholesale trade, though less so among support industries that supply products from further upstream.

Company Snapshot

Eaton
Allegheny and Beaver County

Eaton's mission is to improve the quality of life and the environment through the use of power management technologies and services. We provide sustainable solutions that help our customers effectively manage electrical, hydraulic, and mechanical power – more safely, more efficiently, and more reliably. Our electrical business is a leader in electrical products, systems and services for power quality, distribution and control, and wiring and provides technology-driven solutions that serve the critical needs of the industrial, utility, commercial, residential, and information technology markets.

In Pennsylvania, Eaton's footprint consists of more than 1,500 employees at six locations. The Moon Township facility is home to Eaton's North America circuit breaker design center, and a circuit breaker manufacturing plant is located in the borough of Beaver. At these facilities, the company develops and builds Eaton Power Defense™ circuit breakers, which provide intelligent protection for electric vehicle charging equipment. In addition, Eaton's eMobility business combines products, expertise, and global manufacturing capabilities from Eaton's Electrical and Vehicle businesses to focus on three primary areas for both passenger car and commercial vehicles: intelligent power electronics, power systems, and advanced power distribution and circuit protection.

ADJACENT INDUSTRY ANALYSIS

The ET sector is intertwined with a number of existing industries within the state of Pennsylvania. In order to understand how increased ET activity could impact jobs in Pennsylvania, the research team identified "Adjacent Industries" that have similar workforce competencies, supply chains, and activities to current ET firms. Adjacent Industry analyses help identify talent with similar or complimentary skillsets that could allow for easy transition from one industry to another.

The Adjacent Industries identified in this report currently have little to no involvement in ET activities. Their importance lies in the workers, who have skillsets that would allow 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.

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 that are in the same industry group and progression of the supply chain, as well as those that provide raw materials to the other identified industries (for more information on these industry categories, see Appendix C.).

- **Immediate Adjacent Manufacturing Industries.** This category includes the industries that share a federal industry classification code (six-digit NAICS) with ET manufacturing companies. Transition to ET-related work would be most rapid for companies in Immediate Adjacent Manufacturing Industries. Examples include: Automobile Manufacturing; Motor and Generator Manufacturing; and Other Electronic Component Manufacturing.

- **Secondary Adjacent Manufacturing Industries.** This category includes industries that are in the same general industry classifications (four-digit NAICS codes) but differ at the more granular level (six-digit NAICS codes). These industries conduct the same family of 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 Railroad Rolling Stock 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 growth of the Pennsylvania ET supply chain. Examples include: Plate Work Manufacturing; Iron and Steel Mills and Ferroalloy Manufacturing; and Bolt and Machine Shops.

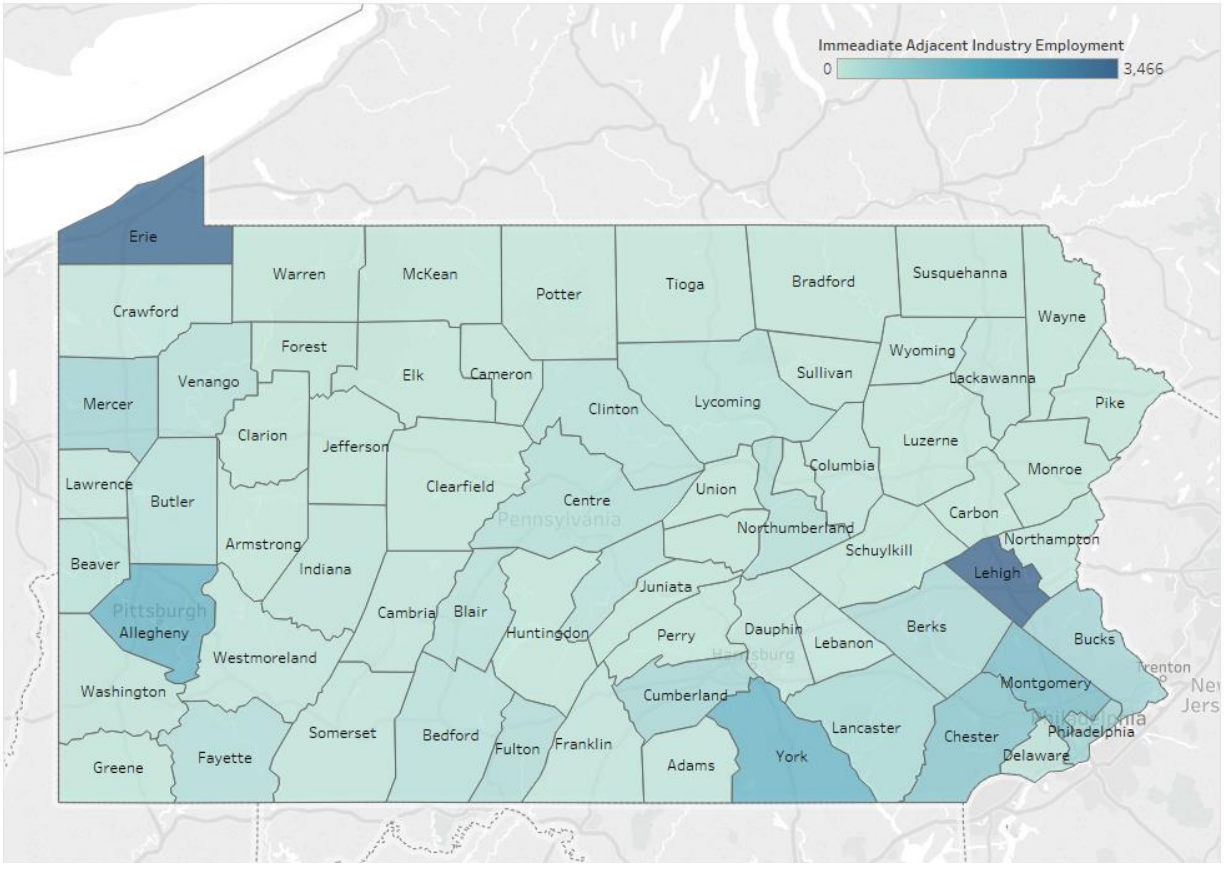
An Adjacent Occupational analysis is somewhat different, in that it is focused on individual workers in the labor market. Such an analysis identifies occupations with similar knowledge, skills, abilities, tasks, and other work activities, regardless of the industry in which they work. The result is a list of occupations that share enough similarities that required workforce or on-the-job training to transition to an ET job would be relatively minimal.

Immediate Adjacent Manufacturing Industries

Industry Analysis

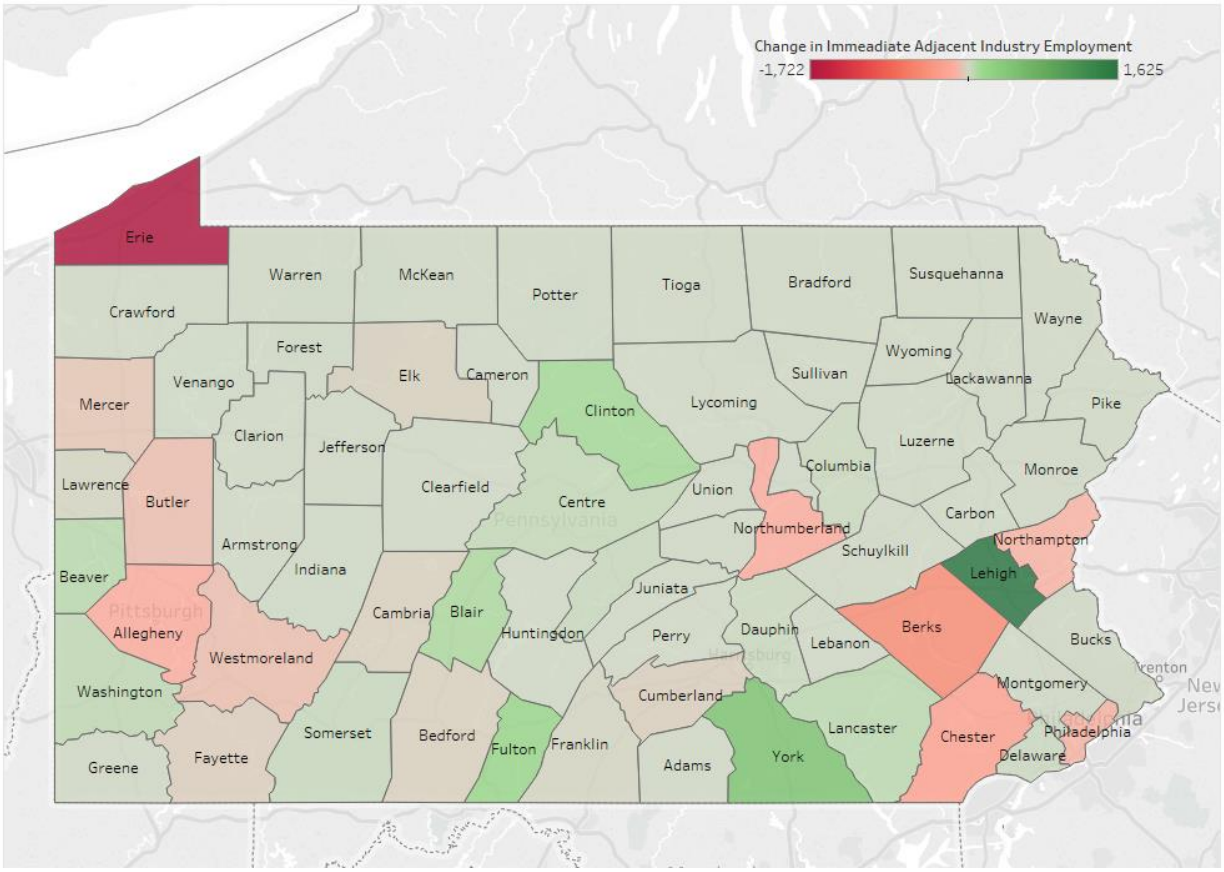
Immediate Adjacent Manufacturing Industries include manufacturing companies that are very similar (in terms of current goods produced and the workforce's abilities and skill sets) to companies identified as ET supply-chain manufacturers. Workers in these industries would have relatively little trouble transitioning to ET. Current workers in these industries are most heavily concentrated in Erie, Lehigh, Allegheny, and York counties (Figure 3). Among the 10 Immediate Adjacent Manufacturing Industries examined are: Motor & Generator Manufacturing; Automobile Manufacturing; Heavy Duty Truck Manufacturing; and Other Motor Vehicle Parts Manufacturing.

Figure 3: Immediate Adjacent Manufacturing Industry Employment, 2019



Between 2014 and 2019, 18 of the 67 counties in Pennsylvania lost employment in these Immediate Adjacent Manufacturing Industries. Erie, Berks, Chester, and Allegheny counties lost the greatest number of jobs in these industries (Figure 4). Increased demand for ET-capable workers could be a lifeline to many of these workers and their communities.

Figure 4: Change in Immediate Adjacent Manufacturing Industry Employment, 2014-2019



Occupation Analysis

Table 3 highlights overall, employment in key occupations that are critical to Immediate Adjacent Industries.[20] Assemblers and Fabricators have lost 2,400 jobs over the past five years (a 5% decline) and are projected to lose another 1,700 jobs over the next five years statewide. Machinists, who earn above average wages among the listed key occupations, have also declined in employment by 2% over the last 5 years. Inspectors, Testers, Sorters, Samplers, and Weighers, who also earn above-average wages, are projected to shed 1,400 workers (a 6% decline) over the next 5 years. Appendix A provides some key education, skill, and ability requirements for many of the occupations listed below. These workers have skills that are critical to ET-related work, so increased ET-related activity in Pennsylvania has the potential to create new opportunities for these workers with relatively little transition, resulting in greater job growth than currently projected.

Table 3. Key Immediate Adjacent Manufacturing Occupations

Key Occupations	2014 Jobs	2019 Jobs	Projected 2024 Jobs[21]	Average Hourly Earnings
Multiple Machine Tool Setters, Operators, and Tenders, Metal and Plastic	6,649	8,744	8,805	$18.37
Mechanical Engineers	14,637	16,841	17,292	$41.22
Laborers and Freight, Stock, and Material Movers, Hand	124,724	153,624	160,075	$15.19
First-Line Supervisors of Production and Operating Workers	27,664	28,398	28,519	$30.03
Machinists	17,905	17,461	17,844	$21.29
Electrical, Electronic, and Electromechanical Assemblers, Except Coil-Winders, Tapers, and Finishers	10,955	11,984	12,194	$16.94
Welders, Cutters, Solderers, and Brazers	15,631	16,277	16,693	$20.97
Inspectors, Testers, Sorters, Samplers, and Weighers	20,285	22,343	20,936	$20.12
Assemblers and Fabricators, All Other, Including Team Assemblers	48,291	45,866	44,195	$16.71
Industrial Engineers	8,251	9,610	10,133	$41.39

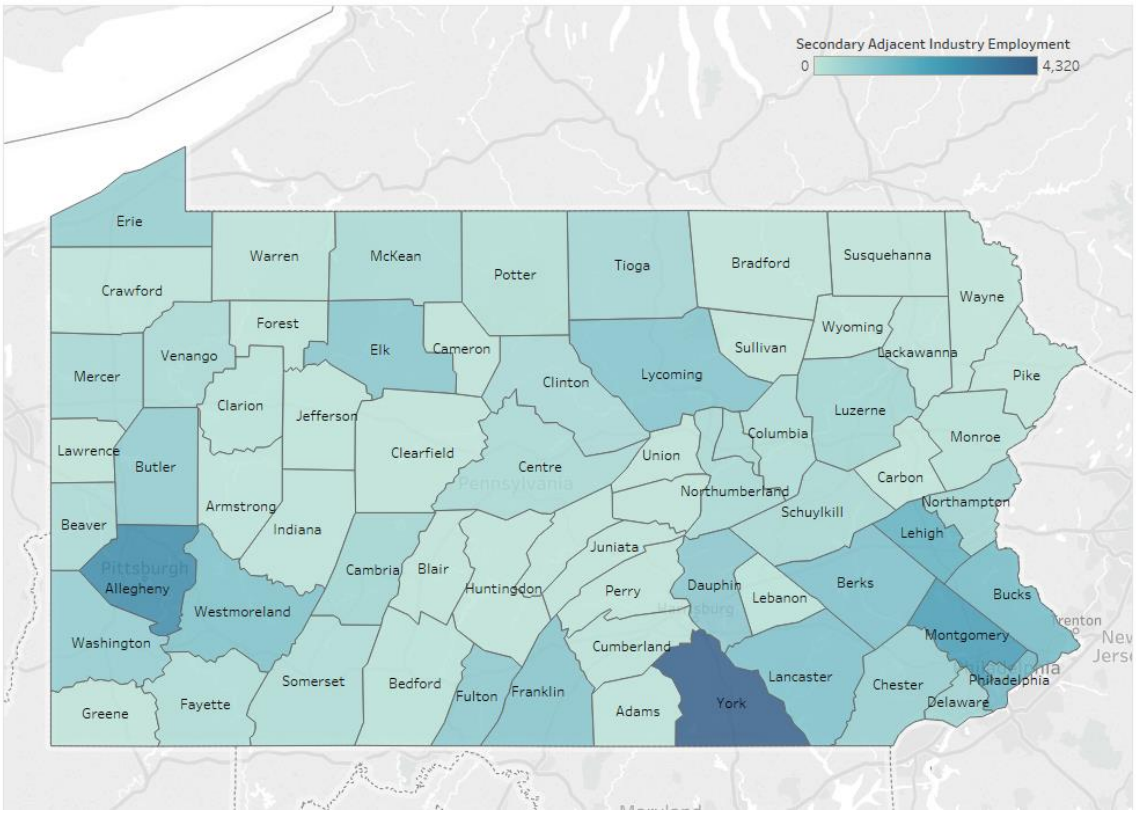
[20] Key occupations are determined through staffing patterns, which show the detailed occupations for a given industry.
[21] These projections are from EMSI 2020.1 and based on occupation-specific growth across the state. They are not based on ET growth estimates.

Secondary Adjacent Manufacturing Industries

Industry Analysis

Secondary Adjacent Manufacturing Industries include manufacturing industries that are related to the type of work done in the ET industry, but would require a bit more effort to transition to ET.[22] They include industries such as: Switchgear and Switch Board Apparatus Manufacturing and Semiconductor Manufacturing. Secondary Adjacent Manufacturing Industries employ a workforce that has relevant knowledge and skill sets, though workers may require some additional training and education in order to transition to an ET-related role. These 32 industries include: Motor Home Manufacturing; Boat Building; and Truck Trailer Manufacturing. These industries employed 35,800 workers in 2019 and employment has experienced steady growth over the past five years, growing 4% during this time. Current workers are most heavily concentrated in Allegheny, Montgomery, and York counties (Figure 5).

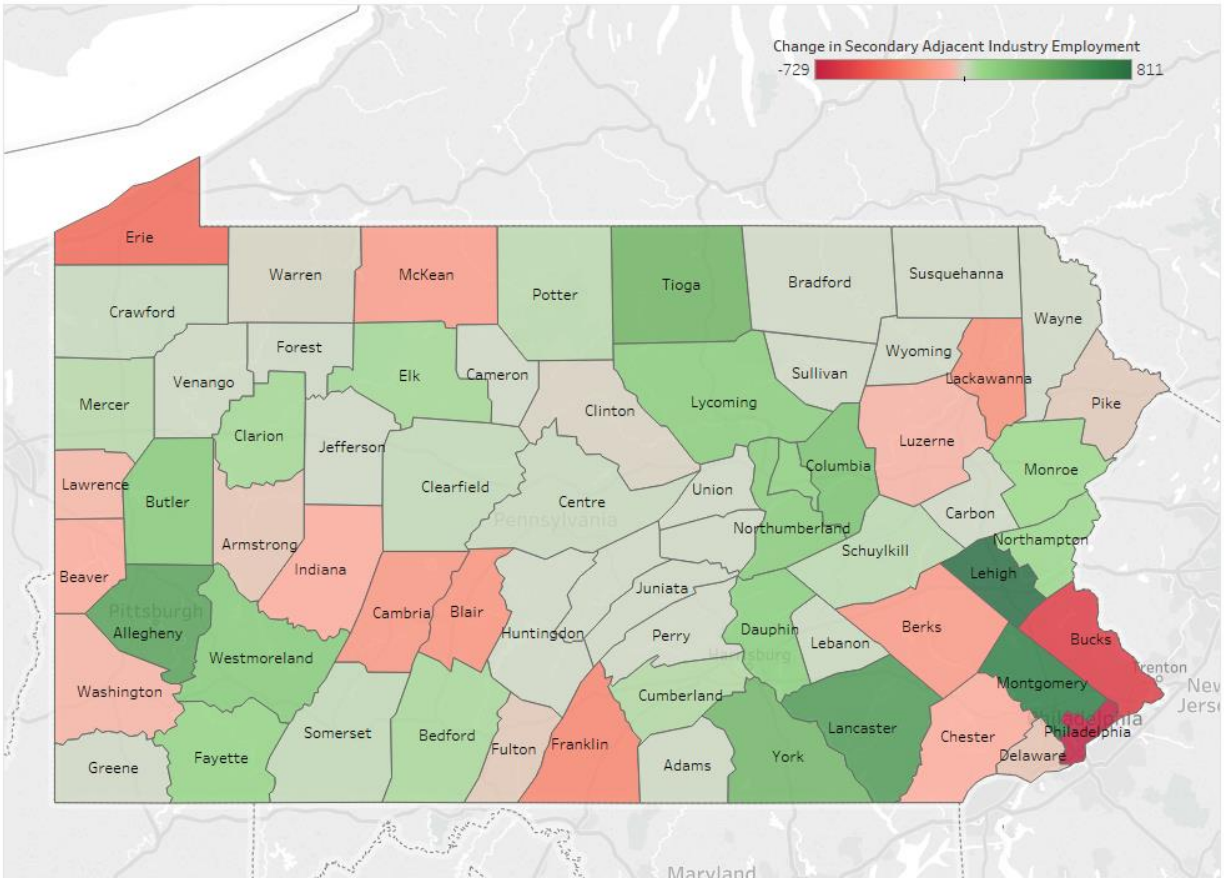
Figure 5: Secondary Adjacent Manufacturing Industry Employment, 2019



[22] Specifically, this includes all six-digit industries that share the same four-digit NAICS as the immediate Adjacent Industries.

Employment among Secondary Adjacent Industries declined in 21 out of 67 counties between 2014 and 2019. Philadelphia County experienced the largest decline in jobs (-729), followed by Bucks and Erie counties (Figure 6). Job losses in these industries could be offset by job gains in ET manufacturing, as many of the skillsets required in these industries are also relevant to ET manufacturing.

Figure 6: Change in Secondary Adjacent Manufacturing Industry Employment, 2014-2019



Occupational Analysis

Many of the occupational titles frequent among existing ET-related jobs are also common occupations among Secondary Adjacent Industries. For example, Table 4 highlights that there are more than 28,300 First-Line Supervisors of Production and Operating Workers, and more than 45,800 Assemblers and Fabricators throughout the state involved in non-ET work. This represents a substantial existing workforce that already has many of the required skills and abilities for equivalent ET-related work and could transition to ET-related work with relative ease and gain greater job growth than currently projected.

Table 4: Key Secondary Adjacent Occupations

Key Occupations	2014 Jobs	2019 Jobs	Projected 2024 Jobs[23]	Average Hourly Earnings
Mechanical Engineers	14,637	16,841	17,292	$41.22
Laborers and Freight, Stock, and Material Movers, Hand	124,724	153,624	160,075	$15.19
First-Line Supervisors of Production and Operating Workers	27,664	28,398	28,519	$30.03
Machinists	17,905	17,461	17,844	$21.29
Cutting, Punching, and Press Machine Setters, Operators, and Tenders, Metal and Plastic	8,284	8,097	7,878	$17.96
Electrical, Electronic, and Electromechanical Assemblers, Except Coil Winders, Tapers, and Finishers	10,955	11,984	12,194	$16.94
Welders, Cutters, Solderers, and Brazers	15,631	16,277	16,693	$20.97
Inspectors, Testers, Sorters, Samplers, and Weighers	20,285	22,343	20,936	$20.12
Assemblers and Fabricators, All Other, Including Team Assemblers	48,291	45,866	44,195	$16.71
Industrial Engineers	8,251	9,610	10,133	$41.39

[23] These projections are from EMSI 2020.1 and based on occupation-specific growth across the state. They are not based on ET growth estimates.

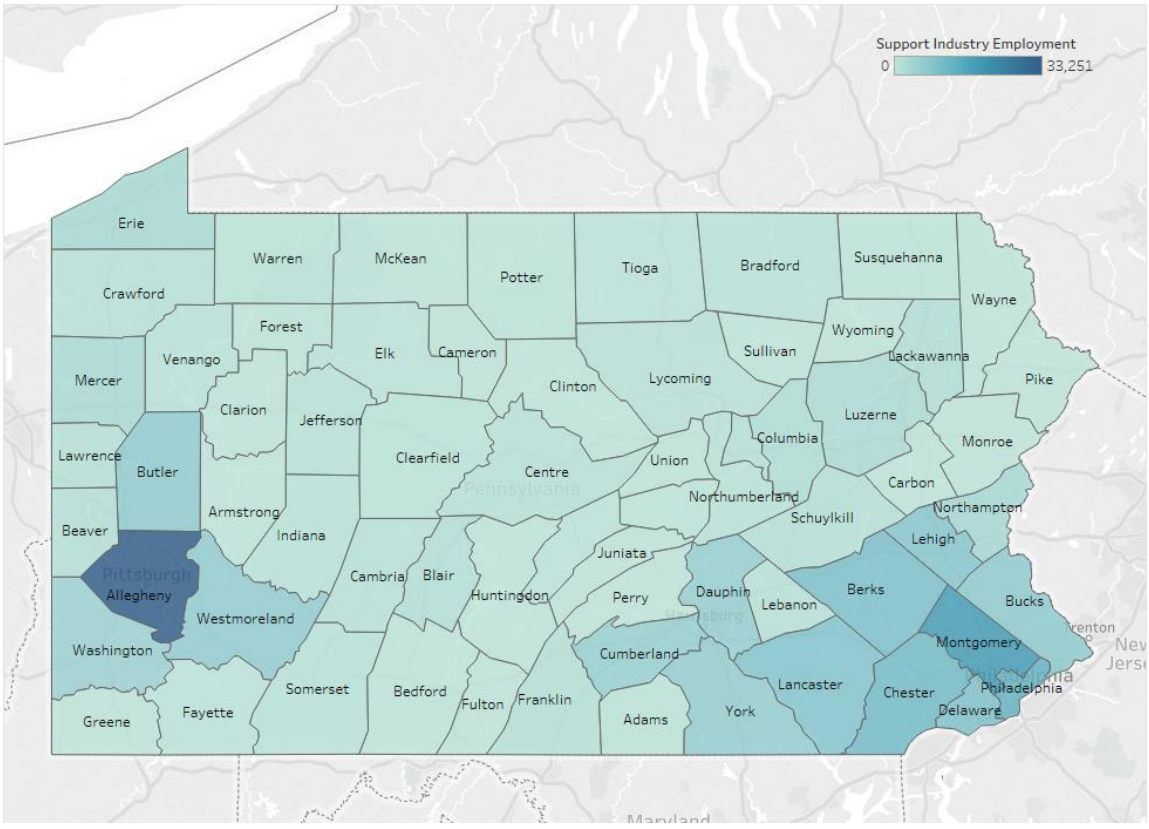
Support Industries

Industry Analysis

Support Industries include companies that are upstream suppliers to Adjacent Industries.[24] This means that as the demand for ET products increases, the demand for goods from Support Industries will increase as well. As the current demand for ET products and services is relatively low, upstream suppliers in Support Industries have only just begun to benefit from ET activities.

This new demand will be helpful to Pennsylvania's economy, particularly its manufacturing sector. There has been notable employment decline between 2014 and 2019 among the industries involved in the supply chain that will be needed for growth in ET manufacturing. Overall employment among these Support Industries – most heavily concentrated in Allegheny, Montgomery, and Chester counties (Figure 7) – has declined by 5,170 jobs (about 3%) over the past five years. Increased production of ET products will bolster employment in these 19 industries, including Fabricated Structural Metal Manufacturing, Industrial Machinery and Equipment, and Machine Shops.

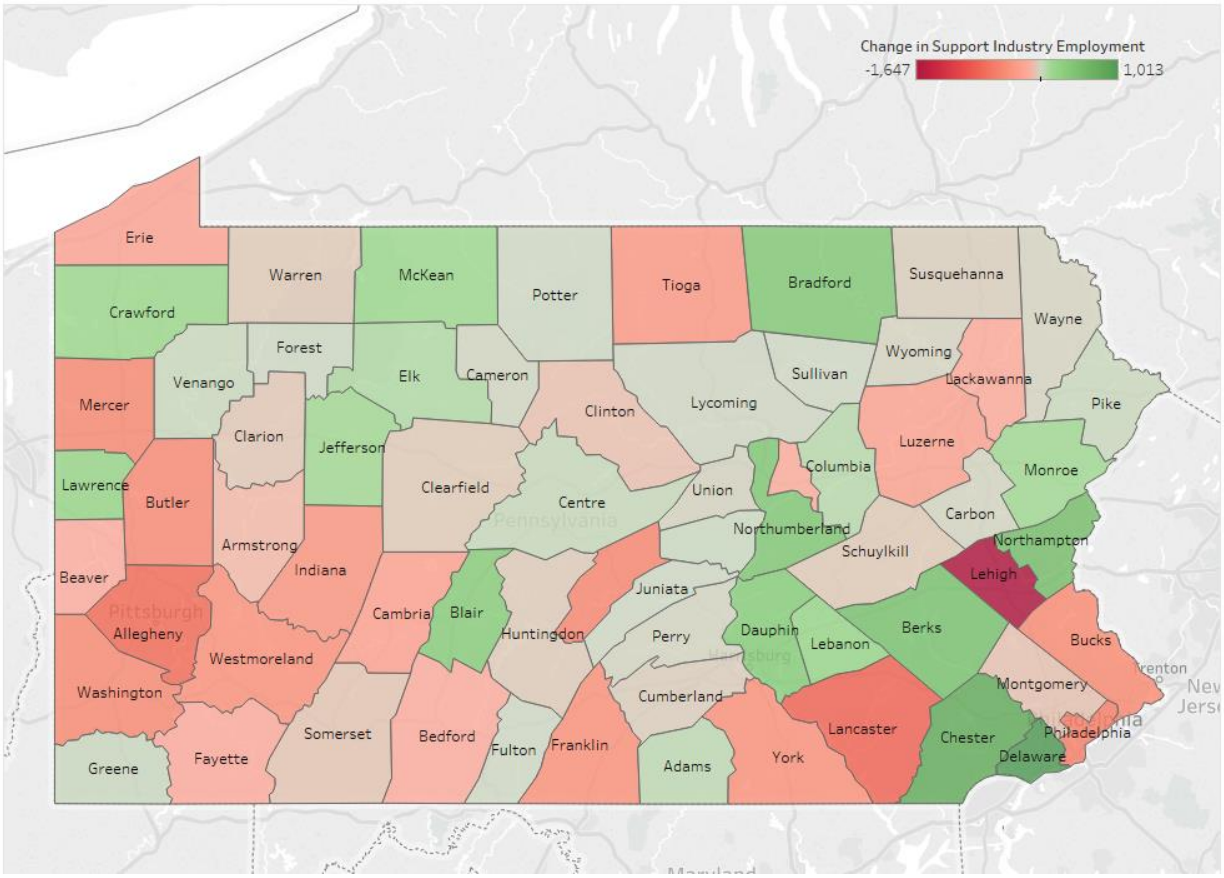
Figure 7. Support Industry Employment, 2019



[24] Support industries do provide some raw materials to existing ET firms, but the small size of the current market has minimal impact.

The overall decline in employment in Support Industries over the last five years was spread widely across the state, with 40 counties in Pennsylvania losing jobs between 2014 and 2019. Counties that lost the greatest number of jobs were Lehigh, Lancaster, and Allegheny (Figure 8). In Lehigh County alone, more than 1,600 jobs in these Support Industries were lost. Many of these jobs, such Assemblers and Fabricators, are key occupations for the current ET industry and could transition toward supporting a burgeoning ET sector in Pennsylvania.

Figure 8: Change in Support Industries Employment, 2014-2019



Occupational Analysis

Table 5 highlights statewide occupations that are currently minimally involved in ET but have potential to be more involved. Among key occupations in the Support Industries are Wholesale and Manufacturing Sales Representatives, which have declined by 1,633 sustainable-wage jobs ($35.23/hr on average) over the past five years across the state. The need for Wholesale and Manufacturing Sales Representatives will increase as ET products and services grow in market share, resulting in more jobs than currently projected. Please see Appendix A for occupational profiles, which highlight the knowledge, skills, and abilities required for many of these roles listed below.

Table 5: Key Support Industry Occupations

Key Occupation	2014 Jobs	2019 Jobs	Projected 2024 Jobs[25]	Average Hourly Earnings
Computer-Controlled Machine Tool Operators, Metal and Plastic	12,001	12,416	11,911	$19.17
Laborers and Freight, Stock, and Material Movers, Hand	124,724	153,624	160,075	$15.19
First-Line Supervisors of Production and Operating Workers	27,664	28,398	28,519	$30.03
Machinists	17,905	17,461	17,844	$21.29
Cutting, Punching, and Press Machine Setters, Operators, and Tenders, Metal and Plastic	8,284	8,097	7,878	$17.96
Sales Representatives, Wholesale and Manufacturing, Except Technical and Scientific Products	59,333	57,700	61,346	$35.23
Welders, Cutters, Solderers, and Brazers	15,631	16,277	16,693	$20.97
Inspectors, Testers, Sorters, Samplers, and Weighers	20,285	22,343	20,936	$20.12
Assemblers and Fabricators, All Other, Including Team Assemblers	48,291	45,866	44,195	$16.71
Engine and Other Machine Assemblers	1,096	990	953	$23.12

[25] These projections are from EMSI 2020.1 and based on occupation-specific growth across the state. They are not based on ET growth estimates.

Company Snapshot

Charge Forward LLC

Lancaster County

Charge Forward was founded in 2016 to fill a knowledge gap between businesses and the benefits (including incentives) associated with electric vehicle charging stations. The firm focuses on consulting and assisting businesses in the installation of charging systems on their properties. Charge Forward's first project was the installation of a solar-powered charging station at a shopping center that provided free charging supported by advertising local businesses on a digital display.

When the firm advises business owners on how to market and leverage charging stations, they remain neutral to both manufacturer and electrical contractor but typically contract with electricians local to the project. Charge Forward also outsources some of its marketing and administrative work to businesses within Pennsylvania. The firm's founder, Travis Eckert, is proud of the strides Pennsylvania has made in EV awareness over the past few years; he sees the largest potential for growth in incentivizing charging station installation in apartment complexes and large employment facilities.

CONCLUSION

The Electric Transportation (ET) sector accounts for nearly 4,400 jobs at 177 locations (151 companies) in 65 counties across the state. ET-related jobs are projected to increase 24% between 2019 and 2024, driven by the increasing share of electric vehicles and increasing the demand for ET products. Many of these occupations offer sustainable wages and careers.

ET jobs represent a diverse range of employment opportunities for workers in the region. More than one-fifth of current ET workers are involved in manufacturing, which presents substantial opportunity for displaced, or at-risk of being displaced, workers in other industries with manufacturing experience. A number of related occupations (such as Assemblers and Fabricators, as well as Cutting, Punching, and Press Machine Setters, Operators and Tenders) have experienced recent declines in employment. The skill sets involved in these occupations would allow workers to transition to ET jobs with little or no additional training, which means ET could provide these occupations with a critical opportunity for growth.

ET also represents a significant opportunity for companies in Support Industries, or the industries that supply raw materials to industries further down the supply chain. Forty counties lost employment in these industries between 2014 and 2019. If ET-related products and services continue to increase in demand, these Support Industries will see growing demand as well, potentially reversing some of the employment losses.

The ET sector in Pennsylvania is nascent but exhibits potential for strong growth in the future, due to increasing local, state, and national demand for cleaner transportation. As a state with both automobile and electrical industry supply chains, Pennsylvania is in prime position to advance the state's transportation infrastructure while providing well-paying jobs to resident workers.

APPENDIX A: OCCUPATIONAL PROFILES

BW Research assembled these occupational profiles to highlight some key occupations involved in manufacturing of ET goods. These occupations are well-paying positions that require and build skills, while also offering pathways that lead to a sustainable career. These occupations were among the most common in the primary manufacturing industries identified. Job figures, earnings data, and education and experience requirements for the occupational profiles were collected from EMSI 2020.1. Occupation definitions, knowledge, skills, and abilities, and related occupations were obtained from O*NET.

Assemblers and Fabricators, All Other, Including Team Assemblers

- 7,021 jobs in Pennsylvania
- Median annual earnings: $32,069 ($15.72/hr)
- High school diploma or equivalent
- No work experience required (entry-level)

Definition

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.

Related Occupations

- Welding, Soldering, and Brazing Machine Setters, Operators, and Tenders
- Cleaning, Washing, and Metal Pickling Equipment Operators and Tenders
- Paper Goods Machine Setters, Operators, and Tenders

	Top Knowledge, Skills, and Abilities
KNOWLEDGE	• Production and Processing • Education and Training • English Language
SKILLS	• Coordination • Speaking • Monitoring
ABILITIES	• Oral Comprehension • Multi-limb Coordination • Oral Expression

Welders, Cutters, Solderers, and Brazers

- 2,282 jobs in Pennsylvania
- Median annual earnings: $39,964 ($19.59/hr)
- High school diploma or equivalent
- No work experience required (entry-level)

Definition

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.

Related Occupations

- Sheet Metal Workers
- Automotive Body and Related Repairers
- Tile and Marble Setters

	Top Knowledge, Skills, and Abilities
KNOWLEDGE	• Mechanical • Design • Production and Processing
SKILLS	• Monitoring • Quality Control Analysis • Coordination
ABILITIES	• Control Precision • Near Vision • Visualization

Electrical, Electronic, and Electromechanical Assemblers, Except Coil Winders, Tapers, and Finishers

- 2,092 jobs in Pennsylvania
- Median annual earnings: $33,130 ($16.24/hr)
- High school diploma or equivalent
- No work experience required (entry-level)

Definition

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

Related Occupations

- Milling and Planing Machine Setters, Operators, and Tenders, Metal and Plastic
- Electromechanical Equipment Assemblers
- Team Assemblers

Top Knowledge, Skills, and Abilities

KNOWLEDGE	• Mechanical • Design • Production and Processing
SKILLS	• Reading Comprehension • Operation Monitoring • Critical Thinking
ABILITIES	• Near Vision • Visualization • Finger Dexterity

First-Line Supervisors of Production and Operating Workers

- 1,469 jobs in Pennsylvania
- Median annual earnings: $59,160 ($29.00/hr)
- High school diploma or equivalent
- Less than 5 years of work experience required (mid-level)

Definition

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.

Related Occupations

- First-Line Supervisors of Animal Husbandry and Animal Care Workers
- First-Line Supervisors of Construction Trades and Extraction Workers
- First-Line Supervisors of Landscaping, Lawn Service, and Groundskeeping Workers

Top Knowledge, Skills, and Abilities

KNOWLEDGE	• Mechanical • Production and Processing • Administration and Management
SKILLS	• Coordination • Speaking • Critical Thinking
ABILITIES	• Oral Comprehension • Oral Expression • Deductive Reasoning

Laborers and Freight, Stock, and Material Movers, Hand

- 1,362 jobs in Pennsylvania
- Median annual earnings: $28,805 ($14.12/hr)
- No formal education credential
- No work experience required (entry-level)

Definition

Manually move freight, stock, or other materials or perform other general labor. Includes all manual laborers not elsewhere classified.

Related Occupations

- Helpers--Production Workers
- Sawing Machine Setters, Operators, and Tenders, Wood
- Welding, Soldering, and Brazing Machine Setters, Operators, and Tenders

Top Knowledge, Skills, and Abilities

KNOWLEDGE	• Mathematics • Transportation • Mechanical
SKILLS	• Coordination • Operation and Control • Operation Monitoring
ABILITIES	• Static Strength • Trunk Strength • Multi-limb Coordination

Mechanical Engineers

- 1,051 jobs in Pennsylvania
- Median annual earnings: $79,703 ($39.07/hr)
- Bachelor's degree
- No work experience required (entry-level)

Definition

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.

Related Occupations

- Nuclear Engineers
- Aerospace Engineers
- Materials Engineers

	Top Knowledge, Skills, and Abilities
KNOWLEDGE	• Engineering and Technology • Design • Mathematics
SKILLS	• Reading Comprehension • Mathematics • Complex Problem Solving
ABILITIES	• Deductive Reasoning • Oral Comprehension • Oral Expression

Multiple Machine Tool Setters, Operators, and Tenders, Metal and Plastic

- 1,011 jobs in Pennsylvania
- Median annual earnings: $37,067 ($18.17/hr)
- High school diploma or equivalent
- No work experience required (entry-level)

Definition

Set up, operate, or tend more than one type of cutting or forming machine tool or robot.

Related Occupations

- Drilling and Boring Machine Tool Setters, Operators, and Tenders, Metal and Plastic
- Machinists
- Extruding and Forming Machine Setters, Operators, and Tenders, Synthetic and Glass Fibers

	Top Knowledge, Skills, and Abilities
KNOWLEDGE	• Mechanical • Mathematics • Production and Processing
SKILLS	• Operation Monitoring • Operation and Control • Quality Control Analysis
ABILITIES	• Control Precision • Visualization • Selective Attention

Inspectors, Testers, Sorters, Samplers, and Weighers

- 994 jobs in Pennsylvania
- Median annual earnings: $39,127 ($19.18/hr)
- High school diploma or equivalent
- No work experience required (entry-level)

Definition

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.

Related Occupations

- Electrical and Electronic Equipment Assemblers
- Weighers, Measurers, Checkers, and Samplers, Recordkeeping
- Team Assemblers

Top Knowledge, Skills, and Abilities

KNOWLEDGE	• Production and Processing • Mathematics • English Language
SKILLS	• Critical Thinking • Reading Comprehension • Operation Monitoring
ABILITIES	• Oral Comprehension • Oral Expression • Near Vision

Sales Representatives, Wholesale and Manufacturing, Except Technical and Scientific Products

- 57,700 jobs in Pennsylvania
- Median annual earnings: $61,402 ($29.52/hr)
- High school diploma or equivalent
- No work experience required (entry-level)

Definition

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.

Related Occupations

- Insurance Sales Agents
- Insurance Underwriters
- Sales Representatives, Wholesale and Manufacturing, Technical and Scientific Products

	Top Knowledge, Skills, and Abilities
KNOWLEDGE	• Sales and Marketing • Customer and Personal Service • English Language
SKILLS	• Active Listening • Speaking • Persuasion
ABILITIES	• Oral Comprehension • Oral Expression • Speech Clarity

Automotive Service Technicians and Mechanics

- 30,365 jobs in Pennsylvania
- Median annual earnings: $38,938 ($18.72/hr)
- Postsecondary nondegree award
- No work experience required (entry-level)

Definition

Diagnose, adjust, repair, or overhaul automotive vehicles.

Related Occupations

- Bus and Truck Mechanics and Diesel Engine Specialists
- Motorcycle Mechanics
- Outdoor Power Equipment and Other Small Engine Mechanics

	Top Knowledge, Skills, and Abilities
KNOWLEDGE	• Mechanical • Customer and Personal Service • English Language
SKILLS	• Repairing • Troubleshooting • Operation and Control
ABILITIES	• Manual Dexterity • Arm-Hand Steadiness • Control Precision

Machinists

- 17,461 jobs in Pennsylvania
- Median annual earnings: $43,722 ($21.02/hr)
- High school diploma or equivalent
- No work experience required (entry-level)

Definition

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.

Related Occupations

- Multiple Machine Tool Setters, Operators, and Tenders, Metal and Plastic
- Drilling and Boring Machine Tool Setters, Operators, and Tenders, Metal and Plastic
- Tool Grinders, Filers, and Sharpeners

Top Knowledge, Skills, and Abilities

KNOWLEDGE	• Mathematics • Mechanical • Production and Processing
SKILLS	• Operation Monitoring • Critical Thinking • Operation and Control
ABILITIES	• Arm-Hand Steadiness • Manual Dexterity • Control Precision

APPENDIX B: 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.

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 12,496 firms in the assembled potential database, 6,163 firms were examined closely by the research team. Of these, 849 were contacted via telephone at least once. Of the 6,333 firms that remain unexamined, 90% fall under five industry codes: 37% percent are electrical contracting firms, 24% are miscellaneous durable goods wholesalers, 18% are urban transit systems, 6% are industrial machinery and equipment wholesalers, and 6% are other electronic parts and equipment merchant wholesalers.

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

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

Having confidently determined the involvement of 2,625 firms out of the BLS estimated 10,293 firms in industries that were identified as potentially involved in ET, the margin of error is among these industries is approximately 1.65% for incidence.

APPENDIX C: INDUSTRY GROUP DEFINITIONS

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

Table 6: Immediate Adjacent Manufacturing Industries

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

Table 7: Secondary Adjacent Industries

NAICS Code	Description
333921	Elevator and Moving Stairway Manufacturing
333922	Conveyor and Conveying Equipment Manufacturing
333923	Overhead Traveling Crane, Hoist, and Monorail System Manufacturing
334310	Audio and Video Equipment Manufacturing
334412	Bare Printed Circuit Board Manufacturing
334413	Semiconductor and Related Device Manufacturing
334416	Capacitor, Resistor, Coil, Transformer, and Other Inductor Manufacturing
334417	Electronic Connector Manufacturing
334418	Printed Circuit Assembly (Electronic Assembly) Manufacturing
335311	Power, Distribution, and Specialty Transformer Manufacturing
335313	Switchgear and Switchboard Apparatus Manufacturing
335314	Relay and Industrial Control Manufacturing
335991	Carbon and Graphite Product Manufacturing
336112	Light Truck and Utility Vehicle Manufacturing

336212	Truck Trailer Manufacturing
336213	Motor Home Manufacturing
336214	Travel Trailer and Camper Manufacturing
336310	Motor Vehicle Gasoline Engine and Engine Parts Manufacturing
336320	Motor Vehicle Electrical and Electronic Equipment Manufacturing
336330	Motor Vehicle Steering and Suspension Components (except Spring) Manufacturing
336340	Motor Vehicle Brake System Manufacturing
336350	Motor Vehicle Transmission and Power Train Parts Manufacturing
336360	Motor Vehicle Seating and Interior Trim Manufacturing
336370	Motor Vehicle Metal Stamping
336412	Aircraft Engine and Engine Parts Manufacturing
336413	Other Aircraft Parts and Auxiliary Equipment Manufacturing
336414	Guided Missile and Space Vehicle Manufacturing
336415	Guided Missile and Space Vehicle Propulsion Unit and Propulsion Unit Parts Manufacturing
336419	Other Guided Missile and Space Vehicle Parts and Auxiliary Equipment Manufacturing
336611	Ship Building and Repairing
336612	Boat Building
336992	Military Armored Vehicle, Tank, and Tank Component Manufacturing

Table 8: Support Industries

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

APPENDIX D: GLOSSARY OF TERMS

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

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

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

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

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

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

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

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

Electrical, Electronic, and Electromechanical Assemblers (Except Coil Winders, Tapers, and Finishers): Assemble or modify electromechanical equipment or devices, such as servomechanisms, gyros, dynamometers, magnetic drums, tape drives, brakes, control linkage, actuators, and appliances.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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