Amping Up Electric Vehicle Manufacturing in the PNW

OPPORTUNITIES FOR BUSINESS, WORKFORCE, AND EDUCATION

Seattle Jobs Initiative
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Abbreviations

EV……………………………………………………….……………………….…….............…Electric Vehicle

ET…………………………………………………….………………………………………..Electric Truck

GST……………………………………………….…………………………...General Service Technician

I-BEST…….………………………………………….……….…Integrated Basic Education and Skills Training

ICE……...………………………………………………………………………Internal Combustion Engines

NAICS…………………………………………..….………….North American Industry Classification System

OEM…………………………………………….………………………….Original Equipment Manufacturer

PSADA……………………………………………………..…Puget Sound Automotive Dealership Association

SJI……………………………………………….……………………………………….Seattle Jobs Initiative

ZEB………………………………………………….…………………………………….Zero-Emissions Bus

Executive Summary

Both Oregon and Washington are national leaders in adopting and supporting climate change policies and initiatives. A key component in both states' broader climate strategy is the electrification of transportation. Only by significantly increasing the share of electric passenger and commercial cars (EVs) on the roads will the states be able to reduce their greenhouse gas emissions and meet their climate goals.

This report addresses the capacity of Oregon and Washington to advance the electrification of their transportation systems through economic and workforce development strategies. The report analyzes the existing EV manufacturing sector in the two states and its capacity for growth, as well as the current workforce and training programs in the EV field. The analysis suggests that Oregon and Washington are well positioned to attract new EV-related business, given the existing activity in the field and the strength of well-established regional tech and aerospace sectors, both of which offer potential synergies in the production of EVs.

Despite the strength and potential of EV manufacturing in the two states, additional workforce initiatives are needed to ensure the field is more equitable and sustainable. In particular, women and people of color are currently over-represented in EV-related occupations with negative economic outlook. By designing and implementing training initiatives that increase access to promising career paths, and by working with the private and education sectors to develop EV specific curricula, the public sector can help build a pipeline of qualified and diverse workers to support the growth of EV business in the region.

Key Findings

Supply chains are developing, making room for new businesses. The production of electric motor vehicles, including passenger and commercial fleets, is undergoing dramatic changes due to technological innovations and new business models in the field. Many of the main components of EVs are not among the key competencies of traditional car manufacturers. Consequently, the barriers to entry to EV manufacturing are low, and new small- and medium-sized companies that have been excluded from the traditional car supply chain have more room to enter the market.

Oregon and Washington have existing EV business and the potential for growth. This report draws from existing work and original research to identify 39 companies in Oregon and Washington in the EV field. The companies include large multinational corporations, such as Daimler in Oregon and Paccar and its subsidiary Kenworth Trucks in Washington, and smaller businesses such as custom car producers Arcimoto in Oregon and Commuter Cars Corporation in Washington. The number of identified companies with explicit connections to the EV supply chain does not fully reflect the region's potential to EV manufacturing, however. This is because the region hosts well-established tech and aerospace industries, which offer potential synergies in the EV field.

Jobs in EV supply chains are predicted to grow, though the predicted growth varies across occupations. With the increasing electrification of transportation, jobs in the EV supply chain in the region are growing. Oregon is predicted to have 6% more jobs in occupations most closely related to the EV supply chain in 2025 than in 2019, and the predicted growth in Washington is 7%. There are differences between occupations, however. For example, jobs for Electricians, Software Developers, and Operations Research Analysts, the highest growing occupations in both states, are expected to grow at an average of 13.4% in Oregon and 15.0% in Washington. At the same time, the occupations with most negative outlook, Electronic Equipment Installers and Repairers for Motor Vehicles, and Electrical, Electronic, and Electromechanical Assemblers are predicted to decline at an average of 8.0% in Oregon and 9.3% in Washington.

Women and people of color in the EV-related workforce are particularly vulnerable to economic trends. The different growth rates of occupations most closely related to the EV supply chain have dramatic implications for the workforce because the demographics of the workforce varies across occupations. In particular, the share of women is much higher in the occupations that are expected to see a decline in jobs, 33%, than in the occupations with expected growth, 16%. For comparison, the overall share of women in the field in the Pacific Northwest is 19%. Similarly, the share of people of color is higher in the occupations with a negative outlook: 36% of the workforce in the declining occupations are people of color, compared to the 31% in the occupations with predicted growth. Overall, people of color are 33.5% of the workforce in the field in the Pacific Northwest. The demographics vary greatly between occupational groups and occupations, however. For example, the share of Asian and Asian American workers is particularly high in many Architecture and Engineering Occupations (19% of the workforce in Oregon and 18% in Washington) and Computer and Mathematical Occupations (21% of the workforce in Oregon and 39% in Washington), thus driving up the overall share of people of color in the field and in the EV-related occupations with a positive outlook. For comparison, the share of Asian and Asian American workers in the overall workforce in the Pacific Northwest is 8.0%.

Recommendations

To ensure a pipeline of qualified workers in the growing EV field, and to develop a workforce development strategy that leads to a more equitable and more sustainable sector, this report recommends the following:

Innovate together with key partners in industry, the public sector, and education and training institutions. Multiple industry experts consulted for this project called for collaboration and coordination between the public, private, and education sectors. The findings of this report support such collaboration. The final section presents the Professional Automotive Training Center at Shoreline Community College in Washington as an example of a successful public-private training partnership: The Center hosts various Service Technician training programs in which auto manufacturers work together with the college to provide the curriculum. The Center has trained more than 1,300 students and the programs have resulted in significant savings in training costs for the partnering employers. Moreover, the programs have successfully placed students in living-wage jobs. By bringing the different stakeholders together, the public sector can play a leading role in ensuring that the technological and business advancements occurring in the EV field are coupled with equally innovative training programs and initiatives in the public sector.

Design and implement training initiatives directed at underserved populations. The workforce research highlights a lack of diversity in certain EV-related occupations and economic trends with negative implications for women and people of color. We recommend designing training programs in the EV field that would target underserved populations and connect them to living wage jobs. For example, the I-BEST programs in Washington provide educational access to individuals who have traditionally struggled in college-level occupational programs, including adult basic education and English-as-a-second-language students. The I-BEST programs provide joint instruction by a basic skills teacher and a technical or academic teacher, helping students with low levels of academic skill to succeed in college-level coursework. In addition to these sorts of college-led programs, underserved populations can benefit from shorter training programs that focus on creating access to entry-level positions. These initiatives have shown promise in many other sectors.

Develop EV-specific curricula and trainings. As the technology in electric vehicles continues to develop and the mass production of EVs expands, the need for a more specialized workforce increases. We recommend working with institutions that have strong educational programs in the EV-related fields to develop curricula and training that is directed at the particular needs of EV production. Public-private training partnerships can also play a role here, as partners in the private sector know the rapidly-changing industry and its occupational needs best, whereas the public sector can ensure that the interventions and initiatives adopted lead to a more diverse and inclusive industry.

The Openings for New Business that Electric Vehicle Production Can Create

As the electrification of transportation continues in the U.S., drivers in the Pacific Northwest have proven to be the among the early adopters. In 2018, the market share of sold electric vehicles (EVs) was higher in Washington (4.3%) and Oregon (3.4%) than in any other state, except for California (7.8%).[1] Moreover, the growing number of electric motor vehicles in the region is not limited to electric cars. For example, the region has adopted an electric school bus,[2] an electric solid waste truck,[3] and electric buses powered by wind energy.[4]

Yet, for two main reasons, we have a very limited understanding of the potential implications of growing electric vehicle[*] sales on workers. First, the supply chains of electric motor vehicles are still developing, due to dramatic technological changes in the field. Many of the key actors in the emerging electric motor vehicle manufacturing are start-ups or small-to-medium sized enterprises that may not be involved in the established supply chains of non-electric motor vehicles.[5–7] Given this emergence of new actors, and the dramatic changes in technology and business models that are closely related to their entrance to the field, the impacts of growing electric motor vehicle manufacturing on the labor force are hard to predict.

Second, the existing labor market data does not track the businesses and jobs in electric motor vehicle manufacturing. More specifically, the standard classification system for businesses and jobs in the U.S., the North American Industry Classification System (NAICS), does not distinguish between the manufacturing of traditional cars and electric cars; or the manufacturing of electric and traditional light trucks and utility vehicles; or the manufacturing of electric and traditional heavy-duty trucks. As a result, the classification does not allow us to analyze the labor force involved in electric motor vehicle manufacturing.[†] The lack of labor market data complicates the analysis of current workers in the sector and this, in turn, makes it difficult to predict future trends.

This report is based on original research that Seattle Jobs Initiative (SJI) conducted with the goal of analyzing the electric motor vehicle-related business in Oregon and Washington, assessing the current and future regional occupational needs in the industry, and identifying potential partners to engage in workforce training. To overcome some of the challenges that the changing supply chains and the lack of data pose, and to achieve a comprehensive assessment of Oregon's and Washington's capacity and potential in EV-related motor vehicle production, SJI undertook the following research tasks:

- Review of existing literature on electric motor vehicle production, including cars, trucks, and buses. The literature review helped us identify the NAICS codes most relevant to the electric

[*] In this report, the term "electric motor vehicle" will include both electric cars and electric commercial vehicles, including buses and trucks.

[†] The Bureau of Labor Statistics (BLS) began to address this issue in 2010 by developing a coding standard that would identify industries and jobs related to producing goods or services that benefit the environment or conserve natural resources.[8] However, due to budget cuts, the project was cancelled in March 2013. In that time, BLS identified the sectors of the auto industry that contain production of green goods and services. However, it is of limited use for analyzing EVs, ETs, and ZEBs production today because the coding does not consider heavy duty truck manufacturing, a significant part of the emerging EV industry.[9]

motor vehicle supply chains. The existing literature and the NAICS codes that we selected for further analysis are presented in the first section of the report.

- Database and online search to identify and examine the businesses in Oregon and Washington that have electric motor vehicle–related production. The details of the research methodology and the results will be presented in the second section.
- Analysis of the existing and potential workforce in electric motor vehicle manufacturing in Oregon and Washington. The third section focuses on analyzing the industry in the region and, especially, its occupational makeup and future occupational demand.
- Identification of key partners. The fourth section introduces institutions and organizations with the greatest potential to contribute to the education and training of the future EV-related workforce in the region.
- The fifth section offers recommendations for future steps.

Throughout this report, the terms "electric vehicle" (EV) and "electric motor vehicle" will be used interchangeably when referring to electric passenger cars and electric commercial vehicles, including buses and trucks. The next section will introduce some technical differences between different types of electric vehicles. However, in general the term "electric car" will refer to battery-run passenger cars, and the terms "electric bus" and "electric truck" will refer to all zero-emissions buses and trucks, including battery- and hydrogen fuel cells –powered vehicles.

Good News: The Barriers to Entry Are Lower in EV-Related Industries

Perhaps the most important difference between the production of EVs and traditional, internal combustion engine vehicles (ICEs) is in the barriers to entry: the barriers to entry are much lower in EV production than in the production of ICEs.[*] This, in turn, creates openings for new small- and medium-sized companies that have been excluded from the existing ICE supply chains. The high entry barriers in the conventional auto industry are created by the well-established manufacturing process: the car is divided into different car sub-systems, or modules, that are then produced simultaneously. This allows companies to increase the scale of production and shrink the associated costs. However, it also requires expensive upfront investment in assembly line equipment, making it difficult for new actors to break into the industry.[10]

Some of these high entry barriers are removed in the mass production of electric vehicles. In EVs, the traditional components of the powertrain (fuel storage, engine and related transmission) are replaced by new modules: battery, electric motor and related transmission. Moreover, many components that are currently used in internal combustion engine vehicles will be no longer necessary (e.g. exhaust, intake, O2 sensor, exhaust gas recirculation or EGR).[10] Other components, such as air conditioning, water units, brakes and steering systems need to be adapted.[11] All these changes are reflected in the supply chain; car manufacturers have traditionally considered the ICE powertrain module as one of their core competencies and, in turn, have not focused on electrical components.[11] As a result, the production of EVs requires new components and competencies outside the existing, established auto supply chain. This creates room for small- and medium-sized enterprises excluded from the traditional car supply chain to enter EV production.[10,12,13] [†]

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[*] Given proprietary rights, the lack of standard classification system for the industry, and the challenges created by the changing technology and business models, the existing research on electric motor vehicle supply chains remains limited. This section is based on analyses that identify some key differences between the supply chains of electric vehicles (EV) and traditional, internal combustion engine (ICE) vehicles.

[†] For example, about 56% of the content of a Chevy Bolt, an EV, comes outside the traditional supply chain.

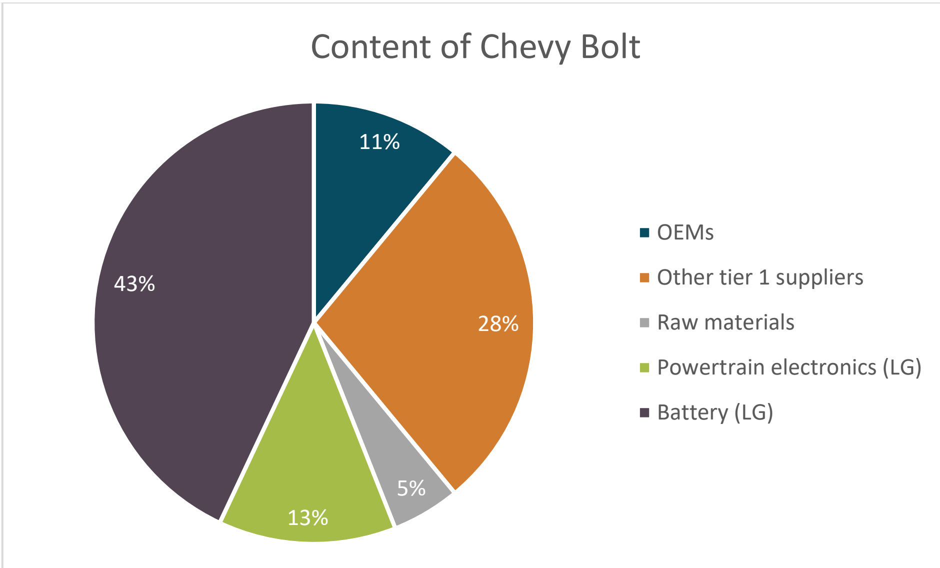
Less research exists on the supply chain of electric commercial vehicles but, in general, their manufacturing is undergoing similar changes as EVs. Various traditional truck and bus manufacturers are currently working on developing electric models and addressing the technical challenges in the sector, and, since 2016, there has been notable progress especially in the development of heavy-duty trucks and city buses.[14] Just as with EVs, the manufacturing of electric trucks and buses has also opened the industry to new actors: according to analysts, new manufacturers like Nikola and Tesla have the potential to disrupt the market and make electric trucks more available even sooner than currently expected.[6] An example of the innovation taking place in the electric bus sector is U.S.-based company, Proterra, that recently announced a partnership with Mitsui & Co. to lease electric batteries. By separating the cost of batteries from the costs of its buses, Proterra promises to bring the cost of its electric buses to roughly the same with a diesel bus.[15]

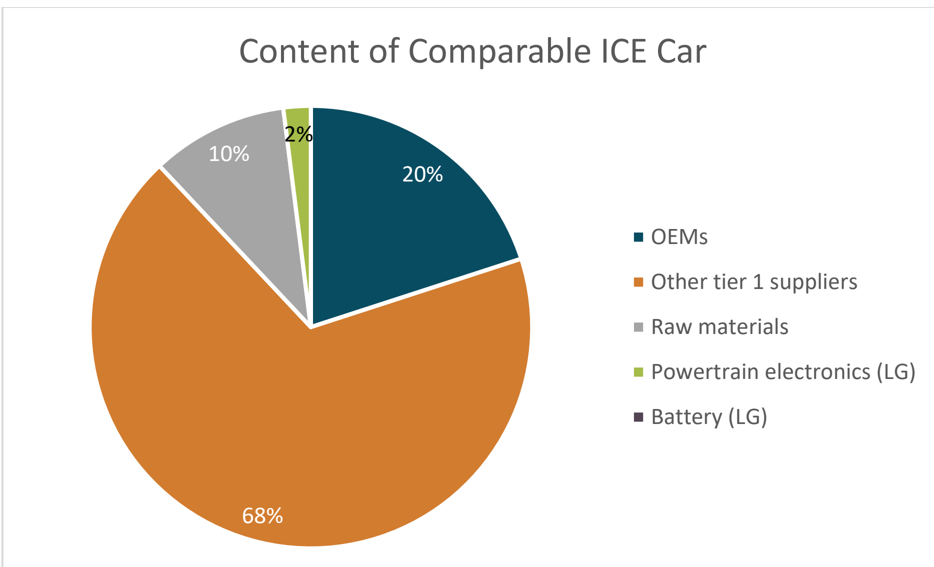
Who Could Enter the EV Field? The Supply Chain in More Detail

In order to identify the companies in EV-related production, and the companies with potential to enter the field, we need to establish the unique components in electric vehicle production. The key difference between an electric motor vehicle and the corresponding traditional vehicle is their power source: while traditional vehicles have an internal combustion engine that generates power by burning gasoline, electric motor vehicles run either on energy stored in rechargeable batteries or on hydrogen fuel.[16*†] The replacement of the internal combustion engine with a battery and an electric motor – the more common technology in passenger cars – changes the established supply chain dramatically, since the internal combustion engine is one of traditional auto manufacturers' core competencies.[11] Consequently, they have built the engine in-house with components from established suppliers that specialize in auto hardware. With EV production, things change: many of the components of internal combustion engine vehicles will no longer be necessary (e.g., exhaust, intake, O2 sensor, EGR)[10] and manufacturers will need to direct their focus to electrical components. Moreover, other existing components, such as air conditioning, water units, brakes and steering systems need to be adapted.[11] These differences force auto manufacturers to modify their existing supply chain.

To compare the components of electric cars and ICEs in more detail, we can look at the supply chain of Chevy Bolt, an electric car. The financial firm UBS took a Chevy Bolt apart and compared the breakdown to a similar ICE car.[13] Figure 1, below, present the key differences between the cars' main components. The figures illustrate that the role of the traditional auto hardware suppliers, often called Tier 1 suppliers, diminishes dramatically when moving from producing an ICE to producing a Chevy Bolt: whereas the role of Tier 1 suppliers beyond powertrain electronics is 68% in the ICE, this percentage is only 28% in the Chevy Bolt. In turn, the battery and powertrain electronics are 56% of Chevy Bolt's contents, while the ICE does not have a battery and the powertrain electronics are only about 2% of the car's contents. In short, many traditional Tier 1 suppliers have only a small role in EV production, and EV production is creating openings for new businesses outside the established supply chains, especially in the production of batteries and electronics.

[*] In electric passenger cars, the battery-driven cars dominate the market, and, for this reason, the analysis below focuses on that technology. The development of hydrogen fuel technology is more advanced in commercial vehicles so the sections on electric trucks and buses will return to the topic.
[†] The Appendix (Appendix A) includes a more detailed presentation of the ICE supply chain.





Source: Hummel P, Lesne D, Radlinger J, et al. UBS Evidence Lab Electric Car Teardown-Disruption Ahead?[13]

Figure 1. Comparison of Chevy Bolt and Comparable ICE Car Components

To identify the openings for new companies in the sector, we tracked down the NAICS codes for the suppliers of Chevy Bolt, as identified by UBS. More specifically, we conducted online searches to find the primary NAICS codes of particular companies supplying certain components to Chevy Bolt. The results of our research are listed in Table 1.[*] This list will then help identify which companies in Oregon and Washington operate in industries that are related to the EV supply chain.

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[*] It is important to note that there is no central agency that assigns companies their "official" NAICS codes. Moreover, the federal government does not release data on companies' NAICS codes or indicate the codes that some of its entities have assigned to businesses. Consequently, different sources might list different codes for companies, making it difficult to establish their "true" NAICS codes. That said, we

Table 1. NAICS Codes for Manufacturing of EV Components

Component	**NAICS code**
Battery Cell	335911 – Storage Battery Manufacturing 335912 - Primary Battery Manufacturing (for fuel cell technology)
Battery Management	
Battery Pack	
Battery Charger	335999 - All Other Miscellaneous Electrical Equipment and Component Manufacturing
Electric Motor	335312 - Motor and Generator Manufacturing
Gearbox	336350 - Motor Vehicle Transmission and Power Train Parts Manufacturing
Power Distribution Module	336320 – Motor Vehicle Electrical and Electronic Equipment Manufacturing
Inverter	334419 - Other Electronic Component Manufacturing
DC/DC Converter	334413 – Semiconductor and Related Device Manufacturing, 335999 - All other miscellaneous electrical equipment and component manufacturing
Thermal Management	336390 - Other Motor Vehicle Parts Manufacturing
Connections/Wiring	336390 - Other Motor Vehicle Parts Manufacturing

Source: Hummel P, Lesne D, Radlinger J, et al. UBS Evidence Lab Electric Car Teardown-Disruption Ahead, SJI's research

Consultations with industry experts suggest that the NAICS codes for electric commercial vehicle production resemble those of EV production. As with electric cars, the supply chains of electric trucks and buses are still developing. In fact, the Director of Product Planning at Kenworth, one of the main truck manufacturers globally, describes the supply base for all electrified components as "relatively immature."[7] The increasing mass production of electric cars does not translate directly to the manufacturing of trucks, as the electrified components of cars cannot be simply applied to trucks. Consequently, truck manufacturers must work with their suppliers to develop electrified components and build up the production of those components.[7] For example, Kenworth is currently ordering components from suppliers and integrating them into the chassis in-house but, at the same time, it is working towards a more vertically integrated supply chain, aiming to build the components in-house at the lowest price possible.[17]

Whereas the mass production of electric vehicles has converged on battery-powered vehicles, electrified trucks and buses are being developed and produced with both battery and hydrogen fuel cell technology.[16] This is partly because of the technical limitations of batteries: today's batteries are too heavy and too expensive to be viable for commercial vehicles.[18] Hydrogen cell technology, in contrast, gives trucks a greater range and quicker refueling times.[16] For this reason, the demand for hydrogen fuel cell buses is also increasing.[16] In order to be able to identify the companies that could participate in the electric commercial vehicle supply chain, we complement the list presented in Table 1 with the code for Primary Battery Manufacturing (335912), a category we identified for businesses that supply fuel cell

consulted industry experts on the list of NAICS above, and they confirmed the codes' relevance to the EV production.

technology used to power electric trucks and buses.[19] The next section of the report proceeds to identify the companies that operate under these NAICS codes in Oregon and Washington, with the goal of establishing the state of the EV related business in the region and the opportunities that the lower barriers to entry in the field offer for business.

Existing and Potential Businesses in the EV-Related Industries

One of the most consistent recommendations across the field of economic development is to improve coordination between industry, education and training institutions, and the public sector. Coordination is needed because when there is a local shortage of appropriate labor, offshoring and automation become increasingly cost-effective options, moving economic activity and jobs out of the region. In addition, many fields are evolving so quickly that workers need to engage regular training and upskilling in order to stay relevant in their field. To facilitate the coordination, we have identified the businesses in Oregon and Washington that are or may be part of the EV supply chain.

Identifying EV-Related Firms in Oregon and Washington

As the electric vehicle industry is emerging, the North American Industry Classification System (NAICS) has not yet developed a classification for it. For this reason, we identified EV-related businesses by searching in two main directions: traditional motor vehicle manufacturing and manufacturing of additional EV-related components, such as electronics and battery manufacturing. By including these two directions, we aim to capture both businesses involved in developing new EV technology, and businesses that integrate existing technology into new, EV products.

We used the database "Business Data" by DatabaseUSA.com, provided by labor market analytics software Emsi.[19*] Database USA uses sources such as new business filings, press releases, corporate websites, and annual reports to gather data on existing businesses. For the motor vehicle manufacturing, we used their database to identify all companies in Oregon and Washington that lists their primary NAICS code as any of the following:

3361 Motor Vehicle Manufacturing
3362 Motor Vehicle Body and Trailer Manufacturing
3363 Motor Vehicle Parts Manufacturing

These 4-digit NAICS codes capture manufacturing in the entire motor vehicle industry, including automobiles, light trucks and utility vehicles, and heavy-duty trucks. In other words, these codes capture the ICE-vehicle manufacturing that is or can also be part of EV-vehicle supply chain. The code 336310 - Motor Vehicle Gasoline Engine and Engine Parts Manufacturing was excluded, however, as that code contains production exclusive to ICE cars.

The list includes parts manufacturing but, importantly, there are several firms that manufacture body panels that are not captured via this list. Body panels are particularly important for EV production, as

[*] DatabaseUSA.com collects the data using proprietary methods, Emsi does not endorse or warrant the data's accuracy or consistency.

electric cars need to be lighter than their ICE counterparts. For this reason, the following codes were added:

331315 Aluminum Sheet, Plate, and Foil Manufacturing
331318 Other Aluminum Rolling, Drawing, and Extruding
331512 Steel Investment Foundries
335991 Carbon and Graphite Production[*]

In order to capture the parts of electric motor vehicle industry that are not classified under the codes for traditional motor vehicle manufacturing, we supplemented the search codes with the EV-relevant NAICS codes, as identified in Section 1.[†] These NAICS codes include:

334419 Other Electronic Component Manufacturing
335312 Motor and Generator Manufacturing
335911 Storage Battery Manufacturing
335912 Primary Battery Manufacturing
335999 All Other Miscellaneous Electrical Equipment and Component Manufacturing
336320 Motor Vehicle Electrical and Electronic Equipment Manufacturing
336350 Motor Vehicle Transmission and Power Train Parts Manufacturing

Identified Firms in the Region

The Business Data database identifies a total of 355 locations for 353 unique firms in Oregon and Washington associated with the selected NAICS codes. This search was augmented by reviewing previous research done in the area, adding design, engineering, and manufacturing for a total of 417 businesses.[‡] We reviewed the companies' websites for any connection or potential connection to EV related business, including trucks and buses, and identified six categories of business:

1. Explicit EV Manufacturing
2. EV Infrastructure Manufacturing (Charging)[§]
3. General Automotive Manufacturing
4. ICE-Oriented Automotive Manufacturing
5. Other Related Manufacturing
6. Not Related[11]

We excluded 204 businesses. This included businesses which were no longer in operation, distributors, metal fabrication and electronic manufacturing that are unrelated to EV, those that manufactured materials tools and instruments that were not themselves EV components, small automotive customization businesses, automotive repair shops, and integrated lock installation companies. The final count is 213 business in 13 industries (Figure 2 & Appendix B).

[*] The Business Data database returned no Carbon and Graphite Production businesses currently operating in Oregon or Washington.
[†] The NAICS code 334413 Semiconductor and Related Device Manufacturing was excluded. DatabaseUSA.com identifies 47 businesses in Oregon and Washington with 334413 as their primary NAICS code.
[‡] Other work has looked more broadly at EV market and infrastructure including sales and advocacy, which are outside of the scope of this work. In addition, a number of the businesses identified are either no longer in operation or no longer in operation in the region.
[§] Though EV charging was explicitly excluded from the scope of this project, eleven firms identified both through the database search and previous work manufacturing charging stations.

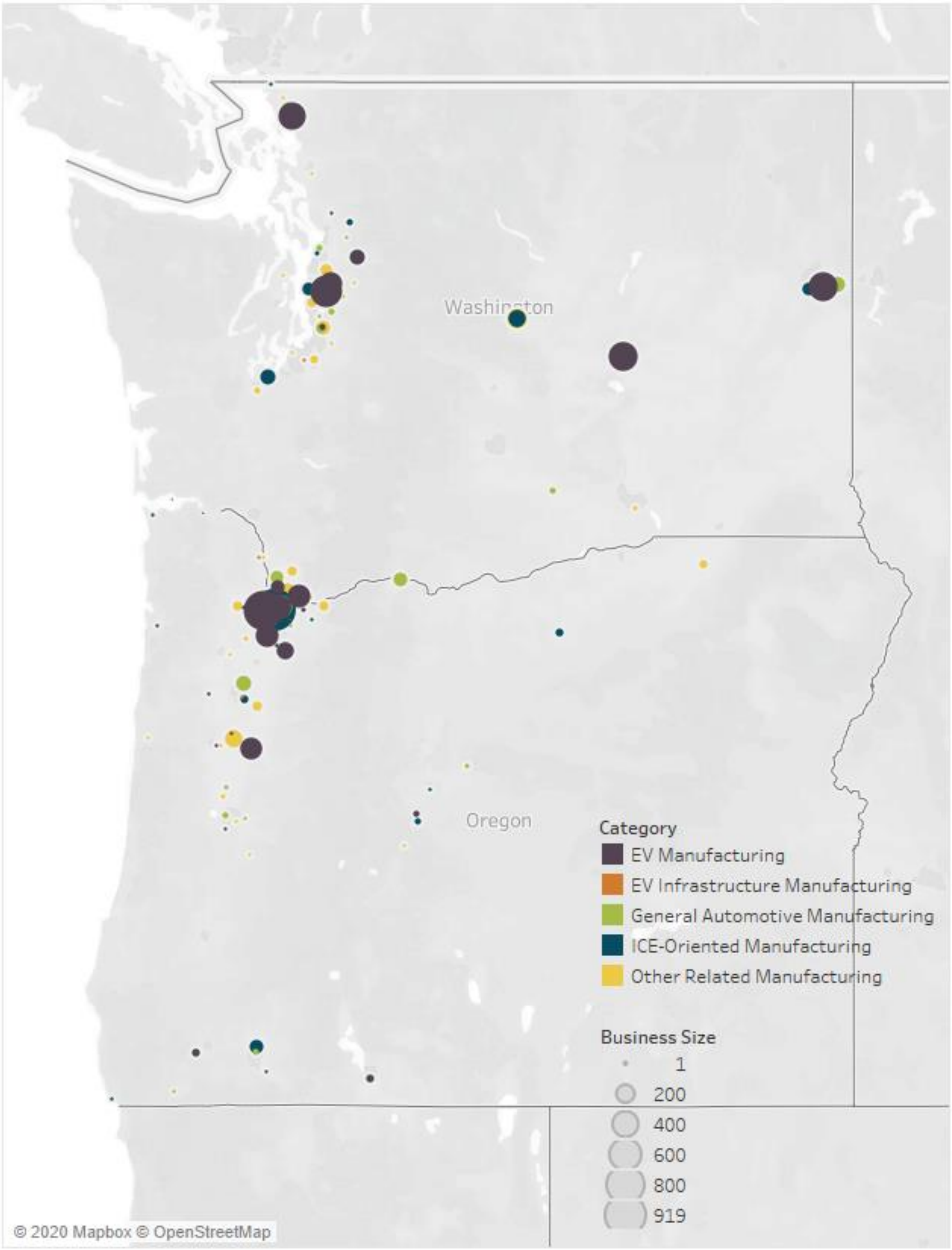


Figure 2. Map of EV-Related Manufacturing in Oregon & Washington

Table 2. EV-Related Manufacturers

Business Name	City	State	Primary NAICS	Business Size	Year Established	Sales Volume
Northwest Power, Inc.	Portland	OR	334419			
Tektronix Component Solutions	Beaverton	OR	334419	200	1994	$43,462,120
Te Connectivity	Wilsonville	OR	334419	300	2000	$65,193,180
Tate Technology Inc	Spokane	WA	334419	33	1991	$6,801,649
Sunstone Circuits	Mulino	OR	334419	168	2005	$36,508,181
Sanmina Corporation	Vancouver	WA	334419	4		$869,242
Qorvo	Bend	OR	334419	25	1989	$5,187,832
Midnite Solar	Arlington	WA	334419	10	2006	$2,301,075
Mcx Inc	Klamath Falls	OR	334419	36	1981	$7,148,073
Maxim Integrated Products	Beaverton	OR	334419	600	1981	$130,386,360
Linear Technology	Bellevue	WA	334419	4	2000	$920,430
Honeywell Electronic	Spokane	WA	334419	400	1961	$82,444,232
Crane Electronics+B252	Redmond	WA	334419	275	1980	$63,279,574
Anolog Devices	Camas	WA	334419	295	1996	$64,106,627
Alpha Technologies Inc	Bellingham	WA	334419	400	1978	$152,328,041
Toshiba International	Vancouver	WA	335312			$368,260
Cooper Bussmann Transportation	Tualatin	OR	335312	55	1972	$20,254,295
SGL Carbon	Moses Lake	WA	335991	450		$107,000,000[20]
Entek International LLC	Lebanon	OR	335999	250	1983	$89,979,350
Anderson Electric Controls Inc	Kent	WA	335999	20	1969	$8,248,897
Excide Technologies	Portland	OR	336111		2017	
Daimler Truck North America	Portland	OR	336111		2018	$13,084,342,825[21]
Arcimoto Inc	Eugene	OR	336111		2007	
Paccar Inc	Bellevue	WA	336111	55	1961	$96,139,207
Commuter Cars Corp	Spokane	WA	336111	3	1998	$4,697,086
Tesla Power Electric	Portland	OR	336390	139	2003	$9,586,506
Cascade German	Gresham	OR	336390	11	2004	$4,715,479
Kenworth Truck Co	Kirkland	WA	336390	523	1923	$237,402,205
Heavy Duty Transaxle Inc	Monroe	WA	336390	139	1995	$63,095,423
Consolidated Metco Inc	Vancouver	WA	336390	100	1964	$80,591,821

The database search identified 30 companies with explicit connections to the sector (see Table 3) and additional 19[*] were drawn from prior research. These firms are a variety of sizes. There are several small businesses alongside large multinational corporations. The presence of the small firms is evidence there are lower barriers to entry in the EV-sector. However, these firms are by-and-large established firms. Twenty-one of them were established 20 years or more ago and none were founded this decade.

The presence of the large multinationals is evidence that this is a viable business model, particularly as EVs require new infrastructure—charging stations and overhead lines—and the large multinational corporations also manufacture EV infrastructure.

Fourteen of the companies identified operate in Oregon, and 15 in Washington. According to the Business Data database none of the companies is female- or minority-owned. Their median number of employees is 139, and their median sales volume is $39,985,150.50[†], though this is the overall sales volume and not unique to EV manufacturing with a few key exceptions. However, we are missing data from a few key firms, both those represented in the Business Data and those not represented in that data.

According to our research, six companies in the region produce electric motor vehicles. Daimler in Oregon and Paccar and its subsidiary Kenworth Trucks in Washington manufacture electric heavy trucks, Commuter Cars Corporation in Washington and Arcimoto in Oregon produce custom-made electric commuter cars, and Boxx and RYNO Motor make specialty scooters. In addition to these actors, other employers in the sector are involved in battery manufacturing, battery management and control, body panels, and other components (such as axles), particularly related to heavy industry.

The firms that already have explicit connections to EV manufacturing do not fully reflect the potential for EV manufacturing in the region. Outside of the powertrain, ICE vehicle and EV manufacturing are largely comparable. For example, both ICE vehicles and EV have seats, mirrors, and body panels, though innovative EV companies may also employ unconventional materials or production methods in many of their components. Other components may be more specific to one or the other but existing ICE capacity can be retooled and retrained to make the EV analog.

In contrast, electronics and battery manufacturers, particularly those that do not already have explicit connections to EV manufacturing are not necessarily good fits for the EV supply chain. Several make products that are not directly applicable (e.g., glassware for semi-conductor manufacturing). Others are explicitly committed to another industry (e.g., aerospace) supply chain and, though they may produce something directly applicable to EV production, would have to develop a new market. However, the large presence of both aerospace, defense, and electronics/computer hardware manufacturing in the region means there are many firms that make applicable parts, including several firms that specialize in

[*] Because they were not present in the Business Data database, we do not have data regarding their size, founding, or sales volume. These companies are a mix of local, multinational, small, and large. They are included in Appendix B.
[†] Excludes Daimler Truck North American Sales as the only figures available were sales for the global corporation and not the operations in the Pacific Northwest.

customizing and supporting rapid prototyping, which is promising for an emerging field and keeps barriers to entry low as new firms can contract with these producers for small components.

Volume of Business in the Region

Many of the companies reviewed are privately owned and, as a result, detailed information on their markets, revenues, and role in electric motor vehicle supply chains are not publicly available. However, we can assess the purchases that the companies with the electric motor vehicle relevant NAICS codes are making in and out the region. While this does not allow us to focus only on EV-related business, it gives us an estimation of how much of their supply comes from within and outside the Pacific Northwest.

Table 3. Industry Purchases and Sales in Oregon and Washington in 2018: All Motor Vehicle Industry[*]

State	NAICS codes group	In-state/ In-region Purchases	% In-state/ In-region Purchases	Imported Purchases	% Imported Purchases	Total Purchases
OR	Motor vehicle industry (4-digit NAICS)	$780,617,741	45.0	$952,231,519	55.0	$1,732,849,260
WA	Motor vehicle industry (4-digit NAICS)	$738,696,223	34.1	$1,429,075,739	65.9	$2,167,771,962
OR and WA	Motor vehicle industry (4-digit NAICS)	$1,783,606,777	45.7	$2,117,014,446	54.3	$3,900,621,223

Source: Emsi

Table 3 presents the in-region purchases for the companies that operate in the "traditional" auto industry (NAICS codes 3361 Motor Vehicle Manufacturing, 3362 Motor Vehicle Body and Trailer Manufacturing, 3363 Motor Vehicle Parts Manufacturing). Both in Oregon and Washington, the companies import more components than buy them in-state. However, Washington relies more on imports than Oregon: Washington imports 65.9% of the purchases and buys 34.1% in-state, whereas in Oregon the share of out-of-state imports is 55.0% and the share of in-state purchases is 45.0%.

Similarly, when we focus on the purchases of all electric motor vehicle–related industries, including the "traditional" auto industry and the producers of other components of electric motor vehicles, as identified in Section 1, Washington relies more on imports than Oregon does. Companies in Washington import

[*] For Oregon and Washington, the table presents the in-state and out-of-state purchases. For Oregon and Washington combined (the last row of the table), the table presents the in-region and out-of-region purchases.

54.8% of their purchases, whereas that share is only 40.1% in Oregon. Table 4 presents these in-state and out-of-state purchases for electric motor vehicle–related industries in Oregon, Washington, and the states combined*. The table also lists the total in-region sales to other industries. The last two columns of the table show that while the total purchases in these industries are about the same in Oregon and Washington, the industries in Washington sell more of their products and services to other industries in the state ($1,317,983,538) than the industries in Oregon do ($913,268,274).

Finally, it is important to keep in mind that the traditional auto industry is relatively small in the Pacific Northwest. According to EMSI, the traditional auto industry (NAICS codes 3361, 3362, 3363) employed 10,525 people in Oregon and Washington in 2019. The number is 71% below the national average. A producer of a custom-made electric car in Washington suggests that the lack of well-established passenger car manufacturing makes it difficult to find parts in the region. We consulted with Rick Woodbury, President of Commuter Cars, in order to gain additional insight into the in-region purchases of the EV field. Commuter Cars, based in Spokane, WA, produces the Tango, an extra-narrow electric car. According to Woodbury, it is hard to obtain parts for the Tango in the region. He has made deals with local dealerships for some parts of the Tango and bought some of the required materials, such as copper sheets and carbon fiber, regionally. Most of the components, however, have been ordered online, usually from the U.S. Midwest or China.

Table 4. Electric Motor Vehicle-Related Industry Purchases and Sales in Oregon and Washington in 2018†

State	**In-state/ In-region Purchases**	**% In-state/ In-region Purchases**	**Imported Purchases**	**% Imported Purchases**	**Total Purchases**	**Total In-state/ In-region Sales (to other industries)**
OR	$1,379,502,171	59.4	$942,406,992	40.1	$2,321,909,163	$913,268,274
WA	$771,288,206	35.2	$1,420,764,015	54.8	$2,192,052,221	$1,317,983,538
OR & WA	$2,449,214,803	54.3	$2,064,746,582	45.7	$4,513,961,385	$3,760,325,847

Industries of companies identified above (6-digit NAICS). Source: Emsi

* The industries include the following NAICS codes: 3361, 3362, 3363, 334419, 335312, 335911, 335912, 335999, 336320, 336350.

† For Oregon and Washington, the table presents the in-state and out-of-state purchases. For Oregon and Washington combined (the last row of the table), the table presents the in-region and out-of-region purchases.

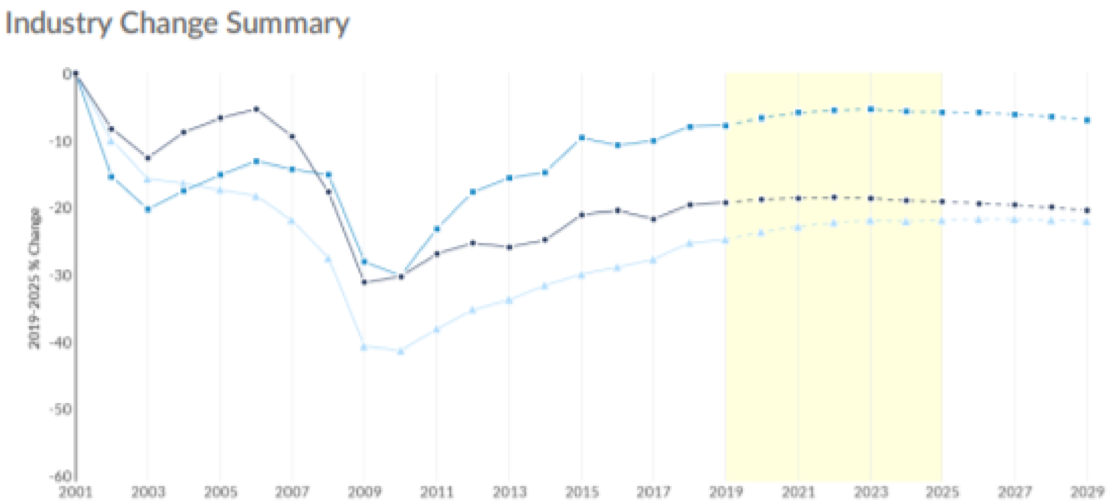
To conclude, the EV industry has a foothold in the region. This is thanks to a combination of low barriers to entry, making it possible for new firms to enter, along with the well-established tech sector and aerospace industry, which have a cadre of firms that make customized components for rapid prototyping. This is promising for the industry as a whole, even if the region has not been considered a stronghold for manufacturing of traditional passenger cars. Our consultations with industry representatives suggest that while there are not many regional suppliers overall, there are potential synergies in the EV and related fields like aerospace and computer hardware manufacturing, large industries in Oregon and Washington.

Taking advantage of the potential synergies in the EV and other related fields does present some specific workforce challenges, however. Namely, workers must be adaptable and receive ongoing training in an emerging industry that is developing prototypes. In order to take advantage of the strengths created by these existing, emerging industries, effective coordination with players in the field is critical so that both workers entering the field and incumbent workers are supported. The next section of the report takes a closer look at the workforce that is connected to the EV-related industries in the Pacific Northwest, and Section 4 will identify key partners to consider for workforce development.

The Current and Future Workforce in the EV-Related Industries

This section analyzes the workforce related to the electric vehicle supply chain in Oregon and Washington. The research leads to a few important conclusions. First, the EV-related industries employ plenty of workers in Oregon and Washington. While the overall predictions for future job openings in these industries are somewhat negative, partly due to offshoring and automation, there is notable variation between different occupations. For example, openings in occupational groups such as Engineering and Computer Science Occupations are predicted to increase, while jobs in many Production Occupations are expected to decrease. Furthermore, when we analyze the current workforce in these occupations in more detail, we uncover some concerning trends. For instance, the occupations with disproportionally high shares of women and people of color tend to have more negative outlooks than the occupations that are dominated by white and male workers. The findings have clear implications when considering preparing the regional workforce for the electrification of transportation: while the EV-related industries employ plenty of workers, education and training policies and initiatives are needed to ensure that the most vulnerable workers in these sectors are able to enter the growing fields.

Figure 3 presents the projected overall change in the number of jobs in the industries connected to the EV supply chain from 2019 to 2025.* In 2019, Oregon and Washington employed 37,884 and 15,826 workers in the sector, respectively.† The workforce in Oregon is projected to decline by 11 jobs (0%) and in Washington by 328 jobs (2%) by 2025. For comparison, the graph also includes the predicted change in the U.S. as a whole which is, at a 4% increase, higher than in the Pacific Northwest.



	Region	2019 Jobs	2025 Jobs	Change	% Change	2019 Average Earnings	2019 Payrolled Business Locations
●	Oregon	38,244	38,292	48	0%	$153,872	345
■	Washington	16,054	16,400	346	2%	$88,665	329
▲	United States	1,681,381	1,747,937	66,556	4%	$94,777	20,371

** Industry Change Summary - Settings*

Source: Emsi

Figure 3. Projected Change in Electric Motor Vehicle-Related Industries

In both states, the Semiconductor and Other Electronic Component Manufacturing (NAICS code 3344) industries employ the largest share of workers: 79% of the workforce in Oregon and 44% of the workforce in Washington works in that sector. To ensure that changes in this industry–or any other industry among the electric motor vehicle-related industries–is not driving the overall pattern in Figure 3, we can examine

* The analysis is done with the following 4-digit NAICS codes: Motor Vehicle Manufacturing (NAICS code 3361, includes the manufacturing of cars, light trucks and utility vehicles, and heavy duty trucks), Motor Vehicle Body and Trailer Manufacturing (NAICS code 3362), Motor Vehicle Parts Manufacturing (NAICS code 3363), Semiconductor and Other Electronic Component Manufacturing (NAICS code 3344), Electrical Equipment Manufacturing (NAICS code 3353), and Other Electrical Equipment and Component Manufacturing (3359, includes primary battery and storage battery manufacturing).

† The share of workers in these industries of overall workforce in the state is 2.0% in Oregon and 0.5% in Washington.

the projections in each EV-related industry individually. Table 5 presents these projections, highlighting some variation between the industries.

Table 5. Predicted Change in Jobs in Electric Motor Vehicle-Related Industries in 2019-2025

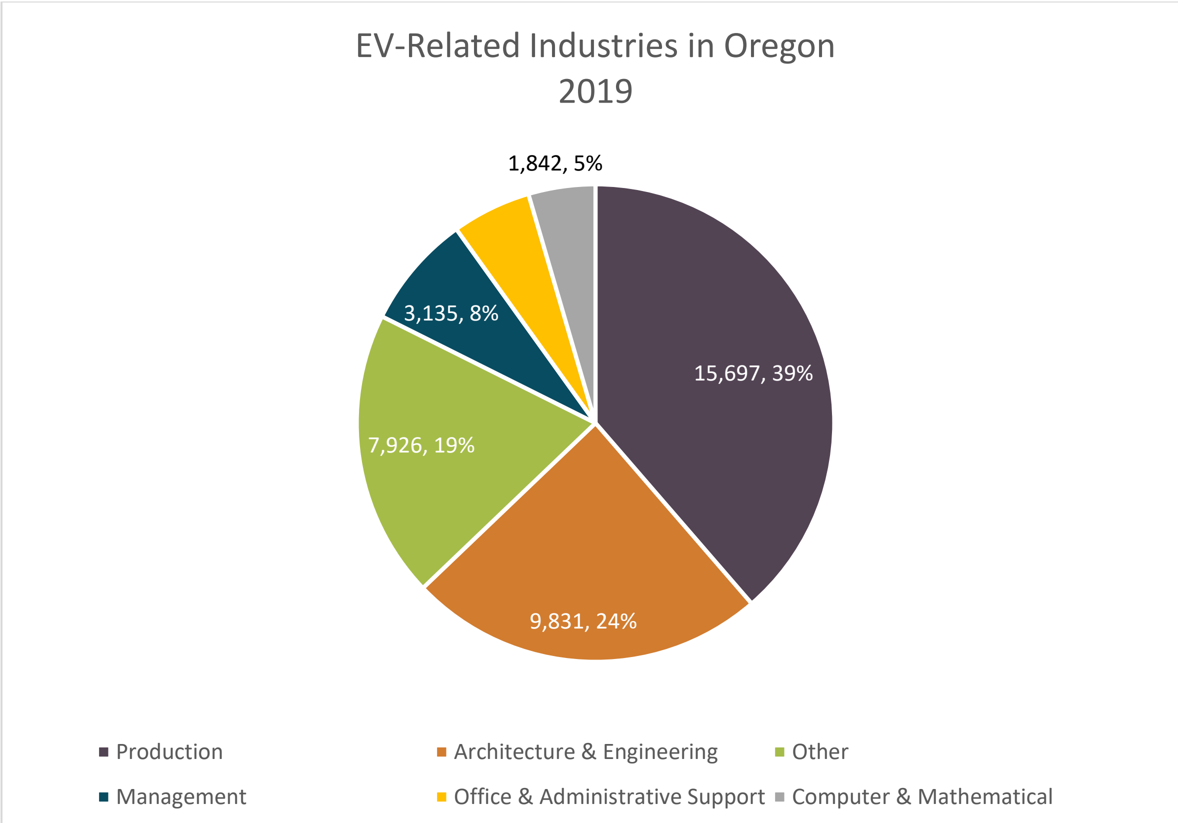
Industry	**Oregon**	**Washington**	**United States**
Motor Vehicle Mfg (3361)	-7% (791 and 733)	10% (1,353 and 1,489)	9% (238,287 and 259,350)
Motor Vehicle Body and Trailer Mfg (3362)	4% (3,569 and 3,694)	2% (797 and 813)	7% (165,133 and 176,878)
Motor Vehicle Parts Mfg(3363)	-3% (1,604 and 1,551)	2% (2,412 and 2,460)	5% (601,655 and 630,203)
Semiconductor and Other Electronic Component Mfg (3344)	0% (29,897 and 29,943)	-1% (6,954 and 6,910)	-2% (373,151 and 365,065)
Electrical Equipment Mfg (3353)	4% (658 and 686)	10% (3,183 and 3,500)	1% (142,396 and 143,212)
Other Electrical Equipment and Component Mfg (3359)	-8% (1,369 and 1,265)	-13% (1,128 and 983)	7% (147,842 and 158,757)

Source: Emsi

Analysts often point out that electric cars are mechanically less complex than traditional cars and, for that reason, the production of electric cars is less labor intensive. This is predicted to disrupt the workforce in the traditional auto industry.[22] Unfortunately, since the NAICS codes do not distinguish production of electric motor vehicles from production of traditional motor vehicles, the data does not allow us to tease out the impacts of electrification of transportation on the workforce in more detail. However, Table 2 suggests that the Pacific Northwest should be somewhat insulated from this trend. This is because the industries that include the traditional auto manufacturing – Manufacturing of Motor Vehicles, Motor Vehicle Bodies, and Motor Vehicle Parts – are relatively small employers in the Pacific Northwest. Their share of the workers in the region is 20%, compared to the remaining 80% employed in the industries identified as exclusive to the EV supply chain. Moreover, the outlook for job growth between 2019 and 2025 is better for the exclusively EV-related industries: those jobs are predicted to grow in the region at an average rate of 1.7%, compared to a 1.7% average decline in jobs in the traditional auto manufacturing industries.[*]

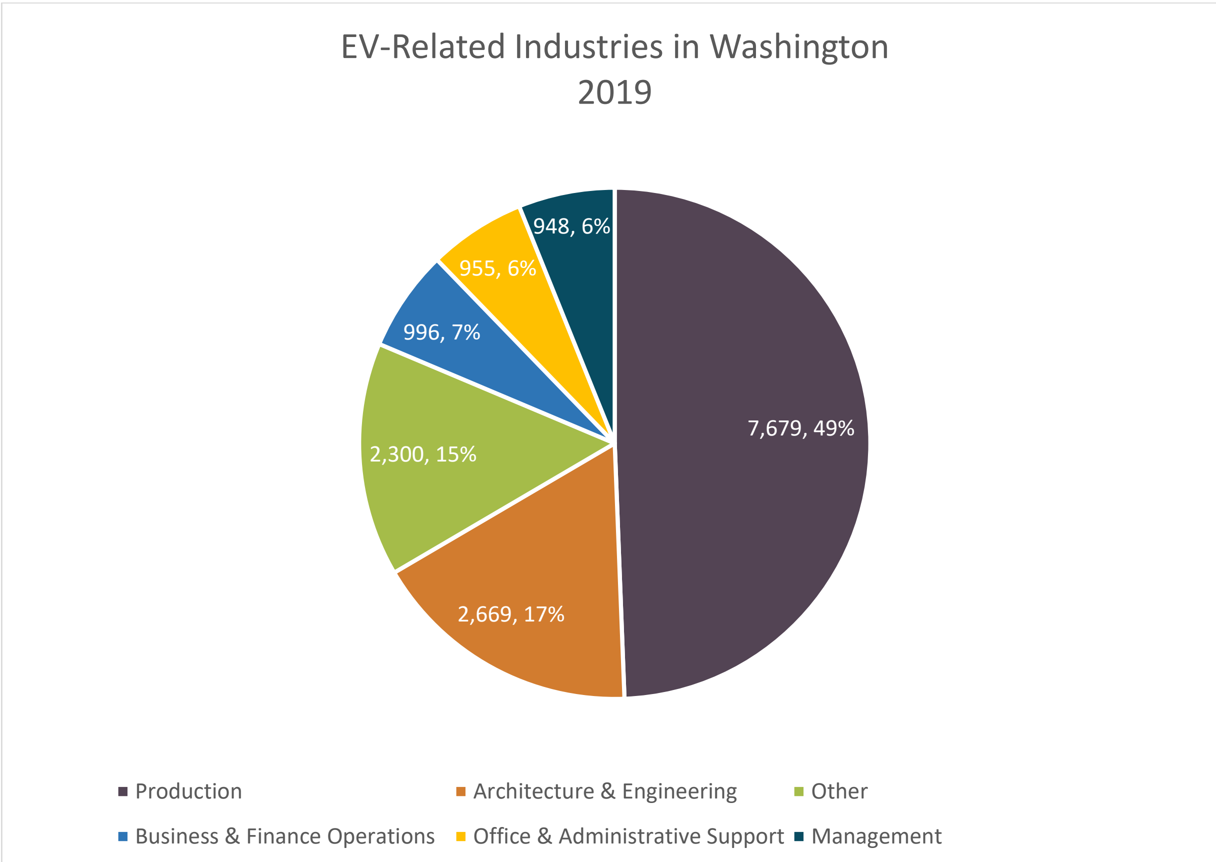
To analyze the occupations that work in the industries connected the electric motor vehicle supply chain, we can map out the industries' occupational makeup following the federal Standard Occupational Classification (SOC) system, a system that classifies all workers into one of over 800 occupational categories.[23] Figures 4 and 5 present the broader groups of occupations that work in the electric motor vehicle –related industries in Oregon and Washington.

[*] It is important to keep in mind that the industries considered "traditional auto manufacturing industries" also include activity related to EV production, and the "exclusively EV-related industries" contain production outside of EV components. Since the NAICS codes do not separate between ICE and EV production, this analysis is the closest estimation possible of their differences.



Source: Emsi

Figure 4. Occupational Makeup of Electric Motor Vehicle-Related Industries in Oregon, 2019



Source: Emsi

Figure 5. Occupational Makeup of Electric Motor Vehicle-Related Industries in Washington, 2019

In both states, Production Occupations are the most common occupations in these industries: in Oregon, they form 39% and in Washington 49% of the total workforce connected to these industries[*]. The second largest occupational group in both states is Architecture and Engineering Occupations, with 24% of the workforce in the industries in Oregon and 17% in Washington[†]. After these two occupational groups, the remaining workforce in both states is divided relatively equally between Management, Business and Financial Operations, Office and Administrative Support, Computer and Mathematical Occupations; and to somewhat lesser extent between other occupational groups such as Transportation and Material Moving; and Installation, Maintenance, and Repair Occupations.

This high-level analysis illustrates that Oregon and Washington have industries connected to the EV supply chain. Moreover, the growth in industries that produce EV components outpaces that of the traditional auto industries: jobs are expected to increase 1.7% in the former and decrease 1.7% in the latter. This analysis is tentative, since the absence of industry codes prevents us from fully separating the production of EVs and their components from the production of traditional cars. Keeping this in mind, the

[*] The three most common occupations in this occupational groups in these sectors are Semiconductor Processors; Electrical, Electronic, and Electromechanical Assemblers; and Assemblers and Fabricators in Oregon; and Assembler and Fabricators; Electrical, Electronic, and Electromechanical Assemblers; and First-Line Supervisors of Production and Operating Workers in Washington.

[†] The three most common occupations in this group are General and Operations Managers; Industrial Production Managers, and Computer and Information Systems Managers in Oregon; and Industrial Engineers; Electrical Engineers; and Electronics Engineers in Washington.

analysis offers reason for some optimism: some of the workforce necessary for the electrification of transportation already exists in the Pacific Northwest, and jobs in some of the industries connected to EV supply chain are projected to grow. The following section will take a closer look at this workforce and their demographics.

The Occupational Infrastructure Exists: Workers in EV-Related Occupations

To gain insight into the regional workforce in jobs most relevant to the EV supply chains, we build on the work of the Luskin Center for Innovation at UCLA. The Center has developed a list of occupations related to the supply chain of plug-in electric vehicles[*]. We modify their list by excluding the occupations that are not core to the production: Customer Service Representatives, Fire Fighters, Police and Sheriff's Patrol Officers, and Retail Salespersons. Our conversations with industry experts confirm that the list that we adopt after these modifications – 30 occupations in total – include the key occupations in electric truck and bus manufacturing, as well.[†]

Tables 6 and 7 offer key labor market data for jobs in these occupations in Oregon and Washington, respectively. Specifically, the table presents for each occupation the number of jobs in 2019, the number of projected annual openings (including new jobs and openings due to retiring workforce), the percent change in jobs from 2019 to 2025, the median hourly earnings in 2019, and the median hourly earnings adjusted to cost of living.

Table 6. Electric Motor Vehicle-Related Occupations in Oregon

	Occupation	**2019 Jobs**	**Annual Openings (incl. new jobs & retirements)**	**2019 - 2025 % Change**	**Median Hourly Earnings**	**COL Adjusted Median Hourly Earnings**
Architecture and Engineering Occupations	Chemical Engineers	403	35	11%	$44.11	$38.36
	Computer Hardware Engineers	1,316	90	2%	$53.59	$46.60
	Electrical Engineers	2,613	220	10%	$42.73	$37.16
	Electronics Engineers, Except Computer	5,512	389	3%	$41.60	$36.17
	Industrial Engineers	4,084	341	10%	$42.62	$37.06
	Materials Engineers	529	41	2%	$42.66	$37.10
	Mechanical Engineers	4,140	330	9%	$39.75	$34.57
	Mechanical Drafters	580	61	10%	$26.31	$22.88
	Electrical and Electronics Engineering Technicians	3,525	325	3%	$30.17	$26.23
	Electro-Mechanical Technicians	105	12	13%	$25.64	$22.30
	Mechanical Engineering Technicians	594	58	4%	$24.69	$21.47

[†] To be clear, the data on occupations does not allow for an exclusive focus on electric motor vehicle-related business either, but it offers us a more detailed picture of the workforce in jobs most relevant to the EV supply chains.

	Total Jobs, Openings, and % Change; Median Earnings	23,401	1,901	6%	$41.60	$36.17
Computer and Mathematical Occupations	Computer Systems Analysts	5,650	447	8%	$42.61	$37.05
	Computer Programmers	2,489	160	(-2%)	$39.07	$33.97
	Software Developers, Applications	15,967	1,431	13%	$48.11	$41.83
	Software Developers, Systems Software	2,878	246	11%	$50.90	$44.26
	Network and Computer Systems Administrators	3,832	293	8%	$38.71	$33.66
	Operations Research Analysts	1,238	114	17%	$38.62	$33.58
	Total Jobs, Openings, and % Change; Median Earnings	32,054	2,690	10%	$40.84	$35.51
Construction and Extraction Occupations	Electricians	8,955	1,254	14%	$34.12	$29.67
	Total Jobs, Openings, and % Change; Median Earnings	8,955	1,254	14%	$34.12	$29.67
Installation, Maintenance, and Repair Occupations	Telecommunications Equipment Installers and Repairers, Except Line Installers	2,234	236	(-3%)	$29.04	$25.25
	Electric Motor, Power Tool, and Related Repairers	239	25	5%	$20.87	$18.15
	Electronic Equipment Installers and Repairers, Motor Vehicles	82	8	(11%)	$19.95	$17.35
	Automotive Service Technicians and Mechanics	6,779	699	5%	$20.93	$18.20
	Total Jobs, Openings, and % Change; Median Earnings	9,334	967	3%	$20.90	$18.17
Life, Physical, and Social Science Occupations	Chemists	679	76	11%	$33.62	$29.23
	Materials Scientists	95	10	9%	$46.99	$40.86
	Urban and Regional Planners	907	84	6%	$39.01	$33.92
	Total Jobs, Openings, and % Change; Median Earnings	1,680	170	8%	$39.01	$33.92
Management Occupations	Industrial Production Managers	2,798	225	5%	$43.30	$37.65
	Total Jobs, Openings, and % Change; Median Earnings	2,798	225	5%	$43.30	$37.65

Production Occupations	Electrical, Electronic, and Electromechanical Assemblers, Except Coil Winders, Tapers, and Finishers	5,079	576	(-8%)	$16.11	$14.01
	Assemblers and Fabricators, All Other, Including Team Assemblers	12,351	1,439	(-2%)	$15.70	$13.65
	Computer-Controlled Machine Tool Operators, Metal and Plastic	2,392	270	6%	$19.83	$17.24
	Machinists	3,444	421	10%	$22.79	$19.82
	Total Jobs, Openings, and % Change; Median Earnings	23,265	2,706	(-1%)	$17.97	$15.63
	Total Jobs, Openings, and % Change; Median Earnings	**101,489**	**9,912**	**6%**	**$38.67**	**$33.62**

Source: Emsi

Tables 6 and 7 point out a notable difference between Oregon and Washington: Washington employs twice as many workers in the occupations related to the EV supply chain as Oregon: 225,116 workers in Washington compared to Oregon's 101,489 workers. Most of this difference is driven by the much greater demand in Computer and Mathematical Occupations in Washington: 112,964 of the state's workers are in this occupational group, whereas that number is 32,054 in Oregon. Overall, the high numbers of workers in the different occupational groups suggests that when it comes to considering starting new electric motor vehicle business in the Pacific Northwest, a key piece of infrastructure, occupational supply, exists in the region already.

Table 7. Electric Motor Vehicle-Related Occupations in Washington

	Occupation	**2019 Jobs**	**Annual Openings (incl. new jobs & retirements)**	**2019 - 2025 % Change**	**Median Hourly Earnings**	**COL Adjusted Median Hourly Earnings**
Architecture and Engineering Occupations	Chemical Engineers	629	45	2%	$48.29	$42.36
	Computer Hardware Engineers	1,701	130	7%	$57.95	$50.83
	Electrical Engineers	5,794	403	2%	$53.71	$47.11
	Electronics Engineers, Except Computer	3,338	229	2%	$51.40	$45.09
	Industrial Engineers	7,082	531	5%	$50.11	$43.96
	Materials Engineers	1,024	77	0%	$51.87	$45.50
	Mechanical Engineers	7,875	541	3%	$43.52	$38.18
	Mechanical Drafters	2,040	182	1%	$38.23	$33.54
	Electrical and Electronics Engineering Technicians	2,404	227	4%	$34.58	$30.33
	Electro-Mechanical Technicians	150	14	1%	$42.31	$37.11
	Mechanical Engineering Technicians	980	88	(-2%)	$30.89	$27.10

	Total Jobs, Openings, and % Change; Median Earnings	33,018	2,463	3%	$48.29	$42.36
Computer and Mathematical Occupations	Computer Systems Analysts	18,196	1,436	8%	$45.12	$39.58
	Computer Programmers	9,723	620	(-2%)	$63.23	$55.46
	Software Developers, Applications	56,467	5,435	17%	$61.63	$54.06
	Software Developers, Systems Software	16,718	1,309	8%	$58.40	$51.23
	Network and Computer Systems Administrators	8,839	679	8%	$43.00	$37.72
	Operations Research Analysts	3,021	271	16%	$44.15	$38.73
	Total Jobs, Openings, and % Change; Median Earnings	112,964	9,751	12%	$51.76	$45.40
Construction and Extraction Occupations	Electricians	18,992	2,457	9%	$31.56	$27.68
	Total Jobs, Openings, and % Change; Median Earnings	18,992	2,457	9%	$31.56	$27.68
Installation, Maintenance, and Repair Occupations	Automotive Service Technicians and Mechanics	13,452	1,349	4%	$22.88	$20.07
	Electric Motor, Power Tool, and Related Repairers	340	37	6%	$26.33	$23.10
	Electronic Equipment Installers and Repairers, Motor Vehicles	221	20	(-17%)	$25.64	$22.49
	Telecommunications Equipment Installers and Repairers, Except Line Installers	4,924	526	(-2%)	$32.22	$28.26
	Total Jobs, Openings, and % Change; Median Earnings	18,938	1,932	(-2%)	$25.99	$22.79
Life, Physical, and Social Science Occupations	Chemists	1,739	171	4%	$38.73	$33.97
	Materials Scientists	396	36	0%	$50.33	$44.15
	Urban and Regional Planners	2,126	201	7%	$38.90	$34.12
	Total Jobs, Openings, and % Change; Median Earnings	4,261	408	5%	$38.90	$34.12
Management Occupations	Industrial Production Managers	2,806	221	4%	$57.59	$50.52
	Total Jobs, Openings, and % Change; Median Earnings	2,806	221	4%	$57.59	$50.52
Production Occupations	Electrical, Electronic, and Electromechanical Assemblers, Except Coil Winders, Tapers, and Finishers	4,861	556	(-9%)	$18.66	$16.37
	Assemblers and Fabricators, All Other, Including Team Assemblers	16,685	1,931	(-4%)	$17.22	$15.11

	Computer-Controlled Machine Tool Operators, Metal and Plastic	2,212	237	3%	$28.42	$24.93
	Machinists	10,380	1,108	2%	$24.09	$21.13
	Total Jobs, Openings, and % Change; Median Earnings	34,137	3,831	(-2%)	$21.38	$18.75
	Total Jobs, Openings, and % Change; Median Earnings	**225,116**	**21,063**	**7%**	**$42.55**	**$37.42**

Source: Emsi

A closer look at the occupations suggests that there is wide variation in the projected demand. Among the occupational groups, the Computer and Mathematical Occupations and the Construction and Extraction Occupations (including only Electricians) are expected to grow the fastest in both states. The lowest growth rates are predicted for Production Occupations: a 2% decrease in Washington and a 1% decrease in Oregon. However, there is a significant variation within the different Production Occupations as well: in both states, Computer-Controlled Machine Tool Operators will be in demand, whereas the number of jobs for Electrical, Electronic, and Electromechanical Assemblers are expected to decrease. This decrease in jobs for Electrical, Electronic, and Electromechanical Assemblers may seem surprising at first, but the trend is a part of a wider decline in manufacturing labor force, caused by offshoring and automation.

Finally, we also examined the regional variation in future occupational needs in the electric motor vehicle-related occupations. Perhaps the most striking regional difference is in the demand for Electricians. The predicted increase in these jobs is 18.4% in the Portland metropolitan area, defined as the Portland-Vancouver-Hillsboro OR-WA metropolitan statistical area by the U.S. Census Bureau. The predicted growth for electricians is smaller in Oregon overall, 13.7%, and it is significantly lower in the Seattle metropolitan area, defined as the Seattle-Tacoma-Bellevue area, at 6.4%. For more on the regional variation between the occupational groups, see the Appendix (Appendix C).

Challenges that Workforce Development Faces: Low Education Occupations Will Grow Slowest

Importantly, most of the electric motor vehicle-related occupations require high levels of education. Table 8 lists the key occupations according to the typical level of education required for an entry-level position, together with required work experience and typical on-the-job training. Twenty-one of the 30 occupations require at least an associate degree, and only seven are open for candidates with only high school diploma. In 2019, those seven occupations employed 32% of the workers in EV-related occupations in Oregon and 24% in Washington.

Table 8. Required Education and Experience in Electric Motor Vehicle-Related Occupations

Occupation	**Typical Entry Level Education**	**Work Experience Required**	**Typical On-The-Job Training**
Electricians	High school diploma or equivalent	None	Apprenticeship
Electric Motor, Power Tool, and Related Repairers	High school diploma or equivalent	Less than 5 years	Moderate-term on-the-job training
Electronic Equipment Installers and Repairers, Motor Vehicles	High school diploma or equivalent	None	Moderate-term on-the-job training
Electrical, Electronic, and Electromechanical Assemblers, Except Coil Winders, Tapers, and Finishers	High school diploma or equivalent	None	Moderate-term on-the-job training
Assemblers and Fabricators, All Other, Including Team Assemblers	High school diploma or equivalent	None	Moderate-term on-the-job training
Computer-Controlled Machine Tool Operators, Metal and Plastic	High school diploma or equivalent	None	Moderate-term on-the-job training
Machinists	High school diploma or equivalent	None	Long-term on-the-job training
Telecommunications Equipment Installers and Repairers, Except Line Installers	Postsecondary nondegree award	None	Moderate-term on-the-job training
Automotive Service Technicians and Mechanics	Postsecondary nondegree award	None	Short-term on-the-job training
Mechanical Drafters	Associate degree	None	None
Electrical and Electronics Engineering Technicians	Associate degree	None	None
Electro-Mechanical Technicians	Associate degree	None	None
Mechanical Engineering Technicians	Associate degree	None	None
Industrial Production Managers	Bachelor's degree	5 years or more	None
Computer Systems Analysts	Bachelor's degree	None	None
Computer Programmers	Bachelor's degree	None	None
Software Developers, Applications	Bachelor's degree	None	None
Software Developers, Systems Software	Bachelor's degree	None	None
Network and Computer Systems Administrators	Bachelor's degree	None	None
Operations Research Analysts	Bachelor's degree	None	None
Chemical Engineers	Bachelor's degree	None	None
Computer Hardware Engineers	Bachelor's degree	None	None
Electrical Engineers	Bachelor's degree	None	None
Electronics Engineers, Except Computer	Bachelor's degree	None	None
Industrial Engineers	Bachelor's degree	None	None
Materials Engineers	Bachelor's degree	None	None

Mechanical Engineers	Bachelor's degree	None	None
Chemists	Bachelor's degree	None	None
Materials Scientists	Bachelor's degree	None	None
Urban and Regional Planners	Master's degree	None	None

Source: Emsi

Assessing the job growth by education level, projected growth is highest for jobs that require a bachelor's or a master's degree. The trend holds for both Oregon and Washington, as well as the Pacific Northwest and the country as a whole: the predicted increase in openings is almost 10% across the regions. In turn, the occupational demand is predicted to grow the slowest in the occupations that require only a high school diploma. The exception is Washington, where the predicted growth is slightly slower for the occupations that require an associate degree. Table 9 presents these growth rates in more detail.

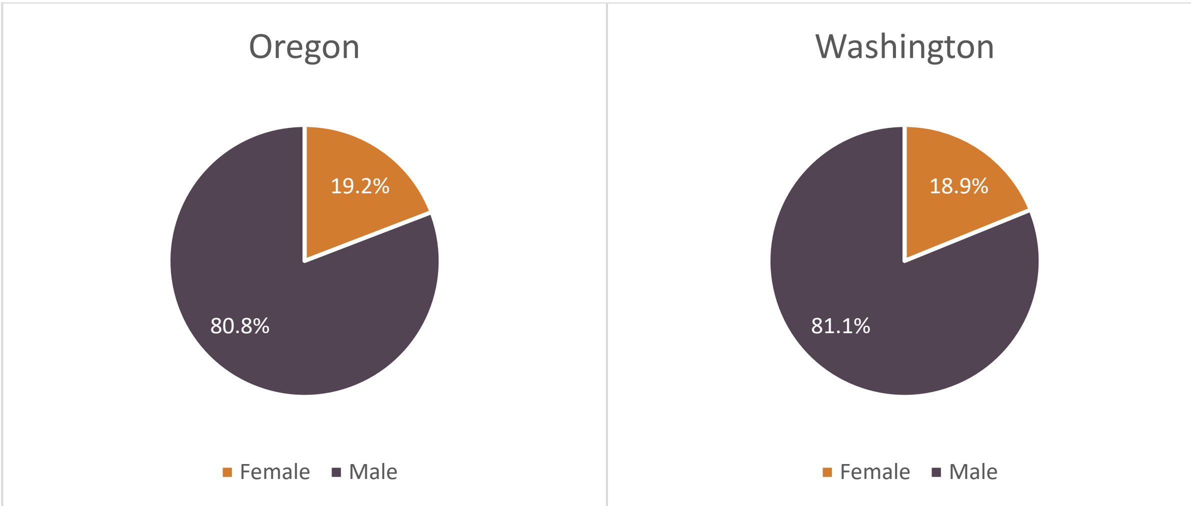
Table 9. Projected Growth in Electric Motor Vehicle-Related Occupations

Occupational Group by education	**2019 – 2025 % Change in Jobs, OR and WA**	**2019 – 2025 % Change in Jobs, OR**	**2019 – 2025 % Change in Jobs, WA**	**2019 – 2025 % Change in Jobs, United States**
HS diploma or Postsecondary nondegree award	2.3	3.2	1.7	1.8
Associate degree	2.7	3.9	1.6	5.3
Bachelor's degree or master's degree	9.5	8.7	9.8	10.0

Source: Emsi

Demographics of Workers Highlight the Need for Workforce Development Initiatives

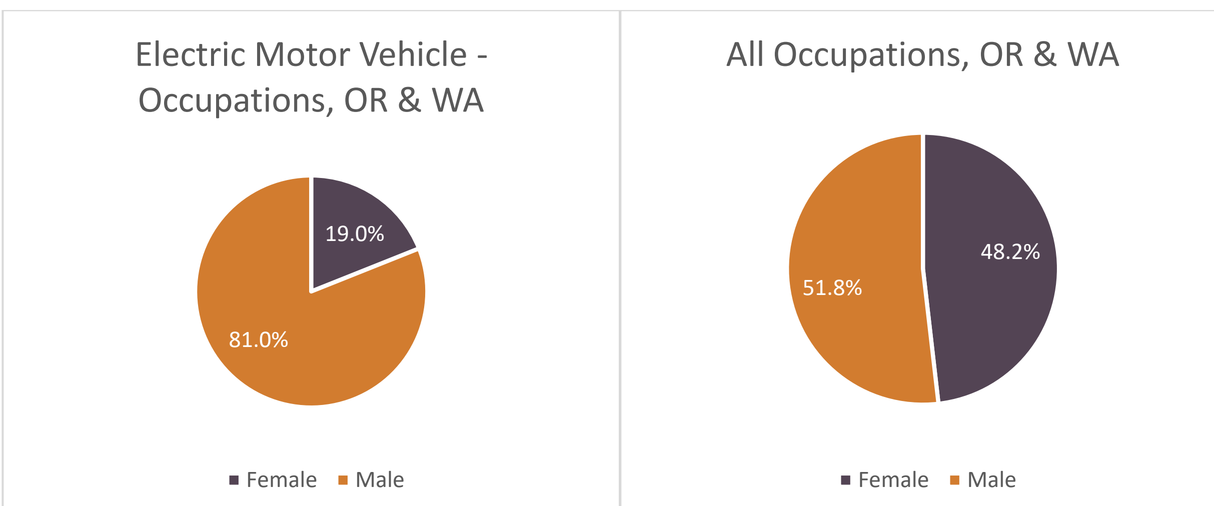
This section analyzes the demographics of the workers in the occupations related to electric motor vehicle production in the region. Starting with gender, a breakdown of the workforce reveals that the occupations are dominated by male workers. Figure 6 shows that female workers form only 19.2% of the workforce in Oregon and 18.9% in Washington. The share of female workers is somewhat lower in both states than nationally, as the share of female workers in the electric motor vehicle-related occupations is 21.0% across all U.S. states.



Source: Emsi

Figure 6. Gender Distribution of Electric Motor Vehicle –related Occupations in OR and WA, 2019

To ensure that the gender distribution in the electric motor vehicle-related occupations is not a reflection of the gender distribution of the workforce in general, we can compare the share of women in the EV-related occupations to their share in the workforce in Oregon and Washington. Figure 7 suggests that these occupations are indeed particularly male dominated: while women are only 19.0% of workers in the EV-related occupations in Pacific Northwest, they represent 48.2% of the region's total workforce.

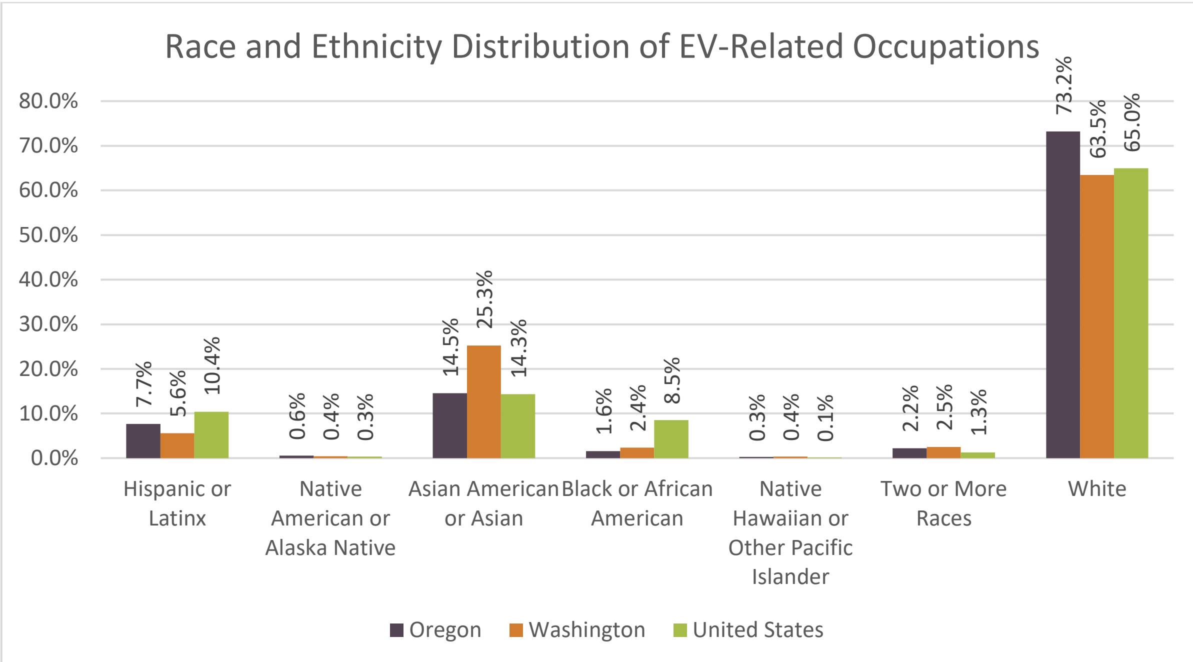


Source: Emsi

Figure 7. Gender Distribution of Electric Motor Vehicle –related Occupations in OR and WA, and in Overall OR and WA Workforce, 2019

An analysis of the race and ethnicity of workers within the electric motor vehicle-related occupations reveals a notable difference between Oregon and Washington. As Figures 8 and 9 point out, the labor force in Washington is more diverse than in Oregon: people of color are 36.5% of the Washington workforce in electric motor vehicle occupations, compared to 26.8% in Oregon. However, as will be discussed below, the difference stems mostly from the larger share of Asian American and Asian workers in Computer and Mathematical Occupations in Washington: Asian American and Asian workers represent 25.3% of workers in these occupations in Washington, whereas their share of Oregon's Computer and

Mathematical Occupations is only 14.5%. When we exclude the Computer and Mathematical Occupations from the analysis, the share of people of color of the EV-related workforce is 25.7% in Oregon and 26.5% in Washington.

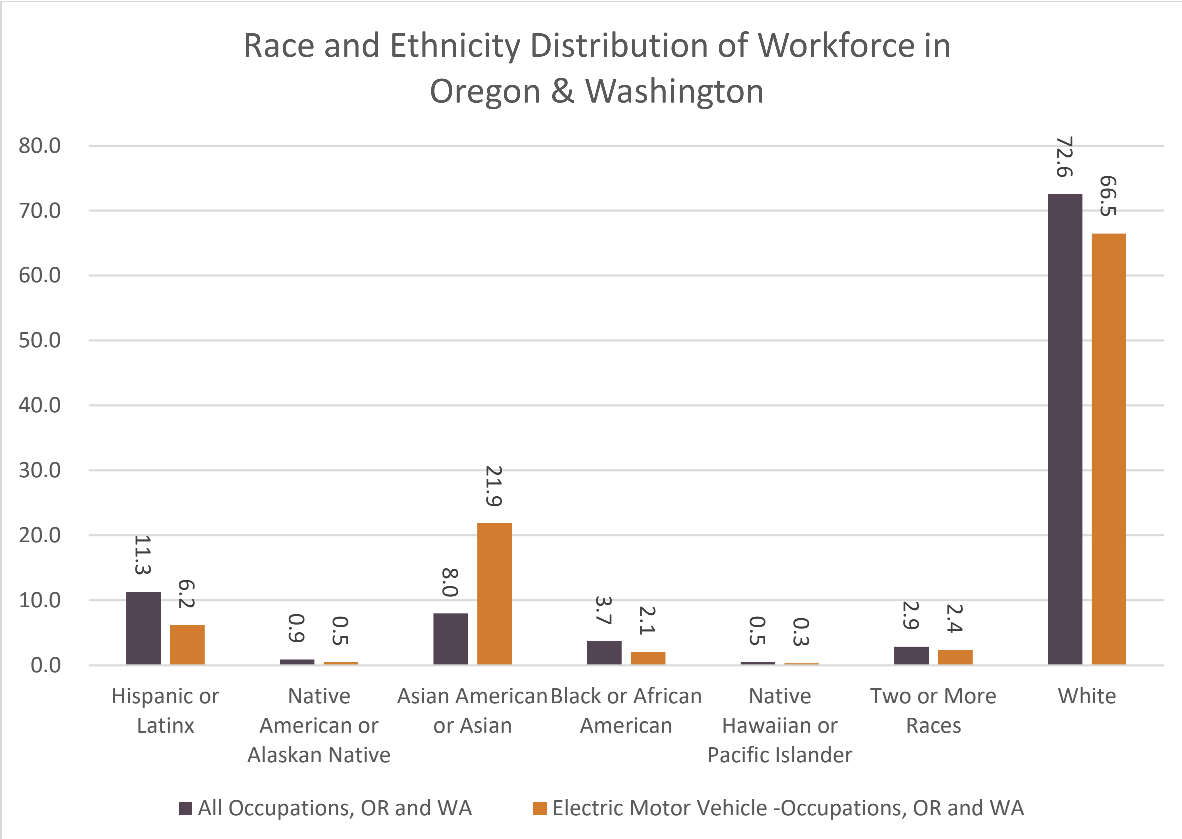


Source: Emsi

Figure 8. Race and Ethnicity Distribution of Electric Motor Vehicle-Related Occupations in Oregon and Washington and the US, 2019

A comparison with all US workers in these occupations reveals that the share of people of color in the EV-related occupations in the U.S. as a whole (35.0%) is about the same in Washington (36.5%) and nearly ten percentage points higher than in Oregon (26.8%). The share of Hispanic or Latino workers is notably lower in both Oregon (7.7%) and Washington (5.6%) than nationally (10.4%).

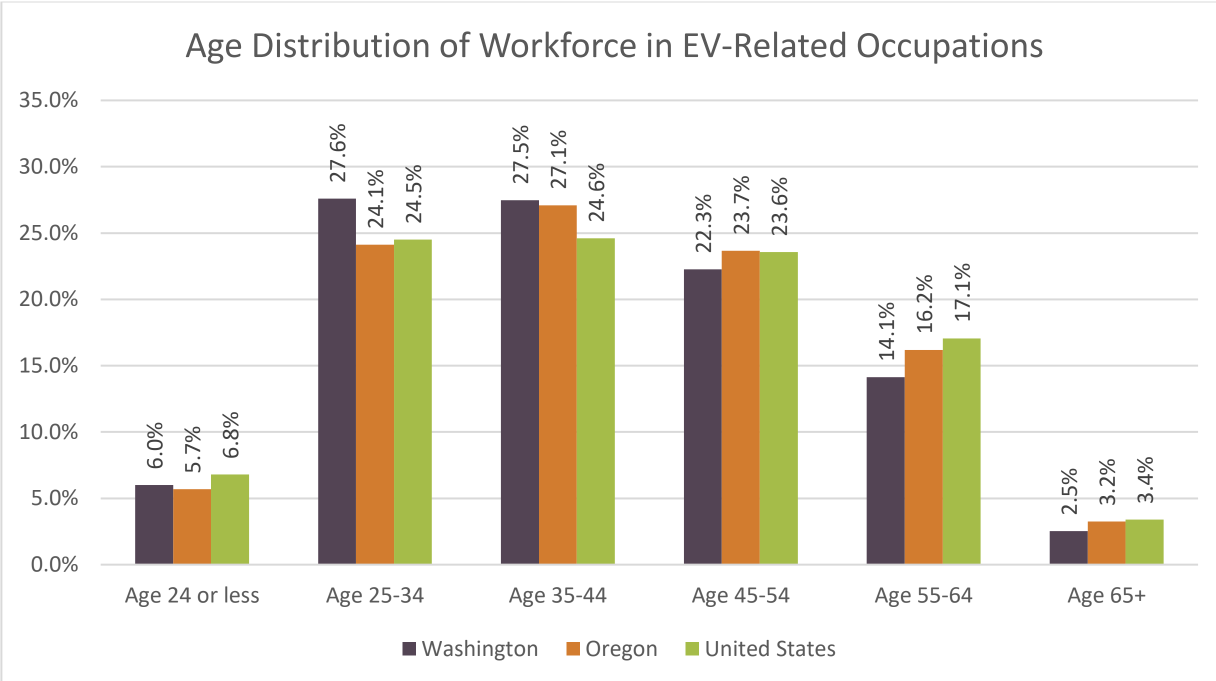
Finally, there are some differences between the demographics of people who work in the EV-related occupations in Oregon and Washington, and people in the regional workforce in general. Most notably, as Figure 9 illustrates, the electric motor vehicle-related occupations have disproportionally more Asian American and Asian workers. At the same time, the shares of Hispanic or Latino workers and white workers are smaller than in the regional workforce at large.



Source: Emsi

Figure 9. Race and Ethnicity Distribution of Electric Motor Vehicle-Related Occupations in Oregon and Washington and Overall in Oregon and Washington Workforce, 2019

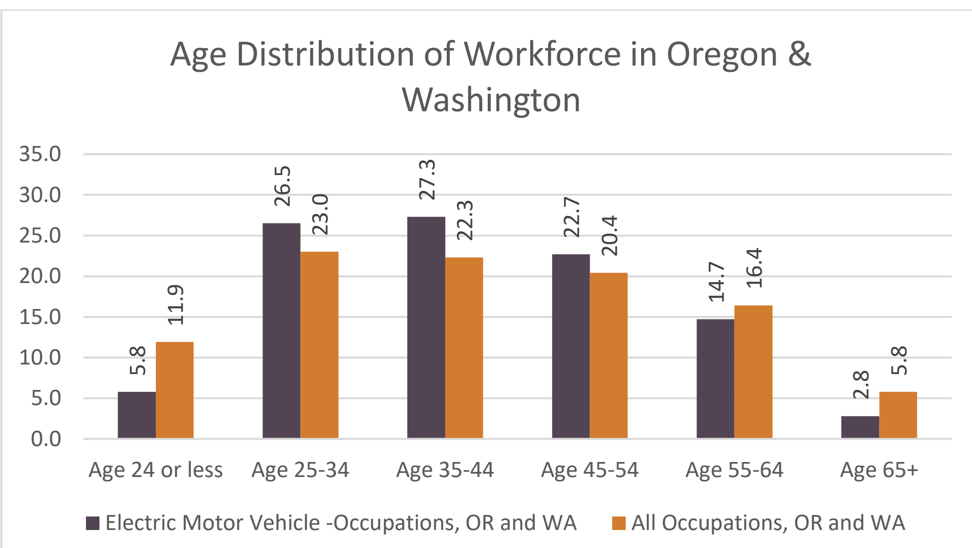
Looking at the age distribution of workers in the EV-related occupations, the workers in Oregon and Washington skew somewhat younger than the overall labor force in these occupations in the U.S. Figure 10 presents the age breakdown of the occupations. The biggest share of workers in the electric motor vehicle occupations in the Pacific Northwest are between 35-44 years old. This is also the most populated age group across all U.S. states, but the share of this age group is smaller nationally (24.6%) than in Oregon (27.1%) and Washington (27.5%). In Washington, the share of workers in the age group 25-34, 27.6%, is notably higher than in Oregon (24.1%) and in the country as a whole (24.5%).



Source: Emsi

Figure 10. Age Breakdown of Electric Motor Vehicle-Related Occupations in Oregon, Washington, and the United States, 2019

The regional workforce in EV-related occupations also skews younger than the overall workforce in the region. Figure 11 illustrates this trend. While there is a significantly higher percentage of workers aged 24 or younger in the overall workforce than in the electric motor vehicle -occupations, this relationship is reversed with the next three age groups. The greatest share of regional labor force in these occupations is between 35 and 44 years of age: 27.3% of the workers fall within this age group. The second largest age group is only slightly smaller with 26.5% of workers.



Source: Emsi

Figure 11. Age Breakdown of Electric Motor Vehicle-Related Occupations in Oregon and Washington, and in Overall Oregon and Washington Workforce, 2019

To make sure that these demographic trends are not driven by certain occupational groups, we compare the demographics of workers in different occupational subgroups. Table 10 presents the gender distribution for all EV–related subgroups. The shares are, overall, close to those at the national level. However, both in Oregon and Washington, and in the U.S. as a whole, there are clear differences between the subgroups. Within the subgroups, the greatest share of women works in Life, Physical, and Social Occupations, a group that includes Chemists, Material Scientists, and Urban and Regional Planners. The share of women in these occupations is 42.3% in Oregon and 41.2% in Washington. The smallest percentage of women, in turn, is in Construction and Extraction Occupations, a group that includes Electricians: 2.3% of Electricians in Oregon are women and the share of female Electricians is 3.1% in Washington.

Table 10. Share of Women in Electric Motor Vehicle-Related Occupations by Subgroup in Oregon, Washington, and the United States, 2019 (Growth in Jobs in Parenthesis)

Electric Motor Vehicle-Related Occupations	**Oregon**	**Washington**	**United States**
Architecture and Engineering Occupations	11.9 (6%)	13.0 (3%)	13.1
Computer and Mathematical Occupations	24.0 (10%)	22.2 (12%)	25.1
Construction and Extraction Occupations	2.3 (14%)	3.1 (9%)	2.7
Installation, Maintenance, and Repair Occupations	3.4 (3%)	4.1 (-2%)	4.1
Life, Physical, and Social Science Occupations	42.3 (8%)	41.2 (5%)	40.8
Management Occupations	15.5 (5%)	17.2 (4%)	17.1
Production Occupations	31.4 (-1%)	27.6 (-2%)	32.4

Source: Emsi

Similarly, there are some significant differences between occupational subgroups when it comes to the ethnicity of the workforce, presented in Table 11. The labor force in electric motor vehicle –related occupations in Pacific Northwest is least diverse in Construction and Extraction Occupations: the share of people of color in these occupations is 12.8% in Oregon and 17.1% in Washington. The workforce is most diverse in Computer and Mathematical Occupations: the share of people of color is 29.2% in Oregon and 46.6% in Washington. These numbers are mostly driven by Asian American and Asian workers: their share of workers in Computer and Mathematical Occupations is 20.7% in Oregon and 38.5% in Washington. The percentage in Washington is much higher than in the country as a whole, where Asian American and Asian workers are 27.4% of the employees in these occupations.

Table 11. Share of People of Color in Electric Motor Vehicle-Related Occupations by Subgroup in Oregon, Washington, and the United States, 2019

Electric Motor Vehicle-Related Occupations	**Oregon**	**Washington**	**United States**
Architecture and Engineering Occupations	28.0 (6%)	26.7 (3%)	27.8
Computer and Mathematical Occupations	29.2 (10%)	46.6 (12%)	41.3
Construction and Extraction Occupations	12.8 (14%)	17.1 (9%)	25.4
Installation, Maintenance, and Repair Occupations	19.3 (3%)	25.4 (-2%)	31.3
Life, Physical, and Social Science Occupations	18.5 (8%)	25.1 (5%)	32.5
Management Occupations	16.0 (5%)	19.0 (4%)	20.5
Production Occupations	32.5 (-1%)	32.9 (-2%)	37.6

Source: Emsi

We also evaluated the demographics of workers in occupations with lower educational requirements and compared those to demographics of workers in occupations with higher educational requirements. The differences are not drastic in Oregon, due to the high share of Asian American and Asian workers in the Architecture and Engineering Occupations and Computer and Mathematical Occupations, occupations that oftentimes require a bachelor's degree. The share of non-white workers in the occupations that require a bachelor's or a master's is 28.0% in Oregon, compared to the share of non-white workers in the occupations with only high school diploma or equivalent required, 25.3%. In Washington, non-white workers are actually a greater share of workers in occupations with high educational requirements: 41.8% of workers in occupations with bachelor's or master's required are non-white, whereas in high school diploma required occupations this share is only 26.7%.

To assess the demographics of growing versus declining occupations, Table 12 groups together the occupations in Oregon and Washington that are expected to experience job growth between 2019 and 2025, and the occupations that are projected to lose jobs within that time frame. The share of women is much higher in the declining occupations, 32.6%, compared to 16.0% in the growing occupations. Similarly, the share of people of color is higher in the occupations with a negative outlook: 36.0% versus a 31.1% share in the occupations experiencing growth. The table includes a separate category for Asian American and Asian workers, as their higher number in the growing occupational groups that include engineering and computer science-related fields drives up the share of people of color in the category for growing occupations.

Table 12. Share of Women and People of Color in Electric Motor Vehicle-Related Occupations by Expected Growth between 2019-2025, Oregon and Washington

Electric Motor Vehicle-Related Occupations	**Female**	**People of Color**	**Asian American and Asian (%)**
Growing Occupations (9.1%)	16.0	31.1%	23.0%
Declining Occupations (-3.7%)	32.6	36.0%	17.4%

Source: Emsi

Finally, there is some variation across the occupation groups in the age of the workforce. For example, there are more younger workers in Production Occupations than in some of the occupations that require higher education or more experience, especially Management Occupations. However, these differences are less notable. The table illustrating these trends is included in the Appendix (Appendix D).

This section has analyzed the current workforce in the industries connected to the EV supply chain and its growth projections. Due to lacking data, the analysis cannot examine the workers employed directly in EV-related industries. However, we can examine the overall labor force in jobs considered essential for EV production. Such analysis is of interest when considering the region's potential for new electric motor vehicle business. For example, most of the workers in Computer and Mathematical Occupations in Washington are undoubtedly employed in high tech. One industry expert consulted for this research described the implications for the EV industry: on the one hand, the region has trained and attracted plenty of skills and talent in fields relevant to EV production. On the other, that talent is often not in the exact fields most in need in EV production and, moreover, the competition for that talent is intense. In other words, the existence of a workforce with training and skills needed for EV production is an asset for the region. However, specific training or other interventions might be necessary to prepare that workforce for the electrification of transportation.

The demographic analysis of the current and future workforce stresses a need for policies and interventions, as well. It is important to note that the demographic data vary greatly among the relevant occupations and the occupational groups. For example, women are about a fifth of the workforce in Computer and Mathematical Occupations both in Oregon and Washington, while their share of Electricians is 2.3% and 3.1% respectively. However, overall, women and people of color will be challenged by the economic decline in EV-related occupations more than men and white people. This is because the shares of women and people of color are notably higher in the EV-related occupations that are expected to decline in the short-to-median term.[*] In other words, women and minorities are particularly vulnerable to economic changes in the field. Therefore, we need interventions that aim to ensure that women and people of color have opportunities to upskill or gain additional training that prepare for economic trends in the EV fields. In a similar vein, policies and initiatives can increase access for women and people of color into fields they are currently underrepresented in and that are economically promising.

Key Partners for Innovation in Workforce Development

The analysis so far has established that Oregon and Washington have both plenty of business with possible openings in the EV supply chain, and a labor force with workers in the occupations required for the EV production. However, the analysis has also shown that workforce development is needed in order to prepare industry and the labor force better for the electrification of transportation. For that development to happen, coordination between industry, public sector, and education is required.

This section assesses the educational infrastructure that currently prepares local workforce for occupations relevant to EV production in the Pacific Northwest. The section also highlights where curricula and training development is needed. In particular, there are two types of recommended interventions. First, in order to ensure a diverse workforce in the sector, we need to consider how to

[*] As a reminder, the share of Asian and Asian American workers is high in the Computer and Mathematical Occupations, especially in Washington. When we exclude these occupations from the analysis, the difference between the demographics of growing and declining occupations becomes more evident.

increase access to the trainings that provide a pipeline for the EV sector and, especially, how to increase access for those populations who are currently left behind. Second, collaboration between industry, the public sector, and the education sector is required to ensure that the education and training programs in the region are well suited for the demands of the EV sector. The first intervention is about ensuring access to the field, and the second aims to improve the existing education and training programs in the region so that they include EV specific components.

Table 13 presents some demographic data for EV related occupations that are expected to experience negative growth between 2019 and 2025 in Oregon and Washington. The share of women in these declining occupations is 32.6%. For comparison, female workers represent 16.0% of the labor force in growing occupations. In other words, the share of women in declining occupations – most with low entry-level educational requirements – is dramatically higher than in the growing occupations – most of which require an associate degree or higher. The relationship is similar for people of color, though not quite as striking: in the declining occupations, people of color are 36.0% of the workforce, compared to 33.1% in growing occupations. For this difference, it is important to keep in mind that Asian American and Asian workers form a disproportionally great share of many of the growing occupations that require relatively high education.

Table 13. Occupations in Decline in Oregon and Washington (combined), 2019

Occupation	**2019-2025 % Change in Jobs**	**Typical Entry Level Education**	**Female %**	**People of Color %**
Computer Programmers	-1.8	Bachelor's degree	20.9	37.8
Telecommunications Equipment Installers and Repairers, Except Line Installers	-2.2	Postsecondary nondegree	10.6	22.5
Electronic Equipment Installers and Repairers, Motor Vehicles	-15.5	High school diploma or equivalent	3.6	28.3
Electrical, Electronic, and Electromechanical Assemblers, Except Coil Winders, Tapers, and Finishers	-8.3	High school diploma or equivalent	51.6	47.4
Assemblers and Fabricators, All Other, Including Team Assemblers	-3.2	High school diploma or equivalent	36.7	36.1
Total	-3.7		32.6	36.0

Source: Emsi

This data underscores a need for initiatives and training programs that can provide underserved populations access to career pathways in the growing occupations. The focus of such initiatives should be on trainings that are relatively short, in order to ensure the participants' ability to complete the programs and begin earning. Moreover, the programs should pay extra attention to the support needs of participants.

Shoreline Community College in Washington offers an example of an institution that has embraced such educational innovations. Shoreline College's Automotive Department partnered with Seattle Jobs Initiative in 2005 to test a pilot project curriculum for Automotive General Service Technician (GST) training with a group of students from low-income backgrounds traditionally excluded from college-driven training programs. The goal of the pilot was to place program participants in living wage automotive careers and, at the same time, test whether the program could serve as an ongoing entry point to the sector for underserved populations. The college provided the students with tuition and free tutoring, while SJI assisted them with wrap-around supports and case management services, including job readiness training, job search assistance, and support for job retention, among other supports.

The pilot was a part of a broader initiative to increase access to training for underserved populations, and was among the first Integrated Basic Education and Skills Training (I-BEST) programs, developed by the Washington State Board for Community and Technical Colleges together with the community and technical colleges in the state. I-BEST programs are designed to provide low-income students with a structured pathway to jobs in high-demand, high-wage industries. The instruction is team based: one teacher is in charge of basic skills teaching in reading, math and/or English language, while another teacher provides technical skills training. In this way, students who might lack the basics skills needed to enter traditional college-level occupational classes gain access to a promising field.

I-BEST programs, including the Automotive GST program at Shoreline College, have been a success. Research shows that I-BEST students are more likely to continue into credit-bearing coursework, earn credits toward a college credential, earn occupational certificates, and make point gains on basic skills tests than basic skills students in general.[24] Moreover, the students in I-BEST programs are older and more often female than average basic skills students, and higher percentage of them come from the lowest quintiles of socioeconomic status.[25] Based on these positive outcomes, community and technical colleges across Washington have expanded the number of I-BEST programs, now numbering 239, and the programs have attracted attention and interest in replication around the country, as well.[25–27]

The Automotive Department at Shoreline College has also succeeded in building strong partnerships with the private sector. An instructor in the College approached the Puget Sound Automotive Dealership Association (PSADA) in the 1980s with the goal of connecting better with local employers for the good of the community and the college students.[28] He highlighted the savings that employers would realize by leasing training space on the college campus rather than training incumbent workers in Portland.[*] Thanks to the instructor's advocacy and two capital campaigns he mounted, the college opened a new training facility, the Professional Automotive Training Center in 1992. The Center was further expanded in 2010. In this space, the instructor brought the college and local dealers together and helped in setting up multiple dealer-sponsored programs in the college. Today, the training site hosts programs with partners such as Chrysler, General Motors, Honda, Tesla and Toyota, and more than 1,300 students have graduated from the Center.[28]

Interestingly, the most recent program addition in Shoreline College's Automotive Department focuses on training in the EV field. Tesla's START program started in the College in the fall of 2018, and it is currently one of several START programs across the country. The selected students go through an intensive, 12-week training program that prepares them for Service Technician positions at Tesla Service Centers in

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[*] According to Shoreline College and Washington Auto Dealers Association, the partnership with the college would save employers approximately $8,594/worker that needs ongoing training; $26,928/worker requiring training to the equivalency of a program graduate; $34,152 in employing and training a program graduate; and, if four hours of labor of the eight hours that the student works at the dealership over two years in the program are counted, the dealership realizes $170,280 in additional labor income. For more details on the project and the return on investment calculation, see Nagley 2017.[28]

the U.S.[29] The program is attractive for students for various reasons. According to Sarah Budriunas, Sr. Project Manager of Tesla's Workforce Development and Education Programs, the on-the-job training for an electric vehicle technician takes a traditional automotive technician about 1-1.5 years on average. Tesla's program offers students an opportunity to gain EV training in only 12 weeks. The program is a paid internship allowing students to focus on training and coursework throughout the program duration. Finally, Tesla assists successful graduates with job placement at Tesla Service Center in the U.S. As of December 2019, over 300 students have graduated from Tesla START, 13% of which are from Shoreline.

The goal of Tesla's program is to build a pipeline of trained professionals for a growing field. The company has a significant presence is the Pacific Northwest: it has three regional service centers in the Seattle area, one regional service center in Spokane, and one in Portland. As more and more consumers choose electric vehicles, the program aims to ensure a supply of service technicians required for that growth. In addition to building a local talent pipeline, one of Tesla's goals for the program is to invest in the community.[25]

The innovations and initiatives in the Automotive Department at Shoreline College highlight how public-private partnerships can institutionalize and continue to develop in a way that responds to the needs of students and employers. Beyond these examples, there are a number of somewhat less specialized programs in the healthcare industry that aim to increase local access to entry level positions with potential for upskilling in the future.[*] These kinds of short-term trainings designed in collaboration with industry and the public and education sectors have great potential for increasing diversity in the workforce, as the programs can consider both specific industry needs and provide support services that are essential for ensuring that people who enter the program can complete it successfully.

Apprenticeships offer another potential path towards the creation of a more diverse workforce. Just like the shorter trainings discussed above, apprenticeships can be more accessible than traditional college programs, as the on-the-job training component allows trainees to earn while learning new skills. Some relevant programs exist in the region already, including The Puget Sound Electrical Joint Apprenticeship and Training Committee's programs for electrical contractors and the program for General Journeyman Electricians.[30,31]

Finally, it is important not to overlook opportunities that exist in the occupations with a negative outlook. Assembler jobs, for example, are entry-level jobs that only require a high school diploma and moderate on-the-job training. Assembler positions in the Pacific Northwest are expected to decline dramatically between 2019 and 2025, partly due to offshoring and automation. Yet, these can be critical jobs in advanced manufacturing career pathways as individuals work while waiting for apprenticeship openings or other upskilling opportunities in the same company. Acknowledging the role that they can play in moving someone towards a career path is important and identifying key employers who are willing to support their workers in this way could be a first step in developing more opportunities to upskill for underserved populations, even if the number of jobs in these occupations declines in the future.

[*] See, for example, https://hospitaltoolkits.org/workforce/case-studies/johns-hopkins-university-health-system/ and http://www.seattlejobsinitiative.com/job-seekers/growhire/.

Another type of key workforce development initiative would focus on improving the existing education and training programs in the field by designing components that focus specifically on EV-related skills training. The Luskin Center for Innovation at UCLA identified the occupations in the EV supply chain with the most urgent need for such component.[32] They did so by examining which EV related occupations are likely to experience both an increase in openings and a change in the nature of the work. The occupations undergoing these changes need training and curriculum development, in order to ensure the pipeline of qualified workforce amidst the changes. We modify their list by including only the occupations related to EV supply chain. The resulting priority occupations are: Computer Systems Administrators & Analysts, Computer Programmers, Computer Software Developers; Materials, Chemical and Computer Engineers, Chemists, Material scientists, and Operations research analysts.

The following table identifies the institutions in Oregon and Washington that reported completed degrees in 2018 in the programs that most directly translate into these occupations.[*] The listing of completions in all the EV-related occupations is presented in the Appendix (Appendix E). The institutions in Table 14 are candidates for partners in curriculum development for EV-specific education and training components, as they have existing programs training workforce to these occupations. We recommend engaging these institutions for planning and designing of new educational components that focus on the specific needs of the EV industry. The Appendix (Appendix F) also provides a list of the institutions that rank in top 10 in the region when it comes to the number of completions in different types of programs.

Table 14. Completions in EV-related Programs in Oregon and Washington, 2018[†]

Institution	**State**	**Chemists**	**Computer Programmers**	**Material Engineers**	**Chemical Engineers**	**Computer Hardware Engineers**	**Material Scientist**	**Software Developers**
Bates Technical College	WA		6					
Bellevue College	WA		51					
Big Bend Community College	WA		5					
Cascadia College	WA		57		1			
Central Washington University	WA	17						
Centralia College	WA		5					
Clark College	WA				0			
Clover Park Technical College	WA		16					
Columbia Basin College	WA		8					
Concordia University-Portland	OR	2						
Eastern Washington University	WA	13						
Edmonds Community College	WA		69		4			
George Fox University	OR	3						
Gonzaga University	WA	4						

[*] The data for program completions is collected following the Classification of Instructional Programs (CIP). Since there is no official crosswalk between the occupations analyzed in the previous section, classified according to SOC, and CIP, we conduct this crosswalk according to our best effort. There were no reported completions in programs in Computer Systems Analysis and Operations Research Analysis. More research is needed to identify the programs that prepare students for these occupations in the region.

[†] Includes distance offered and non-distance offered programs.

Green River College	WA		77		9			
Heritage University	WA	2						
Highline College	WA		6					
Klamath Community College	OR							31
Lake Washington Institute of Technology	WA		27					
Lane Community College	OR		11					
Lewis & Clark College	OR	17						
Linfield College-McMinnville Campus	OR	2						
Linn-Benton Community College	OR	1						
Lower Columbia College	WA		7		2			
Mt Hood Community College	OR	1						
North Seattle College	WA		6					
Olympic College	WA		6		1			
Oregon Institute of Technology	OR							44
Oregon State University	OR	80			163		12	
Pacific Lutheran University	WA	19						
Pacific University	OR	15						
Peninsula College	WA		10					
Portland State University	OR	33		9				
Reed College	OR	12						
Renton Technical College	WA		77					
Rogue Community College	OR					2		22
Saint Martin's University	WA	1						
Seattle Central College	WA		10					
Seattle Pacific University	WA	7						
Seattle University	WA	5						
Shoreline Community College	WA				2			
Skagit Valley College	WA		1					
South Puget Sound Community College	WA		16					
Southern Oregon University	OR	16						
Spokane Falls Community College	WA				2			
Tacoma Community College	WA				1			
University of Oregon	OR	89						
University of Portland	OR	29						
University of Puget Sound	WA	10						
University of Washington-Bothell Campus	WA	3						
University of Washington-Seattle Campus	WA	130		97	118			
Walla Walla University	WA	3						
Washington State University	WA	34		57	57			
Western Oregon University	OR	6						
Western Washington University	WA	42						
Whitman College	WA	9						
Whitworth University	WA	21						
Willamette University	WA	23						

Source: Emsi

In addition to the partners listed in this section, there are plenty of organizations focused on advocating for growing the EV field. When planning the suggested interventions, or other initiatives in the field, these organizations could provide crucial expertise and outreach capacity. Some of these organizations include Plug-in America, Forth, PEV Dialogue Group, and West Coast Electric Fleets.

In conclusion, this report has emphasized the need for coordination between industry, education, and public sector in order to prepare the workforce for the growing EV production. This section presents two types of initiatives and proposes potential partners for such initiatives: first, addressing the lack of diversity in the EV related occupations with training programs that target underserved populations. Second, engaging existing educational programs that train workforce for the EV industries that are in most need when it comes to trained professionals. The goal of this engagement would be to start developing program components and trainings that focus specifically on EV-related content.

Recommendations

The growing adoption of electric passenger vehicles and electric commercial vehicles is creating new business opportunities for companies that have not formed a part of the traditional vehicle supply chains in the past. To be sure, traditional manufacturers are working hard to establish the required supply chains for mass production. Yet, there are also new players entering the field, producing different components for the traditional manufacturers – or even producing their own electric vehicles. As the demand for EVs continues to grow, so do these opportunities, both for established and emerging businesses.

This report has shown that Oregon and Washington are off to a good start when it comes to continuing to develop regional EV production. Both states have plenty of ongoing and potential EV-related business and both have workforce needed in the field. However, the report has also highlighted some challenges that the region faces. Some of these challenges are specific to the Pacific Northwest. Most importantly, the workforce in the EV-related occupations in the region is less diverse than nationally, and many of the more diverse occupations in Oregon and Washington are projected to decline in the short-to-medium term. More specifically, the analysis finds that occupations with a greater share of women and people of color compared to their overall share of the EV-related workforce have a negative economic outlook in the next five years. Other challenges are not unique to the Pacific Northwest: the negative growth projections for certain occupations are partly due to offshoring and automation, both trends occurring regionally and nationally. Another key challenge, also observed across the U.S., is the lack of training and training components that would meet the demand for highly specialized workers in the EV field.

To answer these challenges and continue to work towards greater electrification of transportation, this report recommends the following:

- **Innovate Together with Key Partners in Industry, Public Sector, and Education:** Multiple industry experts consulted for this project called for collaboration and coordination between the public, private, and the education sectors. In fact, some viewed this sort of collaboration essential for the region to ensure a pipeline of qualified professionals for the rapidly changing industry. The research conducted for this report supports such collaboration. The industry needs to be included to share their understanding of the dramatic changes in the field and their occupational needs. The public sector has a crucial role in coordinating the work, and, perhaps even more importantly, ensuring that the resulting interventions and initiatives create a more diverse and inclusive industry. Finally, the education sector offers expertise and existing educational infrastructure to be able to design and implement education and training components quickly. The Professional Automotive Training Center at Shoreline Community College in Washington serves as an example of a successful and sustainable private-public partnership. By learning from their experiences, and the experiences of other similar partnerships, and by inviting all the stakeholders in the table, the region can develop a creative and comprehensive workforce strategy that prepares the region better for the continuing electrification of transportation.

- **Training Initiatives Directed to Underserved Populations:** The workforce research highlighted lack of diversity in the EV-related occupations, and some troubling trends when it comes to the occupations with least educational requirements. We recommend designing and implementing training initiatives that would specifically target underserved populations. For example, the I-BEST programs in Washington, college programs that combine basic skills training with technical training, have succeeded in improving the educational outcomes for many underserved populations. Similarly, short-term training programs that focus on creating access to entry-level positions have proven to be promising in other sectors. Working with employers willing to upskill their workforce is another way of targeting workers who need help in getting on to a career path. To create a pipeline of qualified and diverse EV professionals, we recommend workforce initiatives that adopt these approaches.

- **Developing EV-specific Curriculum and Trainings**: As the technology in electric vehicles continues to develop and their mass production becomes more and more common place, the need for increasingly specialized labor force increases. We recommend working with institutions that have strong educational programs in the EV-related fields to develop training that is directed at the particular needs of EV production. Another promising venue for improving EV-specific curriculum is to work in close collaboration with the industry. By bringing part of the training in-house, companies can train their workforce in a very targeted way. At the same time, the public sector can ensure that the adopted solutions consider the greater goals of workforce development as well, including diversity and sustainability.

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Appendix A

There are five key actors in the production of a traditional car: cars are designed and manufactured by original equipment manufacturers, or OEMs. The OEMs receive necessary components from Tier 1 suppliers who specialize in auto hardware and usually work closely with one or two OEM. Tier 1 suppliers, in turn, receive components from Tier 2 suppliers who are experts in their specific domain and serve clients across industries. All of these actors—OEMs, Tier 1 and Tier 2 suppliers—also receive raw materials from Tier 3 suppliers. The ready product is sold at a dealership, which in turn provides OEMs information about their demand - necessary information for OEMs to guarantee the supply of new cars. The table below presents these actors, together with their products and a few examples of products and companies.

Supplier	**Product**	**Product example**	**Company example**	**Supplies to**
Tier 3	Raw or close-to-raw materials	Metal, plastic		Tiers 1 and 2 and OEMs
Tier 2	Specific parts	Computer chip manufacturer	Intel, NVIDIA	Tier 1
Tier 1	Automotive-grade hardware	In-car entertainment technologies, steering systems	Delphi, Bosch	OEM
OEM (original equipment manufacturer)	Design, marketing, and assembling cars	Car	Ford, Toyota	Dealers
Dealership	Customer service, maintenance and repair			

Source: Modified from https://medium.com/self-driving-cars/the-automotive-supply-chain-explained-d4e74250106f

Appendix B

Using DatabaseUSA and previous research 415 businesses in Oregon and Washington associated with the selected NAICS codes were identified.* Business that were no long in operation, distributors, metal fabricators, and electronic manufacturers unrelated to EV were excluded, for a total of 211 business is 12 industries. They can be divided into six categories of business:

1. Explicit EV Manufacturing
2. EV Infrastructure Manufacturing (Charging)†
3. General Automotive Manufacturing
4. ICE-Oriented Automotive Manufacturing
5. Other Related Manufacturing
6. Not Related[11]

Category	Business Name	Business Size	Primary NAICS Code	Industry Name	Sales Volume (USD)	Year Established	Website	Address	City	State
1	Maxim Integrated Products	600	334419	Other Electronic Component Manufacturing	$130,386,360.00	1981	www.maxim-ic.com	14320 SW Jenkins Rd	Beaverton	OR
1	Mcx Inc	36	334419	Other Electronic Component Manufacturing	$7,148,073.00	1981	www.mcxinc.com	2811 Broadmore St Ste 301	Klamath Falls	OR
1	Northwest Power Inc	0	334419	Other Electronic Component Manufacturing	$0.00		www.vicorpower.com	4211 Se International Way Ste F	Portland	OR
1	Qorvo	25	334419	Other Electronic Component Manufacturing	$5,187,832.00	1989	www.qorvo.com	63140 Britta St	Bend	OR
1	Sunstone Circuits	168	334419	Other Electronic Component Manufacturing	$36,508,181.00	2005	www.sunstone.com	13626 S Freeman Rd	Mulino	OR

* Other work has looked more broadly at EV market and infrastructure including sales and advocacy, which are outside of the scope of this work. In addition, a number of the businesses identified are either no longer in operation or no longer in operation in the region.

† Though EV charging was explicitly excluded from the scope of this project, eleven firms identified both through the database search and previous work manufacturing charging stations.

1	Te Connectivity	300	334419	Other Electronic Component Manufacturing	$65,193,180.00	2000	www.te.com	10025 SW Freeman Dr	Wilsonville	OR
1	Tektronix Component Solutions	200	334419	Other Electronic Component Manufacturing	$43,462,120.00	1994	www.component-solutions.tektronix.com	2905 SW Hocken Ave	Beaverton	OR
1	Alpha Technologies Inc	400	334419	Other Electronic Component Manufacturing	$152,328,041.00	1978	www.alpha.com	3767 Alpha Way	Bellingham	WA
1	Anolog Devices	295	334419	Other Electronic Component Manufacturing	$64,106,627.00	1996	www.linear.com	4200 NW Pacific Rim Blvd	Camas	WA
1	Crane Electronics+B252	275	334419	Other Electronic Component Manufacturing	$63,279,574.00	1980	www.craneae.com	10301 Willows Rd Ne	Redmond	WA
1	Honeywell Electronic Materials	400	334419	Other Electronic Component Manufacturing	$82,444,232.00	1961	www.honeywen.com	15128 E Euclid Ave	Spokane	WA
1	Linear Technology	4	334419	Other Electronic Component Manufacturing	$920,430.00	2000	www.linear.com	2018 156th Ave Ne	Bellevue	WA
1	Midnite Solar	10	334419	Other Electronic Component Manufacturing	$2,301,075.00	2006	www.midnitesolar.com	17722 67th Ave Ne	Arlington	WA
1	Tate Technology Inc	33	334419	Other Electronic Component Manufacturing	$6,801,649.00	1991	www.tatetech.com	3102 E Trent Ave Ste 100	Spokane	WA
1	Toshiba International Corp	1	335312	Motor and Generator Manufacturing	$368,260.00	1875	https://www.toshiba.com/	12321 NW 24th Ave	Vancouver	WA
1	SGL Carbon	450	335991	Carbon and Graphite Product Manufacturing	$107,000,000	1992	https://www.sglcarbon.com/	8781 Randolph Rd NE	Moses Lake	WA
1	Entek International LLC	250	335999	All Other Miscellaneous Electrical Equipment and Component Manufacturing	$89,979,350.00	1983	www.entek.com	250 Hansard Ave	Lebanon	OR
1	Anderson Electric Controls Inc	20	335999	All Other Miscellaneous Electrical Equipment and	$8,248,897.00	1969	www.aecontrols.com	8639 S 212th St	Kent	WA

				Component Manufacturing						
1	Arcimoto Inc	0	336111	Automobile Manufacturing	$0.00	2007	Arcimoto Inc.	2034 W 2nd Ave	Eugene	OR
1	Daimler Truck North America	0	336111	Automobile Manufacturing	$13,084,342,825.00	2018	www.daimler.com	4810 N Lagoon Ave	Portland	OR
1	Excide Technologies	0	336111	Automobile Manufacturing	$0.00	2017	https://www.exide.com/en	13806 Ne Airport Way	Portland	OR
1	Commuter Cars Corp	3	336111	Automobile Manufacturing	$4,697,086.00	1998	www.commutercars.com	715 E Sprague Ave Ste 70	Spokane	WA
1	Paccar Inc	55	336111	Automobile Manufacturing	$96,139,207.00	1961	www.paccar.com	777 Math Ave Ne	Bellevue	WA
1	Cascade German	11	336390	Other Motor Vehicle Parts Manufacturing	$4,715,479.00	2004	https://www.cascadegerman.com/	710 Ne Cleveland Ave	Gresham	OR
1	Tesla Power Electric	139	336390	Other Motor Vehicle Parts Manufacturing	$59,586,506.00	2003	https://www.tesla.com/energy	101 SW Madison St	Portland	OR
1	Consolidated Metco Inc	100	336390	Other Motor Vehicle Parts Manufacturing	$80,591,821.00	1964	www.conmet.com	5701 Se Columbia Way	Vancouver	WA
1	Heavy Duty Transaxle Inc	139	336390	Other Motor Vehicle Parts Manufacturing	$63,095,423.00	1995	www.hdtransaxle.com	35409 State Highway 2	Monroe	WA
1	Kenworth Truck Co	523	336390	Other Motor Vehicle Parts Manufacturing	$237,402,205.00	1923	www.kenworth.com	10630 Ne 38th Pl	Kirkland	WA
1	Cooper Bussmann Transportation	55	335312	Motor and Generator Manufacturing	$20,254,295.00	1972	www.cooperindustries.com	10955 SW Avery St	Tualatin	OR
1	Alltrax Inc	30	335312	Motor and Generator Manufacturing		2001	https://alltraxinc.com/	PO Box 179	Wilderville	OR
1	Amfor Electronics		336320	Motor Vehicle Electrical and Electronic Manufacturing		1961	http://www.amforelectronics.com/	5061 N Lagoon Ave	Portland	OR
1	Blue Sky Design	1				1992	https://www.blueskydsn.com/	82811 Jackson Marlow Rd.	Eugene	OR
1	Boxx						https://www.boxxcorp.com/site/6	939 SE Alder St	Portland	OR

1	Cafe Electric						https://www.cafeelectric.com/	311 SW 2nd St	Corvallis	OR
1	Cascadia Motion					2019	https://www.cascadiamotion.com/	7929 SW Burns Way	Wilsonville	OR
1	Cummins					1919	https://www.cummins.com/	300 W Valley View Rd	Talent	OR
1	Eaton					1911	https://www.eaton.com/us/en-us.html	10955 SW Avery St	Tualatin	OR
1	EnerG2					2003	https://energ2.com/	3000 SW Calapooia St	Albany	OR
1	EVDrive					2011	https://evdrive.com/	2123 NE Aloclek Dr	Hillsboro	OR
1	Hydro Extrusion		331318	Other Aluminum Rolling, Drawing, and Extruding		1905	https://www.hydro.com/en-us	2929 W 2nd St	Dallas	OR
1	Hydro Extrusion	166	331318	Other Aluminum Rolling, Drawing, and Extruding	$96,853,663.00	1905	https://www.hydro.com/en-us	7933 NE 21st Ave	Portland	OR
1	Hydro Extrusion		331318	Other Aluminum Rolling, Drawing, and Extruding		1905	https://www.hydro.com/en-us	2001 Kotobuki Way	Vancouver	WA
1	Hyster/Nuvera					1929	https://www.hyster.com/north-america/	400 NE Blue Lake Rd	Fairview	OR
1	Intel		334413	Semiconductor and Related Device Manufacturing		1968	https://www.intel.com	2501 NE Century Blvd	Hillsboro	OR
1	KersTech					2008	http://kerstech.com/	P.O. 1895	Beaverton	OR
1	Metric Mind Corporation					1999	http://www.metricmind.com/	10117 SE Sunnyside Rd	Clackamas	OR
1	RYNO Motors						http://rynomotors.com		Beaverton	OR
1	ShiftEV					2009	https://shiftev.com/	127 SE 2nd Ave	Albany	OR
1	Tinitron Inc					1997	http://www.tinitron.com/index.html	6501 NW Croeni Rd	Hillsboro	OR
2	Delta Products Corporation Beaverton Oregon	1	334419	Other Electronic Component Manufacturing	$217,311.00	1993	www.delta-americas.com	15125 SW Koll Parkway	Beaverton	OR

2	Dunestar Systems	3	334419	Other Electronic Component Manufacturing	$651,932.00	1991	www.dunestar.com	59530 Yarmer Ln	Saint Helens	OR
2	Eit LLC	2	334419	Other Electronic Component Manufacturing	$460,215.00	2015	https://www.eit.com/	1709 S 76th St	Tacoma	WA
2	Siemens Ag	11	334419	Other Electronic Component Manufacturing	$2,531,183.00		https://new.siemens.com	13810 Se Eastgate Way	Bellevue	WA
2	EV4						https://ev4.website	2727 SE Raymond St	Portland	OR
2	OPConnect						https://www.opconnect.com/	7150 SW Hampton	Tigard	OR
2	Powin Corporation						http://www.powinenergy.com	20550 SW 115th Ave	Tualatin	OR
2	Schneider Electric						https://www.se.com/us/en/	12345 Leveton Dr	Tualatin	OR
2	Schneider Electric					1838	https://www.se.com/us/en/	Fairview Industrial Dr SE	Salem	OR
2	Schneider Electric					1838	https://www.se.com/us/en/	7525 SE 24th St	Mercer Island	WA
2	Shorepower Technology					2004	https://www.shorepower.com	5291 NE Elam Young Pkwy	Hillsboro	OR
3	911 Circuits	3	334419	Other Electronic Component Manufacturing	$620,403.00	2013	https://911circuits.com/	4785 Portland Rd Ne	Salem	OR
3	Air Weigh	15	334419	Other Electronic Component Manufacturing	$3,184,237.00		www.air-weigh.com	1730 Willow Creek Cir Ste 100	Eugene	OR
3	Ametek Tse	6	334419	Other Electronic Component Manufacturing	$1,303,864.00	1930	https://www.ametek.com/	4755 SW Griffith Dr	Beaverton	OR
3	Circuit Graphics Inc	3	334419	Other Electronic Component Manufacturing	$651,932.00	1979	www.circuitgraphicsinc.com	4075 Ne Beaumead St	Hillsboro	OR
3	Electronics Manufacturing Services	5	334419	Other Electronic Component Manufacturing	$1,086,553.00	1984	www.emsnw.com	10950 SW 5th St Ste 180	Beaverton	OR
3	Magnelink Inc	20	334419	Other Electronic Component Manufacturing	$4,346,212.00	1990	www.magnelinkinc.com	1060 Ne 25th Ave Ste C	Hillsboro	OR

3	Northwest Regulator Supply Inc	50	334419	Other Electronic Component Manufacturing	$10,865,530.00	1963	www.amforelectronics.com	5061 N Lagoon Ave	Portland	OR
3	Action Controls Inc	11	334419	Other Electronic Component Manufacturing	$2,531,183.00	1991		8320 S 259th St	Kent	WA
3	Creative Microsystems Inc	19	334419	Other Electronic Component Manufacturing	$4,372,043.00	1987	www.loadman.com	15224 Se Renton Issaquah Rd	Renton	WA
3	Custom Interface Inc	99	334419	Other Electronic Component Manufacturing	$20,449,812.00	1997	www.custominterface.net	410 S Larch St	Bingen	WA
3	Electronetics LLC	20	334419	Other Electronic Component Manufacturing	$4,602,151.00	1983	www.electronetics.us	1320 75th St SW	Everett	WA
3	Fox Link International Inc	2	334419	Other Electronic Component Manufacturing	$460,215.00		www.foxlink.com	2840 Northup Way Ste 108	Bellevue	WA
3	Instrument Sales & Services Inc	11	334419	Other Electronic Component Manufacturing	$2,531,183.00	2011	www.instrumentsales.com	7051 S 234th St	Kent	WA
3	Stress-tek Inc	35	334419	Other Electronic Component Manufacturing	$8,053,764.00	1978	www.stress-tek.com	5920 S 194th St	Kent	WA
3	Tri Coastal Industries	10	334419	Other Electronic Component Manufacturing	$2,301,075.00	1998	www.tciscales.com	17611 Ok Mill Rd	Snohomish	WA
3	Advanced Truck Equipment Inc	28	336111	Automobile Manufacturing	$45,152,223.00	2002	www.advancedtruck.com	4825 Table Rock Rd	Central Point	OR
3	Rogue Truck Body	8	336111	Automobile Manufacturing	$12,261,964.00	2013	www.roguetruckbody.com	30400 Redwood Hwy	Cave Junction	OR
3	Smith Equipment & Welding	18	336111	Automobile Manufacturing	$27,149,759.00	1985	www.watertrucks-tanks.com	13800 Ne Allen Creek Rd	Prineville	OR
3	Star Manufacturing Co	22	336111	Automobile Manufacturing	$34,326,286.00	2001	www.startlrs.com	230 Highway 241	Sunnyside	WA
3	Trivan Truck Body LLC	110	336111	Automobile Manufacturing	$179,782,031.00	2002	www.trivan.net	1385 W Smith Rd	Ferndale	WA
3	Cozy Cruiser Manufacturing Inc	3	336212	Truck Trailer Manufacturing	$784,107.00	1996	www.cozycruiser.com	790 30th St	Springfield	OR

3	Eagle Trailer Manufacturing	11	336212	Truck Trailer Manufacturing	$2,943,159.00	2017	https://trailerworldoforegon.com	6500 Se Johnson Creek Blvd	Portland	OR
3	Eagle Trailer Manufacturing	0	336212	Truck Trailer Manufacturing	$0.00		https://trailerworldoforegon.com	7766 Se 82nd Ave	Portland	OR
3	St Johns Corporation	20	336212	Truck Trailer Manufacturing	$5,351,198.00	2013		8801 N Vancouver Ave	Portland	OR
3	Nor E First Response Inc	13	336212	Truck Trailer Manufacturing	$3,443,738.00	1997	www.nor-e.com	1975 Midway Ln Ste J	Bellingham	WA
3	Tri Van	3	336212	Truck Trailer Manufacturing	$849,948.00	2009	www.trivan.com	13985 Interurban Ave S Ste 200	Seattle	WA
3	Battery Charger Sales & Service	3	336320	Motor Vehicle Electrical and Electronic Equipment Manufacturing	$1,176,075.00	1924	www.philbingroup.com	28 N Russell St	Portland	OR
3	Benz Spring Co	139	336390	Other Motor Vehicle Parts Manufacturing	$56,704,815.00		www.benzspring.com	4897 Indian School Rd Ne Ste 150	Salem	OR
3	Griffith Rubber Mills	35	336390	Other Motor Vehicle Parts Manufacturing	$51,012,908.00	1911	www.griffithrubber.com	2625 NW Industrial St	Portland	OR
3	Hurd's Hardware & Custom	12	336390	Other Motor Vehicle Parts Manufacturing	$4,753,366.00		www.hurdsinc.com	204 Moore St	Harrisburg	OR
3	Piaa	12	336390	Other Motor Vehicle Parts Manufacturing	$5,144,159.00	1963	www.piaa.com	3004 Ne 181st Ave	Portland	OR
3	Truck Rack Custom Fabrication LLC	139	336390	Other Motor Vehicle Parts Manufacturing	$59,586,506.00		www.truckrackinc.com	5819 Se Johnson Creek Blvd	Portland	OR
3	Tk Innovation	7	331318	Other Aluminum Rolling, Drawing, and Extruding	$3,989,690.00	1996	https://www.tkinnovationllc.com/services	90433 Prairie Rd	Eugene	OR
3	Kaiser Alutek Inc	75	331318	Other Aluminum Rolling, Drawing, and Extruding	$41,503,871.00	2010	www.kaiseraluminum.com	3401 N Tschirley Rd	Spokane	WA

3	Pro-tech Industries	88	331318	Other Aluminum Rolling, Drawing, and Extruding	$51,344,110.00	1979	www.protech.net	14113 Ne 3rd Ct	Vancouver	WA
3	Solatens	55	331318	Other Aluminum Rolling, Drawing, and Extruding	$30,436,172.00			16004 E Euclid Ave	Spokane	WA
3	AIMCO		33399	All Other General Purpose Machinery Manufacturing			http://www.aimco-global.com/	10000 SE Pine Street	Portland	OR
3	Anixter					1957	https://www.anixter.com/en_us.html	7661 SW Cirrus Dr	Beaverton	OR
3	IRC Aluminum and Stainless					1981	http://www.ircalum.com/	9038 N Sever Ct	Portland	OR
3	Professional Plastics					1984	https://www.professionalplastics.com/	19801 SW 95th Ave	Tualatin	OR
3	Warn Industries						https://www.warn.com	12900 SE Capps Rd	Clackamas	OR
4	Advanced Flight Systems Inc	10	334419	Other Electronic Component Manufacturing	$2,173,106.00	1995	www.advanced-flight-systems.com	320 S Redwood St	Canby	OR
4	Agri Tronics	40	334419	Other Electronic Component Manufacturing	$7,942,303.00	1995	www.agritronics.com	57701 Ione Gooseberry Rd	Ione	OR
4	Ascentron Inc	110	334419	Other Electronic Component Manufacturing	$23,351,071.00	2002	www.ascentron.com	994 Antelope Rd	White City	OR
4	Assembly Line Inc	5	334419	Other Electronic Component Manufacturing	$992,788.00	1988	www.assembly-line.com	231 Wharf St	Brookings	OR
4	Axiom Electronics Inc	90	334419	Other Electronic Component Manufacturing	$19,557,954.00	1990	www.axiomsmt.com	19545 NW Von Neumann Dr	Beaverton	OR
4	Epic Technical Sales	4	334419	Other Electronic Component Manufacturing	$869,242.00	2017	https://www.epicnw.com	1049 SW Baseline St	Hillsboro	OR
4	Future Technology Devices International	10	334419	Other Electronic Component Manufacturing	$0.00	2013	www.ftdichip.com	7130 SW Fir Loop	Portland	OR
4	Jocko Inc	7	334419	Other Electronic Component Manufacturing	$1,452,593.00	1999	www.jodeco.com	217 SW Pumice Ave Ste G	Redmond	OR

4	Macsema	25	334419	Other Electronic Component Manufacturing	$5,187,832.00	1989	www.macsema.com	1080 Se Centennial St Ste 1	Bend	OR
4	Siemens Mobility Rail Automation	0	334419	Other Electronic Component Manufacturing	$0.00		www.siemens.com	20393 SW Avery Ct	Tualatin	OR
4	South Valley Design	8	334419	Other Electronic Component Manufacturing	$1,738,485.00	1983	https://www.southvalleydesign.com	31841 Se Compton Rd	Boring	OR
4	Bic Inc	20	334419	Other Electronic Component Manufacturing	$4,602,151.00	1962	www.bicharn.com	10401 Mountain Loop Hwy	Granite Falls	WA
4	Blue Sea Systems	75	334419	Other Electronic Component Manufacturing	$16,136,445.00	1993	www.bluesea.com	425 Sequoia Dr Ste 101	Bellingham	WA
4	Kemcor Inc	15	334419	Other Electronic Component Manufacturing	$3,451,613.00	2001	www.kemcor.com	15925 Woodinville Redmond Rd Ne	Woodinville	WA
4	Lyn-tron Inc	78	334419	Other Electronic Component Manufacturing	$16,076,625.00	1957	www.lyntron.com	6001 S Thomas Mallen Rd	Spokane	WA
4	M-tronic Inc	7	334419	Other Electronic Component Manufacturing	$1,442,774.00	2001	http://mtronic.net/	1620 E Houston Ave Ste 700	Spokane	WA
4	Pacific Aerospace & Electronics Inc	164	334419	Other Electronic Component Manufacturing	$33,915,387.00		www.pacaero.com	430 Olds Station Rd	Wenatchee	WA
4	Pei Genesis	4	334419	Other Electronic Component Manufacturing	$920,430.00	2015	https://www.peigenesis.com/		Kirkland	WA
4	Qualitel Everett	11	334419	Other Electronic Component Manufacturing	$2,531,183.00		https://qualitel.com/	11831 Beverly Park Rd Bldg A	Everett	WA
4	Schippers & Crew Inc	65	334419	Other Electronic Component Manufacturing	$14,956,990.00	1990	www.schippers.com	5309 Shilshole Ave NW Ste 100	Seattle	WA
4	Tasc	20	334419	Other Electronic Component Manufacturing	$4,602,151.00	1991	www.tasc-wa.com	2222 N Pacific St	Seattle	WA
4	Electrochem Solutions	250	335911	Storage Battery Manufacturing	$105,281,850.00	1985	www.greatbatch.com	9305 Sw Nimbus Ave	Beaverton	OR

4	Western Star	770	336111	Automobile Manufacturing	$1,271,096,827.00	1969	www.westernstartrucks.com	6936 N Fathom St	Portland	OR
4	Pioneer Truckweld	42	336390	Other Motor Vehicle Parts Manufacturing	$17,133,829.00	1972	www.pioneertruckweld.com	4355 Turner Rd Se	Salem	OR
4	Superior Torque Converters	139	336390	Other Motor Vehicle Parts Manufacturing	$59,586,506.00		https://www.superiortorqueconverter.com	3711 Se Caruthers St	Portland	OR
4	Pacbrake Company	4	336390	Other Motor Vehicle Parts Manufacturing	$1,697,692.00	1961	www.pacbrake.com	1670 Grant Ave	Blaine	WA
4	Red Start Racing	139	336390	Other Motor Vehicle Parts Manufacturing	$61,722,626.00		www.redstartracing.com	2633 Willamette Dr Ne	Olympia	WA
4	JAE Oregon Inc						https://jaeoregon.com/	11555 SW Leveton Dr	Tualatin	OR
4	Lektro						https://www.lektro.com	1190 SE Flightline Dr	Warrenton	OR
5	Volta Volare						http://www.voltavolare.com	4040 Cirrus Ave	McMinnville	OR
5	Crescent Heart Software	10	334419	Other Electronic Component Manufacturing	$2,173,106.00	1981	www.c-h-s.com	2143 Se 55th Ave	Portland	OR
5	Matheson	24	334419	Other Electronic Component Manufacturing	$5,215,454.00	1956	www.mathesongas.com	3030 NW 29th Ave	Portland	OR
5	Microridge Systems Inc	5	334419	Other Electronic Component Manufacturing	$1,037,566.00	1983	www.microridge.com	56888 Enterprise Dr	Bend	OR
5	Mixsignal Design LLC	2	334419	Other Electronic Component Manufacturing	$434,621.00	2002	www.mixsignaldesign.com	3255 Ne Henderson Rd	Corbett	OR
5	Msr	15	334419	Other Electronic Component Manufacturing	$3,259,659.00	2009		8255 Ne Jacobson St Ste 100	Hillsboro	OR
5	Multi-tek	0	334419	Other Electronic Component Manufacturing	$0.00	1994	www.multi-tek.com	3122 Ne 181st Ave	Portland	OR
5	Northwest Rail Electric	20	334419	Other Electronic Component Manufacturing	$4,346,212.00	1983	www.nwrail.com	2630 Se Steele St	Portland	OR
5	Sartron Inc	12	334419	Other Electronic Component Manufacturing	$2,607,727.00	1957	www.sartron.com	114 N Main St	Newberg	OR

5	Spark Electronics	9	334419	Other Electronic Component Manufacturing	$1,910,542.00	2002	https://www.sparkfun.com/	35470 Ross Ln	Cottage Grove	OR
5	Squires Electronics Inc	44	334419	Other Electronic Component Manufacturing	$9,561,666.00	1976	https://supplyfx.com/	503 N 13th Ave	Cornelius	OR
5	Stilwell Baker	4	334419	Other Electronic Component Manufacturing	$869,242.00		www.stillwellbaker.com	6077 Lakeview Blvd. Ste B	Lake Oswego	OR
5	Swift Bridge Technologies Inc	0	334419	Other Electronic Component Manufacturing	$0.00		www.swiftbridgetechnologies.com	6975 Sw Sandburg St Ste 200	Portland	OR
5	Creative Motion Control	46	334419	Other Electronic Component Manufacturing	$10,584,947.00	2010	www.creativemotioncontrol.com	15520 Woodinville Redmond Rd Ne Ste D100	Woodinville	WA
5	Delta Computer Systems	29	334419	Other Electronic Component Manufacturing	$6,302,007.00	1982	www.deltamotion.com	1818 Se 17th St	Battle Ground	WA
5	Electronic Systems Technology Inc	11	334419	Other Electronic Component Manufacturing	$2,322,763.00	1982	www.esteem.com	415 N Quay St Ste B1	Kennewick	WA
5	Exxelia Deyoung Inc	50	334419	Other Electronic Component Manufacturing	$11,505,377.00	1971	www.exxelia.com	12920 Ne 125th Way	Kirkland	WA
5	Front Panel Express LLC	18	334419	Other Electronic Component Manufacturing	$4,141,936.00	2002	www.frontpanelexpress.com	5959 Corson Ave S Ste I	Seattle	WA
5	Goodwinds Kites Inc	5	334419	Other Electronic Component Manufacturing	$1,059,254.00	2008	www.goodwinds.com	1829 Railroad Ave	Mount Vernon	WA
5	Hamilton Sunstrand Corporation	130	334419	Other Electronic Component Manufacturing	$29,913,980.00		www.utcaerospacesystems.com	4020 Lake Washington Blvd Ne Ste 312	Kirkland	WA
5	Jrw Components	3	334419	Other Electronic Component Manufacturing	$690,323.00	2010		31810 Ne 115th Pl	Carnation	WA
5	La Components LLC	2	334419	Other Electronic Component Manufacturing	$460,215.00			24314 Se 2nd Ct	Sammamish	WA

5	Larkin Power Components	3	334419	Other Electronic Component Manufacturing	$618,332.00	1994	www.larkinpower.com	1725 N Park Rd	Spokane	WA
5	Leidos	4	334419	Other Electronic Component Manufacturing	$901,958.00	2014	www.leidos.com	26279 12 Trees Ln NW Ste A	Poulsbo	WA
5	Luma Technologies LLC	42	334419	Other Electronic Component Manufacturing	$9,664,517.00	2006	www.lumatech.com	13226 Se 30th St	Bellevue	WA
5	Microtemp Electronics	2	334419	Other Electronic Component Manufacturing	$434,621.00	1997		2716 Ne 168th Ave	Vancouver	WA
5	Microvision Inc	85	334419	Other Electronic Component Manufacturing	$10,891,000.00	1993	www.microvision.com	6244 185th Ave Ne	Redmond	WA
5	Netig LLC	80	334419	Other Electronic Component Manufacturing	$18,408,603.00	1975	www.net-ig.com	21229 72nd Ave S	Kent	WA
5	Omnisistem	15	334419	Other Electronic Component Manufacturing	$3,451,613.00	1986	www.omnisistem.com	6403 S 2082th St	Kent	WA
5	Panasonic Avionics	50	334419	Other Electronic Component Manufacturing	$11,505,377.00	1990	www.panasonic.aero	22333 29th Dr Se	Bothell	WA
5	Prologic Engineering Inc	10	334419	Other Electronic Component Manufacturing	$2,151,526.00	1993	www.prologic-eng.com	3979 Hammer Dr Ste B	Bellingham	WA
5	Rockwell Collins Inc	11	334419	Other Electronic Component Manufacturing	$2,531,183.00	2013	www.rockwellcollins.com	2377 S 200th St	Seattle	WA
5	Rugid Computer	21	334419	Other Electronic Component Manufacturing	$4,727,121.00	1986	www.rugidcomputer.com		Olympia	WA
5	Sensors In Motion Inc	0	334419	Other Electronic Component Manufacturing	$0.00	2006	https://www.unmannedsystemstechnology.com/	727 Harvard Ave E	Seattle	WA
5	Shipboard Electrical Systems	1	334419	Other Electronic Component Manufacturing	$230,108.00	1973		15300 Se 344th St	Auburn	WA
5	Silicon Forest Electronics	110	334419	Other Electronic Component Manufacturing	$23,904,166.00	1998	www.siliconforestelectronics.com	6204 E 18th St	Vancouver	WA

5	Souriau Pa&e	200	334419	Other Electronic Component Manufacturing	$41,360,228.00	1976	www.pacaero.com	434 Olds Station Rd	Wenatchee	WA
5	Spectralux Avionics	70	334419	Other Electronic Component Manufacturing	$16,107,528.00	1973	www.spectralux.com	12335 134th Ct Ne	Redmond	WA
5	Spindle Dynamics LLC	5	334419	Other Electronic Component Manufacturing	$1,150,538.00	2005	www.spindledynamics.com	7006 27th St W Ste D	Tacoma	WA
5	System To Asic Inc	11	334419	Other Electronic Component Manufacturing	$2,531,183.00	2012	www.system-to-asic.com	12100 Ne 195th St Ste 180	Bothell	WA
5	Ultrasonics International Inc	6	334419	Other Electronic Component Manufacturing	$1,290,916.00	1992	www.sonicpro.com	7044 Portal Way	Ferndale	WA
5	Wegners Wires	3	334419	Other Electronic Component Manufacturing	$690,323.00	1999		7308 139th Street Ct E	Puyallup	WA
5	Kaman Industrial Tech	9	335312	Motor and Generator Manufacturing	$3,314,339.00	1948	www.kamandirect.com	1703 Ne Argyle St	Portland	OR
5	Dykman Electrical Inc	7	335312	Motor and Generator Manufacturing	$2,577,819.00	2005	www.dykman.com	3004 Ne 112th Ave Ste E	Vancouver	WA
5	Jims Electric Trolling	2	335312	Motor and Generator Manufacturing	$698,560.00	1991		4214 S Sunderland Dr	Spokane	WA
5	Mer Marine Engines & Repair	18	335312	Motor and Generator Manufacturing	$7,019,026.00	1964	www.merequipment.com	2400 W Commodore Way	Seattle	WA
5	Johnson Controls	7	335912	Primary Battery Manufacturing	$2,947,892.00	2018	https://www.johnsoncontrols.com/	800 NW 3rd Ave	Canby	OR
5	American Grounding Systems Inc	7	335999	All Other Miscellaneous Electrical Equipment and Component Manufacturing	$2,491,263.00	1996	www.ags.bz	385 NW 1st St	Toledo	OR
5	Black Hawk Tech	43	335999	All Other Miscellaneous Electrical Equipment and Component Manufacturing	$15,938,829.00		https://blackhawktech.com/contact/	220 S 8th St	Aumsville	OR

5	Electro Scientific Industries Inc	300	335999	All Other Miscellaneous Electrical Equipment and Component Manufacturing	$367,884,000.00	1944	www.esi.com	13900 Nw Science Park Dr	Portland	OR
5	Laservia Corp	43	335999	All Other Miscellaneous Electrical Equipment and Component Manufacturing	$16,748,827.00	2001	www.laservia.com		Corbett	OR
5	Optimal Control Systems Inc	10	335999	All Other Miscellaneous Electrical Equipment and Component Manufacturing	$3,599,174.00	1984	www.optimalcontrol.net	2324 Three Lakes Rd Se	Albany	OR
5	Ditco Inc	12	335999	All Other Miscellaneous Electrical Equipment and Component Manufacturing	$4,949,338.00	1980	www.ditco.net	106 E Titus St	Kent	WA
5	Farwest Aircraft Inc	30	335999	All Other Miscellaneous Electrical Equipment and Component Manufacturing	$12,373,345.00	1967	www.farwestair.com	1415 Meridian Ave E	Puyallup	WA
5	Motors & Controls Corporation	9	335999	All Other Miscellaneous Electrical Equipment and Component Manufacturing	$8,021,022.00		www.motors-controls.com	430 Carpenter Rd Se	Lacey	WA
5	R P M Rod Pool Motorsports Inc	3	336111	Automobile Manufacturing	$4,812,165.00	1984		428 S Highland Dr	Kennewick	WA
5	Forest River Rv	1	336213	Motor Home Manufacturing	$254,620.00	2016	https://forestriverinc.com/rvs/		Dallas	OR

5	Guaranty Rv Parts & Travel Center	15	336213	Motor Home Manufacturing	$3,920,536.00		www.guaranty.com	93668 Highway 99 S	Junction City	OR
5	Stag Parkway	1	336213	Motor Home Manufacturing	$267,560.00	2013	https://www.ntpstag.com	6210 N Marine Dr	Portland	OR
5	Superior Rv Manufacturing	7	336213	Motor Home Manufacturing	$1,872,919.00			2139 N T St	Washougal	WA
5	Chalet Inc	0	336214	Travel Trailer and Camper Manufacturing	$0.00		www.chaletrv.com	124 41st Ave Se	Albany	OR
5	Columbia River Mandrel Bending	6	336390	Other Motor Vehicle Parts Manufacturing	$2,572,079.00	2003	www.mandrelbends.com	195 S 15th St	Saint Helens	OR
5	Diamond Eye Manufacturing	40	336390	Other Motor Vehicle Parts Manufacturing	$15,667,463.00	2000	www.diamondeyeperformance.com	107 W Main St	Athena	OR
5	Northwest Motion Products	5	336390	Other Motor Vehicle Parts Manufacturing	$2,143,400.00	2002	www.nwmotionproducts.com	6336 Sw Orchid Dr	Portland	OR
5	Pacific Recreational Products Inc	14	336390	Other Motor Vehicle Parts Manufacturing	$6,001,519.00	1993	www.stowaway2.com	7291 Sw Tech Center Dr	Portland	OR
5	Patrick Industries Inc	70	336390	Other Motor Vehicle Parts Manufacturing	$30,007,593.00	1959	www.patrickind.com	10510 Sw Industrial Way	Tualatin	OR
5	Pro-line Truck Gear	139	336390	Other Motor Vehicle Parts Manufacturing	$55,059,825.00	1992	www.prolinebedliners.com	457 Queen Ave Sw	Albany	OR
5	Yakima Products	139	336390	Other Motor Vehicle Parts Manufacturing	$59,586,506.00	1983	www.yakima.com	4101 Kruse Way	Lake Oswego	OR
5	Trail Tech Inc	15	336390	Other Motor Vehicle Parts Manufacturing	$6,430,199.00	2001	www.trailtech.net	1600 Se 18th Ave	Battle Ground	WA
5	Avant Arc						https://www.avantarc.com/	181 Polk Street	Eugene	OR
5	BBC Steel						https://bbcsteel.com/	2001 S Township Rd	Canby	OR
5	Cascade Composites						http://www.cascadecomposites.com	86365 College View Rd	Eugene	OR
5	Hytek Plastics						http://www.hytekplastics.net/	33911 SE Eastgate Cir	Corvallis	OR

5	Machine Sciences	100				2001	https://www.machinesciences.com/contact-us	10165 SW Commerce Circle	Wilsonville	OR
5	Madden Fabrication					1992	http://www.madfab.com/	2550 25th Place	Portland	OR
5	Parks Metal						http://www.parksmetal.com/	19460 SW Shaw	Aloha	OR
5	Summit Manufacturing						https://www.summitmfgusa.com/	3050 SE 61st Ct	Hillsboro	OR
5	The Lynch Company					1919	https://www.thelynchco.com/	4706 SE 18th Ave	Portland	OR
								5555 N Channel Ave	Portland	OR
5	Vigor						https://vigor.net	9700 SE Lawnfield Rd	Clackamas	OR
5	Vigor						https://vigor.net	1801 16th Ave SW	Seattle	WA
5	Vigor						https://vigor.net	3515 SE Columbia Way	Vancouver	WA

Appendix C

Regional Variation in Growth of EV-related Occupations, 2019 - 2025

Occupational Group	**2019 - 2025 % Change, OR**	**2019 - 2025 % Change, Portland-Vancouver-Hillsboro, OR**	**2019 - 2025 % Change, WA**	**2019 - 2025 % Change, Seattle-Tacoma-Bellevue, WA**
Architecture and Engineering Occupations	6.3	5.7	3.1	1.7
Computer and Mathematical Occupations	10.2	11.0	11.7	11.4
Construction and Extraction Occupations	13.7	18.4	8.8	6.4
Installation, Maintenance, and Repair Occupations	3.0	3.0	2.0	0
Life, Physical, and Social Science Occupations	8.0	8.7	4.9	5.9
Management Occupations	5.3	5.5	4.5	1.7
Production Occupations	-0.9	-1.2	-2.4	-4.5

Source: Emsi

Appendix D

Age Breakdown of Electric Motor Vehicle –related Occupations in Oregon, Washington, and the U.S., 2019

	Oregon	Washington	United States
Architecture and Engineering Occupations			
Age 24 or less	3.3%	4.3%	4.7%
Age 25-34	22.0%	21.8%	21.5%
Age 35-44	25.4%	22.1%	22.1%
Age 45-54	26.3%	25.6%	25.3%
Age 55-64	19.1%	22.2%	21.8%
Age 65+	3.8%	4.2%	4.7%
Computer and Mathematical Occupations			
Age 24 or less	3.3%	4.2%	4.3%
Age 25-34	28.3%	32.1%	29.5%
Age 35-44	32.0%	31.9%	29.1%
Age 45-54	22.1%	20.9%	22.3%
Age 55-64	12.2%	9.4%	12.7%
Age 65+	2.2%	1.5%	2.2%
Construction and Extraction Occupations			
Age 24 or less	8.9%	10.5%	9.0%
Age 25-34	23.6%	26.8%	24.7%
Age 35-44	26.9%	25.8%	25.0%
Age 45-54	22.4%	20.7%	22.6%
Age 55-64	15.5%	13.9%	15.8%
Age 65+	2.8%	2.4%	2.9%
Installation, Maintenance, and Repair Occupations			
Age 24 or less	10.9%	13.0%	11.4%
Age 25-34	25.1%	25.7%	24.7%
Age 35-44	24.9%	24.4%	23.5%
Age 45-54	21.3%	21.1%	22.4%
Age 55-64	14.6%	13.2%	14.7%
Age 65+	3.2%	2.7%	3.3%
Life, Physical, and Social Science Occupations			
Age 24 or less	2.4%	2.8%	3.6%
Age 25-34	24.8%	24.9%	25.8%
Age 35-44	27.6%	23.9%	23.3%
Age 45-54	22.6%	24.0%	23.2%
Age 55-64	18.3%	20.1%	19.2%
Age 65+	4.2%	4.1%	4.9%
Management Occupations			

Age 24 or less	0.9%	0.9%	1.1%
Age 25-34	13.4%	13.4%	12.6%
Age 35-44	25.4%	26.7%	25.0%
Age 45-54	31.8%	31.4%	32.4%
Age 55-64	24.7%	23.4%	25.0%
Age 65+	3.6%	4.0%	3.9%
Production Occupations			
Age 24 or less	8.8%	8.2%	9.4%
Age 25-34	21.7%	21.2%	21.1%
Age 35-44	23.0%	21.1%	21.1%
Age 45-54	23.7%	24.4%	24.2%
Age 55-64	18.7%	21.0%	20.1%
Age 65+	4.2%	4.1%	4.2%

Source: Emsi

Appendix E

Number of Completions in Programs that Prepare Students for Specific EV-related Occupations in Oregon and Washington, 2018

Institution	**State**	**Completions in All (2018)**	**Completions in Architecture and Engineering Occupations**	**Completions in Computer and Mathematical Occupations**	**Completions in Construction and Extraction Occupations**	**Completions in Installation, Maintenance, and Repair Occupations**	**Completions in Life, Physical, and Social Science**	**Completions in Management Occupations**	**Completions in Production Occupations**
University of Washington-Seattle Campus	WA	1,025	824				201		
Oregon State University	OR	840	748				92		
Washington State University	WA	697	590				34	73	
Green River College	WA	468	43	162		164			99
Portland State University	OR	436	313	1	1		58	63	
Spokane Community College	WA	284				262			22
Big Bend Community College	WA	266	3	5	96	162			
Shoreline Community College	WA	192	10			182			
Perry Technical Institute	WA	163			75	67			21
Oregon Institute of Technology	OR	155	111	44					
Eastern Washington University	WA	152	122				30		
Portland Community College	OR	146	24	22		76			24
Renton Technical College	WA	142		77		36			29
University of Portland	OR	132	103				29		
University of Washington-Bothell Campus	WA	129	126				3		
Lake Washington Institute of Technology	WA	128	7	27		43			51
Clover Park Technical College	WA	126		16		88			22
Bellingham Technical College	WA	123	10		49	30			34
Everett Community College	WA	118	36	30					52
University of Oregon	OR	110					110		
Gonzaga University	WA	109	105				4		

South Puget Sound Community College	WA	107	9	16		82			
Clark College	WA	106	10			64			32
Central Oregon Community College	OR	101				101			
Bates Technical College	WA	99	8	6	38	33			14
Edmonds Community College	WA	95	23	72					
Seattle University	WA	91	72	14			5		
Mt Hood Community College	OR	89	7			22	1		59
Walla Walla Community College	WA	83	2			61			20
Bellevue College	WA	77	26	51					
Peninsula College	WA	71		10		59			2
Western Washington University	WA	65	23				42		
Cascadia College	WA	60	3	57					
South Seattle College	WA	56	1			55			
Lower Columbia College	WA	53	7	7		24			15
Tacoma Community College	WA	47	47						
Linn-Benton Community College	OR	46				6	1		39
Klamath Community College	OR	45		31		14			
Central Washington University	WA	42	25				17		
Chemeketa Community College	OR	39	12			26			1
Rogue Community College	OR	39	2	22		15			
Saint Martin's University	WA	39	32				1	6	
Olympic College	WA	39	31	8					
Clackamas Community College	OR	35	1			30			4
Lane Community College	OR	35		11	1	23			
Wenatchee Valley College	WA	31				21			10
Pierce College-Puyallup	WA	25		25					
Grays Harbor College	WA	24				22			2
Willamette University	OR	23					23		
Whatcom Community College	WA	22		22					
Seattle Pacific University	WA	14	7				7		

Centralia College	WA	7	2	5					
Highline College	WA	20		20					
North Seattle College	WA	14		14					
Seattle Central College	WA	14		14					
Pierce College-Fort Steilacoom	WA	9		9					
Yakima Valley College	WA	21		8	1	7			5
Columbia Basin College	WA	21		8		8			5
Skagit Valley College	WA	19		1		17			1
DigiPen Institute of Technology	WA	6		6					
Umpqua Community College	OR	8				8			
Clatsop Community College	OR	8				8			
Reed College	OR	12					12		
Pacific Lutheran University	WA	19					19		
Southern Oregon University	OR	16					16		
Lewis & Clark College	OR	17					17		
Walla Walla University	WA	8				5	3		
Whitworth University	WA	21					21		
Pacific University	OR	15					15		
University of Washington-Tacoma Campus	WA	9					9		
Whitman College	WA	9					9		
Concordia University-Portland	OR	2					2		
George Fox University	OR	3					3		
Western Oregon University	OR	6					6		
Heritage University	WA	2					2		
Linfield College-McMinnville Campus	OR	2					2		
University of Puget Sound	WA	10					10		
Spokane Falls Community College	WA	12	12						

Source: Emsi

Appendix F

Top 10 Institutions in the Region per Number of Completions in Different Types of Programs that Prepare Students for Specific EV-related Occupations, 2018. Type of institution and number of enrolled students listed below

In top 10 for completions in following programs:	Institution	State	All Completions	All Certificates	All Degrees	Award of less than 1 year	Award of at least 1 but less than 2 years	Associate's Degree	Award of at least 2 but less than 4 years	BA Degree	Postbaccalaureate Certificate	MA Degree
All programs, BAs, MAs	University of Washington-Seattle Campus	WA	1,025		1,025					558		372
All programs, BAs, MAs	Oregon State University	OR	840		840					614		160
All programs, BAs, MAs	Washington State University	WA	697	40	657					495	40	108
All programs, Certificates, Awards less than 2 years, Associates	Green River College	WA	468	360	108	359	1	73		35		
All programs, BAs, MAs	Portland State University	OR	435	6	429					176	6	232
All programs, Certificates, Awards less than 2 years, Associates	Spokane Community College	WA	285	234	51	220	14	51				
All programs, Certificates, Awards less than 2 years	Big Bend Community College	WA	266	247	19	227	20	19				
All programs, Certificates, Awards less than 2 years	Shoreline Community College	WA	192	166	26	140	26	26				
All programs, Certificates	Perry Technical Institute	WA	163	163	0		58	0	105			
All programs, BAs	Oregon Institute of Technology	OR	155		155			1		154		
BAs	Eastern Washington University	WA	152	1	151					145	1	6
Associates	Portland Community College	OR	146	60	86		13	86	47			
Certificates, Awards less than 2 yrs	Renton Technical College	WA	142	104	38	7	84	38	13			
BAs	University of Portland	OR	132		132					132		0
BAs, MAs	University of Washington-Bothell Campus	WA	129		129					115		14
Certificates, Awards less than 2 yrs, Associates	Lake Washington Institute of Technology	WA	128	80	48	45	35	48				
Certificates, Awards less than 2 yrs	Clover Park Technical College	WA	126	88	38	64	12	38	12			

Certificates, Awards less than 2 yrs, Associates	Bellingham Technical College	WA	123	81	42	23	58	42				
Awards less than 2 yrs, Associates	Everett Community College	WA	118	78	40	77	1	40				
MAs	University of Oregon	OR	110		110					28		63
Bas	Gonzaga University	WA	109		109					103		6
Certificates, Awards less than 2 yrs	Central Oregon Community College	OR	101	99	2	99	0	2				
Associates	Bates Technical College	WA	99	22	77	3	19	77				
BAs, MAs	Seattle University	WA	91	5	86					77	5	9
Associates	Mt Hood Community College	OR	89	40	49	40	0	49				
Associates	Bellevue College	WA	77	17	60	3	14	60				
MAs	Western Washington University	WA	65		65					54		11
Associates	Tacoma Community College	WA	47		47			47				
MAs	Saint Martin's University	WA	39		39					28		11
MAs	University of Washington-Tacoma Campus	WA	9		9					0		9

Source: Emsi

Institution	**Type of institution, location, and number of enrolled students**
University of Washington-Seattle Campus	Public university in Seattle, WA. Servers approx. 54,000 students annually
Oregon State University	Public university in Corvallis, OR. 32,011 enrolled students in 2018
Washington State University	Public university in Pullman, WA. 20,976 enrolled students
Green River College	Public college in Auburn, WA. 19,113 enrolled students in 2015-16
Portland State University	Public university in Portland, OR. 27,285 enrolled students in 2018-19
Spokane Community College	Public community college in Spokane, WA. Students served in 2018-19: 17,837
Big Bend Community College	Public community college in Mosel Lake, WA
Shoreline Community College	Public community college in Shoreline, WA. Approx. 10,000 enrolled students per year
Perry Technical Institute	Private technical institution in Yakima, WA. Over 750 enrolled students
Oregon Institute of Technology	Public polytechnic university with main campus in Kalamath Falls, OR. Total enrollment in 2019: 5,319
Eastern Washington University	Public university with main campus in Cheney, WA. 12,635 students enrolled in 2018
Portland Community College	Public community college in Portland, OR. Serves approx. 73,000 students

Renton Technical College	Public community college in Renton, WA. 9,651 enrolled students
University of Portland	Private Catholic university in Portland, WA. Approx. 4,000 students
University of Washington-Bothell Campus	Public university in Bothell, WA, one of the three campuses of UW. Enrollment approx. 6,000
Lake Washington Institute of Technology	Public technical institute in Kirkland, WA. 6,571 enrolled students
Clover Park Technical College	Public community college in Lakewood, WA. 6,523 enrolled students
Bellingham Technical College	Public technical college in Bellingham, WA. Annual student headcount in 2017-18: 5,332
Everett Community College	Public community college in Everett, WA. 19,079 enrolled students in 2018-19
University of Oregon	Public university in Eugene, OR. 22,615 enrolled students
Gonzaga University	Private Jesuit university in Spokane, WA. 7,566 enrolled students in 2018
Central Oregon Community College	Public community college in Bend, OR. 15,701 enrolled students in 2017-18
Bates Technical College	Public technical college in Tacoma, WA. Serves approx. 3,000 career training students and 10,000 more community members
Seattle University	Private Jesuit university in Seattle, WA. 7,291 enrolled students in 2018
Mt Hood Community College	Public community college in Gresham, OR. Serves approx. 33,000 students annually
Bellevue College	Public college in Bellevue, WA, with more than 32,000 students served annually
Western Washington University	Public university with main campus in Bellingham, WA. 16,142 enrolled students in 2019
Tacoma Community College	Public community college with main campus in Tacoma, WA. 12,352 students served in 2017-2018 academic year
Saint Martin's University	Private Benedictine university in Lacey, WA. Approx. 1750 enrolled students
University of Washington-Tacoma Campus	Public university in Tacoma, WA, one of the three campuses of UW. Total enrollment in 2019: 5,352

Source: Institutions' websites