TRANSPORTATION ELECTRIFICATION WORKFORCE MARKET STUDY

work. systems
The Portland Metro Workforce Development Board

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EXECUTIVE SUMMARY

Skilled workers are needed to support the electrification of Oregon's transportation system. The Transportation Electrification (TE) Workforce Market Study asks the questions: What will the demand for skilled and diverse workers look like in five, ten, fifteen years? How can workforce and educational systems prepare to meet that demand so that local workers are able to take advantage of new opportunities? How do we ensure these economic opportunities substantively advance racial and gender equity?

TO BETTER UNDERSTAND THE WORKFORCE NEEDS, THIS REPORT EXPLORES THREE THINGS:

- The volume, rate of growth, and range of occupations critical to supporting growth of transportation electrification.
- The occupational needs of anchor institutions in Oregon's EV supply chain.
- Places in the workforce and educational system where meaningful investments in workforce development will lead to a diversified workforce prepared for living wage jobs.

An analysis of existing labor market data led to the identification of the industries, businesses, and occupations most relevant to TE. Using the North American Industry Classification System (NAICS), this study identified TE related businesses included in traditional motor vehicle manufacturing and manufacturing of additional EV—related components, such as battery manufacturing. We also included businesses associated with the electrification of the system, including utilities. TE related businesses exist across the entire span of electrification, from the planning and design of public spaces and private vehicles to the end-of-life recycling of electric batteries.

When possible, we interviewed representatives of Oregon TE anchor institutions about their current and future TE workforce needs. We asked questions including: How much TE work are they doing now? What are they expecting for the future? What occupations are they hiring for? Where do they look for workers? What is important when hiring someone to work in this field? What type of education and certifications do workers need? Are the workers they need hard to find? What populations do they represent?

We provided interviewees with labor market data and compared the data with their experiences. The interviews informed our understanding of worker demand across the TE spectrum.

Through this analysis, we identified 21 target occupations in the TE industry, as defined as those which require less than four years of post-secondary education and pay an average wage of at least $17/hr. Not all the workers in these occupations are working in transportation electrification but the workers have skills which can be applied to TE jobs.

PRELIMINARY FINDINGS FROM THIS STUDY INCLUDE:

- **TE will drive growth in existing occupations and refocus them on electric transportation.** Some new occupations may emerge, but most of the TE workforce will continue to be in existing occupations with expanded training and skill development specific to TE technologies.

TE WILL DRIVE GROWTH IN EXISTING OCCUPATIONS AND REFOCUS THEM ON ELECTRIC TRANSPORTATION. SOME NEW OCCUPATIONS MAY EMERGE, BUT MOST OF THE TE WORKFORCE WILL CONTINUE TO BE IN EXISTING OCCUPATIONS WITH EXPANDED TRAINING AND SKILL DEVELOPMENT SPECIFIC TO TE TECHNOLOGIES.

- **Lack of standardization will lead to duplication and siloed manufacturer trainings.** Until EVs and charging equipment are standardized, supplemental and product-specific OEM training may continue as the main avenue for ensuring the workforce has the qualifications necessary to serve the TE industry.

- **Job growth is likely to exceed expectations.** The combination of new policies and spending will accelerate growth beyond what is indicated from previous years' growth and the shift to EV from the private sector will increase the number of EVs on the road while reducing the availability of vehicles with internal combustion engines.

INVESTING IN TRAINING OPPORTUNITIES CAN LEAD TO INCREASED WORKFORCE DIVERSITY.

- **In Oregon, most TE workforce growth is in electrician-related positions.** Based on interviews, we found the most pressing hiring needs is for licensed electricians. The demand for electricians is primarily related to charging station installation and maintenance.

- **Investing in training opportunities can lead to increased workforce diversity.** The growth of TE in Oregon presents an incredible opportunity to advance equitable economic development and address clear wage and hiring disparities.

BASED ON THESE FINDINGS, THIS STUDY HAS A SET OF RECOMMENDATIONS TO GUIDE TE WORKFORCE DEVELOPMENT EFFORTS:

- **Expand existing training and education opportunities for TE target occupations.** Training and education programs are already available for many TE target occupations. Employers and the workforce system should invest in, and partner with, existing programs to prepare for increased worker demand.

- **Prioritize increasing diversity of the TE workforce.** Now is the time to explicitly include and support the participation of women and people of color in the design phase of potential workforce investments. Increasing diversity across target occupations is an opportunity to advance racial equity through equitable economic opportunity.

- **Embed workforce planning into the infrastructure needs for the industry to grow.** Workforce development is an essential piece of growing TE infrastructure. As these efforts continue to develop, our recommendation is for employers, the public workforce system, and the state to work closely to ensure the time horizon for growing a skilled workforce is accounted for in the state planning efforts.

- **Explore funding mechanisms[12], to effectively invest in the diverse workforce for the future.** Industry leaders, especially employers, should partner and plan for their future workforce needs.

INCREASING DIVERSITY ACROSS TARGET OCCUPATIONS IS AN OPPORTUNITY TO ADVANCE RACIAL EQUITY THROUGH EQUITABLE ECONOMIC OPPORTUNITY.

1 https://www.oregonmetro.gov/public-projects/oregon-convention-center-hotel/jobs-and-job-training
2 https://www.multco.us/multnomah-county/news/county-capital-construction-projects-seeking-workers-striving-toward-workforce

INTRODUCTION

The State of Oregon and local government agencies are adopting and supporting policies and initiatives aimed at addressing climate change. A key component of their strategies is the electrification of the transportation system. Oregon's Department of Environmental Quality (DEQ) estimates that roughly thirty-five percent of greenhouse gas emissions in Oregon during the past thirty years were from transportation[3]. Phasing out the use of internal combustion engines and replacing them with zero emissions vehicles will reduce greenhouse gas emissions and help to meet climate change goals.

To that end, Oregon is incentivizing the use of electric cars through the Clean Vehicle Rebate Program and partnering with fleet operators, including school districts, utilities, and transit agencies to help make the switch to electric vehicles.

Oregon is also investing in the infrastructure needed to support transportation electrification (TE). This includes investment along the West Coast Electric Highway as well as seeking federal dollars to further expand and support public charging infrastructure. Oregon is not alone. Nationally, the Biden administration has proposed $15 billion to help create 500,000 more public charging stations by 2030[4].

The shift toward transportation electrification is not limited to the public sector. Recently, the private sector, and in particular, vehicle manufacturers have announced largescale moves toward vehicle electrification. General Motors plans to exclusively offer electric vehicles by 2035[5]. That includes cars, trucks, and SUVs. Volvo announced it will only make electric vehicles by 2030[6]. Daimler is converting its Portland factory to manufacture the company's all-electric Freightliner trucks[7]. The design, construction, and maintenance of this infrastructure, as well as the growth of manufacturing, sales, maintenance, and management of the TE industry will require a wide variety of skilled workers.

3 Greenhouse Gas Emissions Data. Oregon Department of Energy. State of Oregon: Energy in Oregon - Greenhouse Gas Emissions Data
4 Oregon Department of Transportation : Electric Vehicles and EV Infrastructure : Programs : State of Oregon
5 General Motors, Committing to an All-Electric Future | General Motors (gm.com)
6 Volvo says it will be 'fully electric' by 2030, move car sales online (cnbc.com)
7 Daimler will convert Portland factory to make electric trucks - oregonlive.com

PGE provided funds to support this transportation electrification workforce market study to help PGE, state and local government, and private or nonprofit organizations more effectively target resources to ensure the transportation electrification workforce is available, diverse, and well trained in Oregon. PGE supports an inclusive transition to electric vehicles and the economic, air quality, grid management, and greenhouse gas emissions reduction benefits they can provide.

Worksystems, since it formed as an agency in 1999, has worked intentionally to use labor market information from local, state, and federal agencies alongside first-hand workforce intelligence gathered from local employers to design workforce development programming that maximally benefits job seekers and employers in the community. The approach requires intensive workforce supply and demand data analysis. Resulting workforce analyses are industry-driven, data-based plans to improve the quality of the local workforce in high-growth industries. All strategies have specific goals related to ensuring underrepresented populations gain access to career exposure, training, and jobs.

To better understand the workforce needs, this report explores three things:

- The volume, rate of growth, and range of occupations critical to supporting growth of transportation electrification.

THIS ANALYSIS ASKS THE QUESTIONS: WHAT WILL THE DEMAND LOOK LIKE IN FIVE, TEN, FIFTEEN YEARS? HOW CAN WORKFORCE AND EDUCATIONAL SYSTEMS PREPARE TO MEET THAT DEMAND SO THAT LOCAL WORKERS ARE ABLE TO TAKE ADVANTAGE OF NEW OPPORTUNITIES? HOW DO WE ENSURE THESE ECONOMIC OPPORTUNITIES SUBSTANTIVELY ADVANCE RACIAL AND GENDER EQUITY?

- The occupational needs of anchor institutions in Oregon's EV supply chain.
- Places in the workforce and educational system where meaningful investments in workforce development will lead to a diversified workforce prepared for living wage jobs.

TE is a rapidly developing field. Within the time it has taken to write this report, the industry has experienced a sea change. Public investments at the state and national levels are increasing. Moreover, the automobile industry is making historic commitments not just to the adoption of EVs but to phasing out the production of new internal combustion vehicles entirely.

This report is a first look at the workforce needs as projected today. As the industry grows those needs will evolve. This report identifies places where an investment in training and education will create the best opportunities for high quality jobs. There are some gaps. Despite our best efforts, we were unable to interview representatives from some of the biggest players in Oregon's TE industry. Without input from the companies, it was challenging to accurately reflect their future staffing needs.

With the rapid expansion of the industry, we expect to see in the next few years, it would not be surprising to see Oregon based firms that do not currently play a role in TE expanded into the field.

METHODOLOGY

Geographical scope: This analysis covers the state of Oregon. The one exception is the inclusion of Clark College in Vancouver, WA. Clark College provides education relevant to TE through partnership with Oregon trade associations.

Although this study covers the entire state, the demand for skilled workers will vary depending on the region. EV ownership is currently concentrated in Multnomah and Washington Counties[8]. This is not surprising as they are the most populous and two of the most prosperous counties in the state. As EV ownership and TE expand, the need for qualified workers will grow in every county across Oregon.

AN ANALYSIS OF EXISTING LABOR MARKET DATA LED TO THE IDENTIFICATION OF THE INDUSTRIES, BUSINESSES, AND OCCUPATIONS MOST RELEVANT TO TE.

Some of the occupations in TE are mobile and will likely involve workers traveling to different locations for short term projects. Construction and utility workers, for example, might be onsite for several days or weeks to build and connect infrastructure before continuing onto the next site. Workers will be able to cover large geographic areas. Other occupations, mechanics for example, will likely work in one location and thus serve a smaller geographic area.

Vehicles: This study covers passenger cars, light and heavy-duty trucks, and buses.

Chargers: This study includes all types of chargers, from home to ultra-fast charging points.

An analysis of existing labor market data led to the identification of the industries, businesses, and occupations most relevant to TE. Using the North American Industry Classification System (NAICS), we identified TE related businesses included in traditional motor vehicle manufacturing and manufacturing of additional EV—related components, such as battery

8 State of Oregon: DATA & REPORTS - Oregon Electric Vehicle Dashboard

manufacturing. We also included businesses associated with the electrification of the system, including utilities. TE related businesses exist across the entire span of electrification, from the planning and design of public spaces and private vehicles to the end-of-life recycling of electric batteries.

As part of the identification process, we did a literature review of other studies. Much of what we found focused on individual pieces of the total TE system. From that, we pieced together a picture of all the industries that operate in the state and are related to TE.

WE IDENTIFIED 42 OCCUPATIONS IN NINE SECTORS THAT RELATE DIRECTLY TO TE. THE OCCUPATIONS RANGE FROM URBAN PLANNERS TO MECHANICS TO ELECTRICAL ENGINEERS TO SALES AND MARKETING.

This analysis looks at the entire TE supply chain. However, because it is limited to Oregon, not all pieces of the supply chain are relevant. For example, just two firms in Oregon manufacture batteries. Neither is a large supplier of batteries for electric vehicles. And while there are some small electric passenger vehicle manufacturers, they are niche and not significant producers to meet the forecasted statewide EV demand at this time[9].

After we identified industries and businesses, we looked at occupations. We identified 42 occupations in nine sectors that relate directly to TE. The occupations range from urban planners to mechanics to electrical engineers to sales and marketing.

Of those, we identified twenty-one target occupations. Target occupations are defined as occupations which require less than four years of post-secondary education, pay a median wage of $17/hr. or more, and are expected to grow.

The target occupations represent the greatest opportunity to invest in high-quality careers with minimal barriers to access that will contribute to the success of the TE industry's growth. Investments in target occupations should prioritize opportunities for women and people of color into the growing clean energy economy.

Once we identified the target occupations, we used that information to inform our interviews with the businesses and organizations we identified as anchor institutions. Anchor institutions play an outsized role in transportation electrification in Oregon and are representative of larger trends. When possible, we identified representatives of anchor institutions. The information they provided about current and future staffing needs and anticipated industry growth was instrumental in our understanding of the best way to target resources and create opportunities for Oregon workers.

TRANSPORTATION ELECTRIFICATION IN OREGON

Electrification of the transportation system in Oregon includes both the electric vehicles and the supporting infrastructure.

Photo of Union Electrician

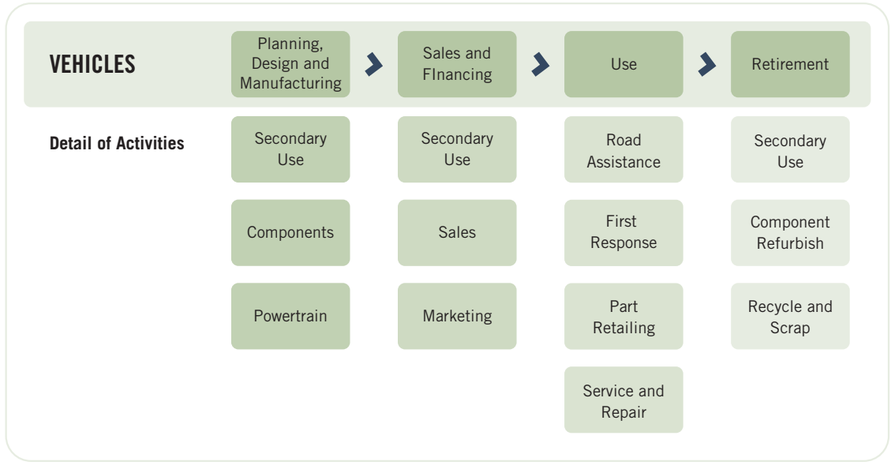
9 DatabaseUSA.com Business-Level Data

PASSENGER VEHICLES

Oregon's first electric passenger vehicle was registered in 1999. Adoption of the technology was initially slow. A sharp increase in EV ownership began in 2015. During the past six years, the number of electric vehicles has increased between sixty-five and sixty-eight percent each year. Today, more than 31,000 electric vehicles are registered in Oregon. EVs are registered in all thirty-six Oregon counties, with slightly more than fifty percent in Multnomah and Washington Counties[10].

The production, sale, maintenance, and retirement of electric vehicles is performed by workers across multiple industry sectors and occupational groups. Before an EV hits the showroom floor, components must be designed and manufactured. New, and increasingly used, EVs are marketed and sold to consumers, many of whom need financing. Once they are on the road, EVs need regular service and repair including replacement parts. A growing secondary market is selling used EVs to commercial and private consumers. At the end of their lifespans, EVs need to be decommissioned, scrapped, and recycled.

FIGURE 1: ELECTRIC VEHICLE SECTORS



10 Oregon Electric Vehicle Dashboard, State of Oregon: DATA & REPORTS - Oregon Electric Vehicle Dashboard

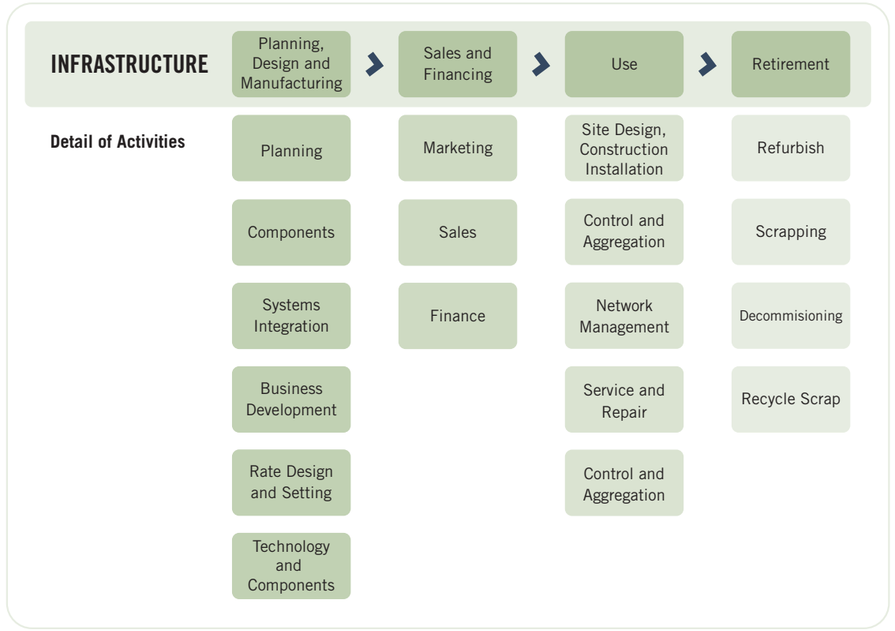
TE INFRASTRUCTURE

The infrastructure to support widespread use of EVs also spans multiple industry sectors and occupational groups. Like the vehicles themselves, the components of the charging infrastructure need to be designed and manufactured. This includes the software and hardware in each charging station, and the connections between the stations and the electric grid.

ELECTRICIANS AND LINEWORKERS INSTALL AND SERVICE THE CHARGERS AND UPDATE THE GRID TO ACCOUNT FOR THE INCREASED ELECTRIC DEMAND.

Sales and marketing teams compete for market share. Urban planners and construction contractors reimagine and redesign parking infrastructure to accommodate EV's power needs. Electricians and lineworkers install and service the chargers and update the grid to account for the increased electric demand. As charging stations reach the end of their lifespan, they too need to be refurbished, decommissioned, and recycled.

FIGURE 2: ELECTRIC TRANSPORTATION INFRASTRUCTURE SECTORS



As it exists today, the transportation infrastructure in Oregon is not sufficient to meet the increased demand for electric vehicle use and ownership.

Oregon has more than 900 public charging stations. They are part of thirteen different networks[11]. Electric vehicles and chargers are not universal. Nineteen percent of chargers are Tesla specific and will not work with other makes of cars. The chargers are concentrated in the Willamette Valley and along the coast. There are few stations in the eastern and southeastern parts of the state.

To meet the projected increase in demand, Oregon will need to expand the charging infrastructure that supports electric vehicle use. The Oregon Department of Transportation (ODOT) released a study in June, 2021 detailing the charging needs and gaps in Oregon[12].

The ODOT study highlights charging infrastructure needs for light-duty zero-emission vehicles, medium and heavy-duty trucks and busses, e-bikes and e-scooters. It also developed a vision of the needed charging infrastructure and propose policy options to expand that infrastructure throughout the state.

The public charging stations along the highway or in public parking spaces are just a piece of the needed infrastructure. There will also be an increased demand for home charging stations. This is true for single and multi-family housing.

Charging stations are becoming a routine part of new condo and apartment construction. In some cases, developers are putting the electric infrastructure into place in anticipation of the demand for specific charging stations from future residents. This trend will be accelerated by the recently passed Oregon HB 2180. The bill requires an amendment to the state building code to require that new construction of large multi-unit buildings include provisions for electric service capacity for specified percentage of parking spaces[13].

11 Go Electric Oregon. Charge on the Go — Go Electric Oregon
12 Oregon Department of Transportation : Transportation Electrification Infrastructure Needs Analysis : Programs : State of Oregon
13 HB2180 2021 Regular Session - Oregon Legislative Information System (oregonlegislature.gov)

Charging infrastructure will also be needed in more commercial spaces – shopping malls, hotels, public parking structures, grocery stores for use by customers, and private employers for use by their employees.

As private and public fleets convert to EV, charging infrastructure will need to be installed. Depending on the size of the fleet and the type of vehicles, that can be as small as a row of charging stations, or it can be as complicated as redesigning an entire bus yard. Installation of charging stations in multi-family housing and other large commercial buildings can require parking lot construction and may require upgrades to electricity distribution system equipment.

As more households, businesses, and fleets electrify, upgrades will be required to the electric grid. Building the infrastructure to support those chargers requires partnerships between utilities, communities, fleets, businesses, governments, and equipment providers. Adding a charging station (or two) to a private home can mean a new electrical panel and adding a row of charging stations to a downtown parking garage down the street from a new condo building may require upgrades to the building's electrical equipment and possibly utility distribution equipment. Electrifying a heavy-duty fleet may require upgrades to nearby substations.

Before they can be installed in new or existing construction, charging stations need to be designed, manufactured, marketed, and sold. After installation, stations must be serviced, maintained, and eventually replaced. The transition to electricity as a fuel requires a consistent and positive driver experience, which means charging providers will need to be reliably staffed for operations and maintenance needs.

THE TE WORKFORCE

INDUSTRIES

The electrification of the transportation system includes work in multiple economic sectors. TE includes the design, manufacture, marketing, and sales of electric vehicles. TE also includes the design, manufacturing, marketing, sales, installation, and repair of charging stations. The charging stations are installed at private homes, both single and multi-family. Commercial vehicles, including public busses-, short- and long-haul delivery trucks, and the cars and trucks are used by municipalities and private businesses. (Table 1)

Thirty-one industries related to TE have a presence in Oregon. With more than 27,000 jobs, semiconductor and related device manufacturing is by far the largest employer, accounting for forty-eight percent of all jobs. The next largest in terms of employment are new car dealers (12,691 jobs), and power and communication line and related structure construction (2,403 jobs). It is important to keep in mind these figures include all activities related to these industries, not just TE-related sales and size. NAICS Codes do not currently break out industry data specific to TE. (Table 1)

TABLE 1: TE RELATED INDUSTRIES IN OREGON, 2021

Source: EMSI

NAICS Code	Sector	2021 Jobs	2031 Jobs	2021 - 2031 % Change	2020 Location Quotient	2020 Jobs Multiplier
221111	Hydroelectric Power Generation	216	234	8%	2.38	5.25
221112	Fossil Fuel Electric Power Generation	242	186	-23%	0.24	5.97
221114	Solar Electric Power Generation	19	28	45%	0.34	4.9
221115	Wind Electric Power Generation	386	544	41%	4.01	5.66
221117	Biomass Electric Power Generation	69	66	-4%	2.83	4.5
221121	Electric Bulk Power Transmission and Control	660	639	-3%	1.92	6.23
221122	Electric Power Distribution	1,548	1,545	0%	0.55	5.64
237130	Power and Communication Line and Related Structures Construction	2,403	2,352	2%	0.84	2.34
238210	Electrical Contractors and Other Wiring Installation Contractors	13,665	15,737	15%	1.08	2.19
331318	Other Aluminum Rolling, Drawing, and Extruding	296	284	-4%	0.81	2.81
331512	Steel Investment Foundries	2,108	2,257	7%	12.45	2.68
334413	Semiconductor and Related Device Manufacturing	27,345	28,417	4%	11.32	3.21
334419	Other Electronic Component Manufacturing	959	819	-15%	1.26	2.13
335312	Motor and Generator Manufacturing	15	13	-14%	0.03	2.28
335911	Storage Battery Manufacturing	229	206	-10%	0.67	2.82
335912	Primary Battery Manufacturing	0	0	0%	0	0
335991	Carbon and Graphite Product Manufacturing	180	186	3%	1.57	3.15
335999	All Other Miscellaneous Electrical Equipment & Component Manufacturing	438	414	-5%	1.13	2.95
336211	Motor Vehicle Body Manufacturing	242	216	-11%	0.34	2.16
336212	Truck Trailer Manufacturing	359	343	-5%	0.73	2.68
336213	Motor Home Manufacturing	259	193	-25%	1.28	1.72
336214	Travel Trailer and Camper Manufacturing	2,226	1,979	-11%	4.13	2.44
336310	Motor Vehicle Gasoline Engine and Engine Parts Manufacturing	39	42	8%	0.05	3.67
336320	Motor Vehicle Electrical and Electronic Equipment Manufacturing	321	292	-9%	0.42	2.93
336330	Motor Vehicle Steering and Suspension Components (except Spring) Manufacturing	<10	<10	Insf. Data	0	7.01

TABLE 1 (CONTINUED)

NAICS Code	Sector	2021 Jobs	2031 Jobs	2021 - 2031 % Change	2020 Location Quotient	2020 Jobs Multiplier
336340	Motor Vehicle Brake System Manufacturing	28	44	57%	0.08	3.14
336350	Motor Vehicle Transmission and Power Train Parts Manufacturing	676	811	20%	0.65	3.64
336360	Motor Vehicle Seating and Interior Trim Manufacturing	20	17	-17%	0.02	2.48
336370	Motor Vehicle Metal Stamping	25	12	-52%	0.03	3.63
336390	Other Motor Vehicle Parts Manufacturing	411	351	-15%	0.23	4.19
423110	Automobile and Other Motor Vehicle Merchant Wholesalers	1,635	1,500	-8%	3.77	1.04
441110	New Car Dealers	12,691	12,637	0%	2.16	0.92
441120	Used Car Dealers	1,449	1,448	0%	1.79	0.7
Total		**57,046**	**57,580**	**1%**		

TABLE 2

In 2020, Oregon firms related to TE had nearly $24 billion in sales. Thirty-five percent of those sales were in Oregon. The remaining seventeen percent were outside of the state. Of the industries related to TE, the largest total sales by far were in semiconductor and related device manufacturing. Just five percent of semiconductor sales are in state. The next largest industries in terms of sales are new car dealers ($2,274,885,677) and electric power distribution ($1,636,183,382). (Table 2)

TABLE 2: TE RELATED INDUSTRIES IN OREGON, 2021

Source: EMSI

NAICS Code	Sector	2020 % In-Region Sales	2020 % Exported Sales	2020 Total Sales
221111	Hydroelectric Power Generation	39%	61%	$202,075,329
221112	Fossil Fuel Electric Power Generation	46%	54%	$312,024,836
221114	Solar Electric Power Generation	83%	17%	$6,810,384
221115	Wind Electric Power Generation	20%	80%	$379,175,675
221117	Biomass Electric Power Generation	24%	76%	$48,324,159
221121	Electric Bulk Power Transmission and Control	50%	50%	$650,282,439
221122	Electric Power Distribution	86%	14%	$1,746,159,837
237130	Power and Communication Line and Related Structures Construction	88%	12%	$573,832,164
238210	Electrical Contractors and Other Wiring Installation Contractors	78%	22%	$3,039,142
331318	Other Aluminum Rolling, Drawing, and Extruding	42%	58%	$118,003,420
331512	Steel Investment Foundries	4%	96%	$667,330,197
334413	Semiconductor and Related Device Manufacturing	5%	95%	$10,670,575,452
334419	Other Electronic Component Manufacturing	30%	70%	$194,327,195
335312	Motor and Generator Manufacturing	44%	56%	$13,186,943
335911	Storage Battery Manufacturing	38%	62%	$113,778,122
335912	Primary Battery Manufacturing	71%	29%	$873,992
335991	Carbon and Graphite Product Manufacturing	24%	76%	$91,814,869
335999	All Other Miscellaneous Electrical Equipment & Component Manufacturing	25%	75%	$176,965,748
336211	Motor Vehicle Body Manufacturing	47%	53%	$55,967,737
336212	Truck Trailer Manufacturing	61%	39%	$139,691,427
336213	Motor Home Manufacturing	29%	71%	$48,786,929

TABLE 2 (CONTINUED)

NAICS Code	**Sector**	**2020 % In-Region Sales**	**2020 % Exported Sales**	**2020 Total Sales**
336214	Travel Trailer and Camper Manufacturing	33%	67%	$846,413,945
336310	Motor Vehicle Gasoline Engine and Engine Parts Manufacturing	66%	34%	$27,773,620
336320	Motor Vehicle Electrical and Electronic Equipment Manufacturing	59%	41%	$142,510,245
336330	Motor Vehicle Steering and Suspension Components (except Spring) Manufacturing	74%	26%	$4,895,250
336340	Motor Vehicle Brake System Manufacturing	78%	22%	$5,779,519
336350	Motor Vehicle Transmission and Power Train Parts Manufacturing	37%	63%	$328,923,019
336360	Motor Vehicle Seating and Interior Trim Manufacturing	19%	81%	$9,513,579
336370	Motor Vehicle Metal Stamping	35%	65%	$22,083,003
336390	Other Motor Vehicle Parts Manufacturing	65%	35%	$315,064,205
423110	Automobile and Other Motor Vehicle Merchant Wholesalers	43%	57%	$720,686,337
441110	New Car Dealers	51%	49%	$2,274,885,677
441120	Used Car Dealers	76%	24%	$370,060,891
Total		**35%**	**65%**	**$24,317,598,282**

TABLE 3

Nearly 2,000 businesses in Oregon operate in sectors connected to TE. The industry with the highest number of payrolled locations in 2020 was electrical contractors and other wiring installation contractors. (Table 3)

TABLE 3: TE BUSINESSES IN OREGON BY NAICS CODE

Source: EMSI

NAICS	Description	2021 Payrolled Business Locations
221122	Electric Power Distribution	84
237130	Power and Communication Line and Related Structures Construction	65
238210	Electrical Contractors and Other Wiring Installation Contractors	909
331318	Other Aluminum Rolling, Drawing, and Extruding	7
331512	Steel Investment Foundries	6
334413	Semiconductor and Related Device Manufacturing	46
334419	Other Electronic Component Manufacturing	32
335312	Motor and Generator Manufacturing	9
335911	Storage Battery Manufacturing	3
335912	Primary Battery Manufacturing	2
335999	All Other Miscellaneous Electrical Equipment and Component Manufacturing	13
336211	Motor Vehicle Body Manufacturing	4
336212	Truck Trailer Manufacturing	6
336214	Travel Trailer and Camper Manufacturing	15
336320	Motor Vehicle Electrical and Electronic Equipment Manufacturing	19
336340	Motor Vehicle Brake System Manufacturing	1
336360	Motor Vehicle Seating and Interior Trim Manufacturing	2
336390	Other Motor Vehicle Parts Manufacturing	53
423110	Automobile and Other Motor Vehicle Merchant Wholesalers	40
441110	New Car Dealers	402
441120	Used Car Dealers	639
Total		**2,357**

TABLE 4: TE ANCHOR INSTITUTIONS

Source: EMSI

Company	Role	Interviewed
ABB Group	Software	Yes
Amazon	Fleet Operator	No
Arcimoto	Vehicle Manufacturing	No
Chargeway	Software	Yes
Christenson Electric, Inc	Infrastructure	Yes
City of Portland	Fleet Operator	Yes
Daimler	Vehicle Manufacturing	No
Eaton	Power Management	No
EC Electric	Infrastructure	Yes
Intel	Software/Hardware	No
EC Electric	Infrastructure	No
Li-Cycle	Recycling	No
Maxim Integrated	Software/Hardware	No
Nissan	Auto Sales	No
OEG	Infrastructure	Yes
Oregon Department of Transportation	Fleet Operator	Yes
Oregon Auto Dealers Association	Auto Sales	Yes
Portland General Electric	Utilities	Yes
RS Davis Recycling	Recycling	No
TE Connectivity	Software/Hardware	No
Tektronics	Software/Hardware	No
Tesla	Auto Sales	No
Tice Electric Company	Infrastructure	Yes
TriMet	Fleet Operator	Yes

ANCHOR INSTITUTIONS

Eighteen anchor institutions play an outsized role in transportation electrification in Oregon or are representative of larger trends. TriMet is just one of the transit agencies around the state that is incorporating electric vehicles. The vehicles available to them and processes for incorporation help us understand what other agencies experience to provide a good understanding of the labor needs.

The anchor institutions include service centers at car dealerships, electrical charging station managers, automobile manufacturers, utility companies, commercial and residential electricians, and municipal fleets.

When possible, we interviewed representatives of the anchor institutions about their current and future TE workforce needs. We asked questions including: How much TE work are they doing now? What are they expecting for the future? What occupations are they hiring for? Where do they look for workers? What is important when hiring someone to work in this field? What type of education and certifications do workers need? Are the workers they need hard to find? What populations do they represent? (Appendix I)

THE ANCHOR INSTITUTIONS INCLUDE SERVICE CENTERS AT CAR DEALERSHIPS, ELECTRICAL CHARGING STATION MANAGERS, AUTOMOBILE MANUFACTURERS, UTILITY COMPANIES, COMMERCIAL AND RESIDENTIAL ELECTRICIANS, AND MUNICIPAL FLEETS.

We provided interviewees with labor market data and compared the data with their experiences. The interviews informed our understanding of worker demand across the TE spectrum.

OCCUPATIONS

More than forty occupations are related to the electrification of Oregon's transportation system. The occupations are in eight occupational groups: architecture and engineering (12), computer and mathematical (7), construction and extraction (1), management (2), installation, maintenance, and repair (7), life physical, and social science (3), office and administrative support (3), arts, design, entertainment, sports, and media (1), and production (6). (Table 5)

TABLE 5: TE OCCUPATIONS IN OREGON, 2020

Source: EMSI

Occupation	2020 Jobs	2020 - 2026 Change	Typical Entry Level Education	Work Experience Required	Typical On-The-Job Training
Architecture and Engineering Occupations					
Electronics Engineers, Except Computer	5,056	89 (2%)	Bachelor's degree	None	None
Mechanical Engineers	3,836	256 (7%)	Bachelor's degree	None	None
Industrial Engineers	4,514	370 (8%)	Bachelor's degree	None	None
Electrical and Electronic Engineering Technologists and Technicians	3,268	50 (2%)	Associate degree	None	None
Electrical Engineers	2,944	238 (8%)	Bachelor's degree	None	None
Computer Hardware Engineers*	1,463	49 (3%)	Bachelor's degree	None	None
Mechanical Drafters	525	16 (3%)	Associate degree	None	None
Mechanical Engineering Technologists and Technicians	517	37 (7%)	Associate degree	None	None
Materials Engineers	489	26 (5%)	Bachelor's degree	None	None
Electrical and Electronics Drafters	360	30 (8%)	Associate degree	None	None
Chemical Engineers	320	41 (13%)	Bachelor's degree	None	None
Electro-Mechanical and Mechatronics Technologists and Technicians	111	7 (6%)	Associate degree	None	None
Computer and Mathematical Occupations					
Software Developers and Software Quality Assurance Analysts and Testers	18,766	2,490 (13%)	Bachelor's degree	None	None
Computer Systems Analysts	6,325	577 (9%)	Bachelor's degree	None	None
Network and Computer Systems Administrators	4,542	288 (6%)	Bachelor's degree	None	None
Computer Programmers	1,885	-14 (-1%)	Bachelor's degree	None	None
Computer Hardware Engineers*	1,463	49 (3%)	Bachelor's degree	None	None
Operations Research Analysts	1,204	234 (19%)	Bachelor's degree	None	None
Life, Physical, and Social Science Technicians, All Other	1,176	48 (4%)	Associate degree	None	None
Construction and Extraction					
Electricians	10,290	1,489 (14%)	HSD	None	Apprenticeship
Management Occupations					
Construction Managers	5,167	834 (16%)	Bachelor's degree	None	Moderate
Industrial Production Managers	2,886	127 (4%)	Bachelor's degree	5+ yr.	None
Installation, Maintenance, and Repair Occupations					
Automotive Service Technicians and Mechanics	7,319	121 (2%)	Postsecondary nondegree award	None	Short-term

TABLE 5 (CONTINUED)

Occupation	2020 Jobs	2020 - 2026 Change	Typical Entry Level Education	Work Experience Required	Typical On-The-Job Training
Telecommunications Equipment Installers and Repairers, Except Line Installers	1,972	9 (0%)	Postsecondary nondegree award	None	Moderate
Electrical Power-Line Installers and Repairers	1,274	109 (9%)	HSD	None	Apprenticeship
Electrical and Electronics Repairers, Commercial and Industrial Equipment	989	29 (3%)	Postsecondary nondegree award	None	Long-term
Electric Motor, Power Tool, and Related Repairers	230	10 (4%)	HSD	> 5yr.	Moderate
Electrical and Electronics Repairers, Powerhouse, Substation, and Relay	226	11 (5%)	Postsecondary nondegree award	> 5yr.	Moderate
Electronic Equipment Installers and Repairers, Motor Vehicles	146	-24 (-16%)	HSD	None	Moderate
Life, Physical, and Social Science Occupations					
Urban and Regional Planners	1,039	71 (7%)	Master's degree	None	None
Chemists	507	71 (14%)	Bachelor's degree	None	None
Materials Scientists	94	6 (6%)	Bachelor's degree	None	None
Office and Administrative Support					
Customer Service Representatives	30,136	1,113 (4%)	HSD	None	Short-term
Procurement Clerks	661	17 (3%)	HSD	None	Moderate
Meter Readers, Utilities	360	-15 (-4%)	HSD	None	Short-term
Arts, Design, Entertainment, Sports, and Media Occupations					
Commercial and Industrial Designers	628	33 (5%)	Bachelor's degree	None	None
Production Occupations					
Miscellaneous Assemblers and Fabricators	12,194	-404 (-3%)	HSD	None	Moderate
Electrical, Electronic, and Electromechanical Assemblers, Except Coil Winders, Tapers, and Finishers	5,208	97 (2%)	HSD	None	Moderate
Machinists	3,565	275 (8%)	HSD	None	Apprenticeship
Computer Numerically Controlled Tool Operators	2,360	-3 (0%)	HSD	None	Moderate
Power Plant Operators	325	24 (7%)	HSD	None	Long-term
Power Distributors and Dispatchers	283	-7 (2%)	HSD	None	Long-term

TABLE 6

Twenty-one of those are target occupations. Target occupations are identified as occupations which require less than four years of post-secondary education and pay an average wage of at least $17/hr. Not all the workers in these occupations are working in transportation electrification but the workers have skills which can be applied to TE jobs. (Table 6)

In 2020, there were more than 41,000 Oregonians employed in target occupations. The largest occupations, electricians (10,290), assemblers and fabricators (12,194), and mechanics (7,319) together account for fifty-five percent of all jobs. (Table 6)

Six of the occupations require an associate degree. Eleven require a high school diploma or equivalent. The remaining four require a postsecondary nondegree award. Except for the jobs that require an associate degree, all the occupations require some amount of on-the-job training. Electricians and machinists require an apprenticeship. (Table 6)

THIRTY PERCENT OF JOBS PAY A MEDIAN WAGE OF $37/HR. OR MORE.

The median hourly wages range from $17/hr. to $52/hr. Thirty-eight percent of the jobs, pay a median wage of less than $22/hr. Thirty percent of jobs pay a median wage of $37/hr. or more. (Table 6)

TABLE 6: TE TARGET OCCUPATION IN OREGON, 2020

Source: EMSI

Occupation	2020 Jobs	2020 - 2026 Change	Median Hourly Earnings	Typical Entry Level Education	Typical On-The-Job Training
Architecture and Engineering Occupations					
Electrical and Electronic Engineering Technologists and Technicians	3,268	50 (2%)	$31.35	Associate degree	None
Mechanical Drafters	525	16 (3%)	$28.30	Associate degree	None
Mechanical Engineering Technologists and Technicians	517	37 (7%)	$26.36	Associate degree	None
Electrical and Electronics Drafters	360	30 (8%)	$32.37	Associate degree	None
Electro-Mechanical and Mechatronics Technologists and Technicians	111	7 (6%)	$25.67	Associate degree	None
Computer and Mathematical Occupations					
Life, Physical, and Social Science Technicians, All Other	1,176	48 (4%)	$25.09	Associate degree	None
Construction and Extraction					
Electricians	10,290	1,489 (14%)	$37.84	HSD	Apprenticeship
Installation, Maintenance, and Repair Occupations					
Automotive Service Technicians and Mechanics	7,319	121 (2%)	$21.27	Postsecondary nondegree award	Short-term
Telecommunications Equipment Installers and Repairers, Except Line Installers	1,972	9 (0%)	$29.81	Postsecondary nondegree award	Moderate
Electrical Power-Line Installers and Repairers	1,274	109 (9%)	$48.52	HSD	Long-term
Electrical and Electronics Repairers, Commercial and Industrial Equipment	989	29 (3%)	$30.42	Postsecondary nondegree award	Long-term
Electric Motor, Power Tool, and Related Repairers*	230	10 (4%)	$26.39	HSD	Moderate
Electrical and Electronics Repairers, Powerhouse, Substation, and Relay*	226	11 (5%)	$50.13	Postsecondary nondegree award	Moderate
Electronic Equipment Installers and Repairers, Motor Vehicles	146	-24 (-16%)	$24.40	HSD	Moderate
Office and Administrative Support					
Procurement Clerks	661	17 (3%)	$20.56	HSD	Moderate
Meter Readers, Utilities	360	-15 (-4%)	$25.67	HSD	Short-term
Production Occupations					
Electrical, Electronic, and Electromechanical Assemblers, Except Coil Winders, Tapers, and Finishers	5,208	97 (2%)	$17.39	HSD	Moderate
Machinists	3,565	275 (8%)	$25.03	HSD	Apprenticeship
Computer Numerically Controlled Tool Operators	2,360	-3 (0%)	$20.72	HSD	Moderate
Power Plant Operators	325	24 (7%)	$48.69	HSD	Long-term
Power Distributors and Dispatchers	283	-7 (2%)	$51.86	HSD	Long-term

The anticipated growth in these occupations is almost certainly an underestimation. It does not consider state investments in transportation electrification. It also does not reflect anticipated market share growth resulting from the private sector move to all electric vehicles.

TABLE 7: TE TARGET OCCUPATION, BY SEX, OREGON, 2020

Source: EMSI

	Sex	Oregon	United States
TE Target Occupations	Female	18%	20%
	Male	82%	80%
All Workers	Female	48%	50%
	Male	52%	50%

TABLE 7

The current labor pool in TE target occupations is disproportionately male. In Oregon, eighty-two percent of workers in TE target occupations are male, compared to fifty-two percent of all workers. The TE workforce in the United States is eighty percent male. (Table 7)

Photo of Union Electrician

TABLE 8

In Oregon, just eighteen percent of jobs in TE target occupations were held by women in 2020. Women were underrepresented in all but three occupations. Of the

WOMEN WERE UNDERREPRESENTED IN ALL BUT THREE OCCUPATIONS.

occupations where women weren't underrepresented, just one (life, physical, and social science technicians, all other) had a median wage higher than $21/hr. (Table 8)

TABLE 8: DETAILED TE TARGET OCCUPATION, BY SEX, OREGON, 2020

Source: EMSI

Description	2020 Jobs	Median Hourly Earnings	Males % of Occupation	Females % of Occupation
Miscellaneous Assemblers and Fabricators	10,479	$16.78	64%	36%
Electrical, Electronic, and Electromechanical Assemblers, Except Coil Winders, Tapers, and Finishers	4,920	$17.39	49%	51%
Procurement Clerks	556	$20.56	42%	58%
Computer Numerically Controlled Tool Operators	2,649	$20.72	92%	8%
Automotive Service Technicians and Mechanics	6,756	$21.27	99%	1%
Electronic Equipment Installers and Repairers, Motor Vehicles	513	$24.40	97%	3%
Machinists	3,660	$25.03	96%	4%
Life, Physical, and Social Science Technicians, All Other	1,255	$25.09	50%	50%
Electro-Mechanical and Mechatronics Technologists and Technicians	99	$25.64	83%	17%
Meter Readers, Utilities	334	$25.67	81%	19%
Mechanical Engineering Technologists and Technicians	495	$26.36	82%	18%
Electric Motor, Power Tool, and Related Repairers	164	$26.39	97%	3%
Mechanical Drafters	591	$28.30	83%	17%
Telecommunications Equipment Installers and Repairers, Except Line Installers	1,921	$29.81	91%	9%
Electrical and Electronics Repairers, Commercial and Industrial Equipment	898	$30.42	95%	5%
Electrical and Electronic Engineering Technologists and Technicians	2,725	$31.53	84%	16%
Electrical and Electronics Drafters	355	$32.27	79%	21%
Electricians	10,143	$37.84	97%	3%
Electrical Power-Line Installers and Repairers	1,087	$48.52	98%	2%
Power Plant Operators	346	$48.69	89%	11%
Electrical and Electronics Repairers, Powerhouse, Substation, and Relay	160	$50.13	94%	3%
Power Distributors and Dispatchers	269	$51.86	90%	10%
Total	**50,375**		**82%**	**18%**

TABLE 9

In Oregon, the racial breakdown of the current labor pool in TE target occupations is almost identical to that of all workers in Oregon, but worker makeup in Oregon is much less diverse than in the US overall, both for the TE market and for all workers, especially for Black workers. The target occupations are slightly more diverse (23% v 22%). (Table 9)

WORKER MAKEUP IN OREGON IS MUCH LESS DIVERSE THAN IN THE US OVERALL, BOTH FOR THE TE MARKET AND FOR ALL WORKERS, ESPECIALLY FOR BLACK WORKERS.

TABLE 9: TE TARGET OCCUPATION, BY RACE, OREGON, 2020

Source: EMSI

		Oregon	United States
TE Target Occupations	Total Diversity % of TE Target Occupations	22%	30%
	Hispanic or Latino	9%	14%
	White	78%	70%
	Black or African American	2%	8%
	American Indian or Alaska Native	1%	1%
	Asian	8%	5%
	Native Hawaiian or Other Pacific Islander	0%	0%
	Two or More Races	2%	1%
All Workers	Total Diversity % of All Workers	23%	37%
	Hispanic or Latino	12%	16%
	White	77%	63%
	Black or African American	3%	13%
	American Indian or Alaska Native	1%	1%
	Asian	5%	6%
	Native Hawaiian or Other Pacific Islander	0%	0%
	Two or More Races	3%	1%

TABLE 10

The occupation with the highest percentage of Black, Indigenous, People of Color (BIPOC) workers, electrical, electronic, and electromechanical assemblers, except coil winders, tapers, and finishers, is also the lowest paying of the TE target occupations. The four other occupations where BIPOC workers are overrepresented have median hourly earnings between $17/hr. and $32/hr. (Table 10)

TABLE 10: DETAILED TE TARGET OCCUPATIONS IN OREGON, BY RACE

Source: EMSI

Description	2020 Jobs	Median Hourly Earnings	BIPOC % of Occupation	White % of Occupation
Electricians	10,143	$37.84	13%	87%
Automotive Service Technicians and Mechanics	6,756	$21.27	20%	80%
Electrical, Electronic, and Electromechanical Assemblers, Except Coil Winders, Tapers, and Finishers	4,920	$17.39	49%	51%
Machinists	3,660	$25.03	18%	82%
Electrical and Electronic Engineering Technologists and Technicians	2,725	$31.53	30%	70%
Computer Numerically Controlled Tool Operators	2,649	$20.72	21%	79%
Telecommunications Equipment Installers and Repairers, Except Line Installers	1,921	$29.81	18%	82%
Life, Physical, and Social Science Technicians, All Other	1,255	$25.09	24%	76%
Electrical Power-Line Installers and Repairers	1,087	$48.52	10%	90%
Electrical and Electronics Repairers, Commercial and Industrial Equipment	898	$30.42	20%	80%
Mechanical Drafters	591	$28.30	17%	83%
Procurement Clerks	556	$20.56	17%	83%
Electronic Equipment Installers and Repairers, Motor Vehicles	513	$24.40	22%	78%
Mechanical Engineering Technologists and Technicians	495	$26.36	26%	74%
Electrical and Electronics Drafters	355	$32.27	19%	81%
Power Plant Operators	346	$48.69	9%	91%
Meter Readers, Utilities	334	$25.67	14%	86%
Power Distributors and Dispatchers	269	$51.86	9%	91%
Electric Motor, Power Tool, and Related Repairers	164	$26.39	15%	85%
Electrical and Electronics Repairers, Powerhouse, Substation, and Relay	160	$50.13	13%	87%
Electro-Mechanical and Mechatronics Technologists and Technicians	99	$25.64	25%	75%
Total	**39,896**		**22%**	**78%**

EDUCATION AND TRAINING

The twenty-one TE target occupations require varying combinations of educational credentials and on the job training. Training for some of the occupations is currently available through a registered apprenticeship program regulated by the Oregon Bureau of Labor and Industries. Training for other occupations is available through an Associate Degree offered by the Oregon community college system.

FIGURE 3: TRAINING AND EDUCATION FOR TE TARGET OCCUPATIONS

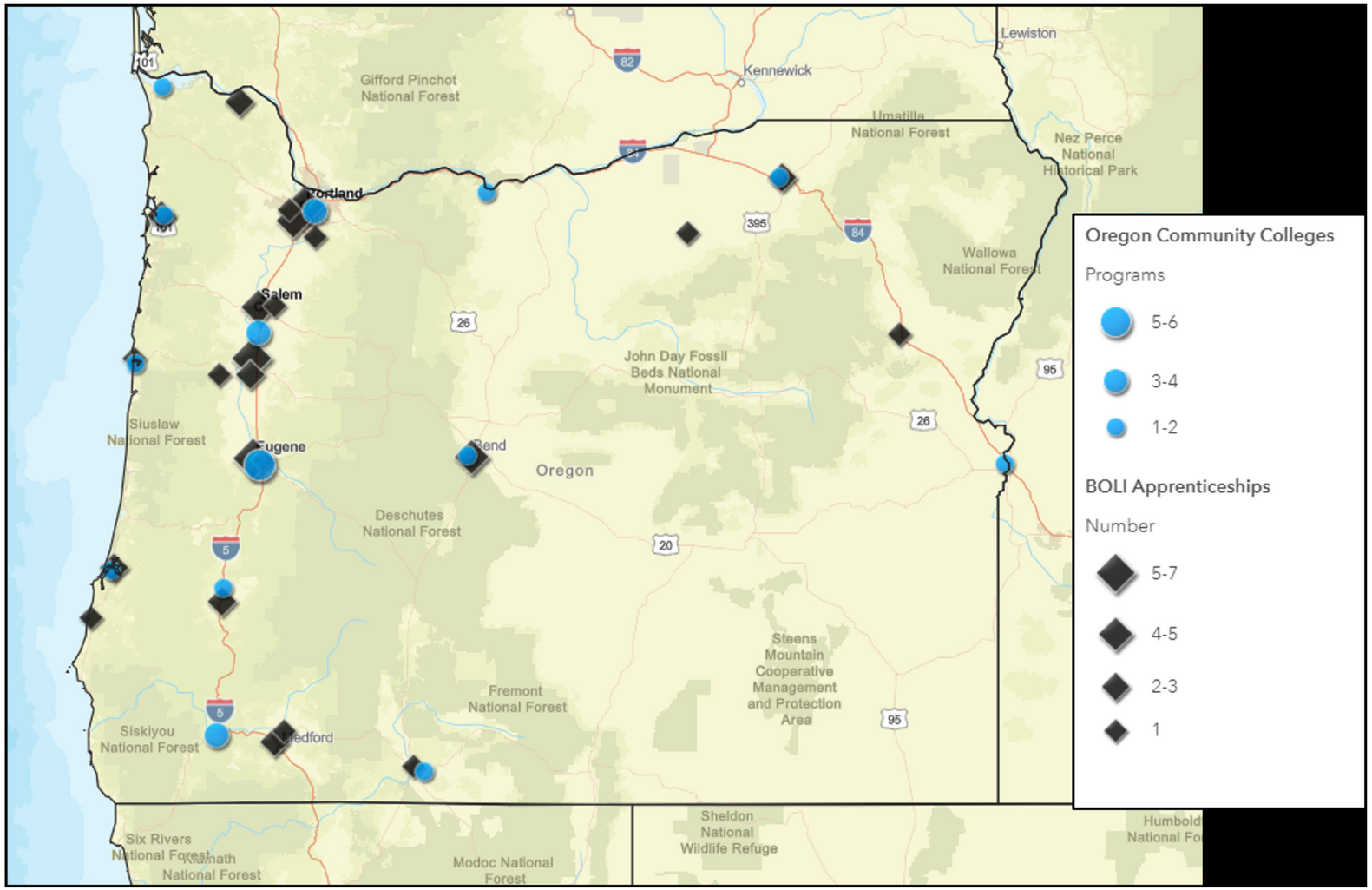


TABLE 11

Ten of the twenty-one target occupations require a post-secondary credential or associate degree. Forty training programs offering credentials in nine occupations are currently offered through the Oregon community college system. Portland Community College offers the greatest number of educational programs (6), followed by Lane Community College (5), Chemeketa Community College (4), and Clackamas Community College (4). (Table 11)

Educational programs for three of the occupations are available at Clark College in Vancouver, WA. Although Clark College is part of the Washington community college system, it is included in this report due to its strong ties with the Oregon auto industry and its role in educating Oregon workers. (Table 11)

One for profit school, Pioneer Pacific in Beaverton, offers educational programs in two of the target occupations. (Table 11)

TABLE 11: EDUCATIONAL PROGRAMS FOR TE TARGET OCCUPATIONS, OREGON AND CLARK COUNTY, WA

Source: EMSI

Program	Level of Education	Institution	Completions (2015)	Completions (2019)
Electrical and Electronic Engineering Technologists and Technicians (CIP 15.0303)	Associate degree	Portland Community College	35	27
	Associate degree	Columbia Gorge Community College	8	12
	Associate degree	Clackamas Community College	8	8
	Associate degree	Rogue Community College	11	7
	Associate degree	ITT Technical Institute-Portland	39	0
	Associate degree	ITT Technical Institute-Salem	14	0
	Associate degree	Lane Community College	7	0
	Associate degree	Pioneer Pacific College	2	0
	Total		**124**	**54**
Mechanical Drafters (CIP 15.1306)	Associate degree	Clark College	0	5
	Associate degree	Portland Community College	5	7
	Total		**5**	**12**
Mechanical Engineering Technologists and Technicians (CIP 15.0805)	Associate degree	Mt Hood Community College	9	2
	Associate degree	Portland Community College	19	15
	Total		**28**	**17**
Electro-Mechanical and Mechatronics Technologists and Technicians (CIP 15.0499)	Associate degree	Chemeketa Community College	4	6
	Total		**4**	**6**
Telecommunications Equipment Installers and Repairers, Except Line Installers (CIP 46.0301)	Associate degree	Clackamas Community College	19	75
	Associate degree	Clark College	1	0
	Associate degree	Mt Hood Community College	3	8
	Associate degree	Linn-Benton Community College	0	4
	Postsecondary nondegree award	Blue Mountain Community College	9	3
	Associate degree	Lane Community College	1	3
	Associate degree	Chemeketa Community College	0	2
	Associate degree	Portland Community College	12	2
	Postsecondary nondegree award	Rogue Community College	0	1
	Associate degree	Tillamook Bay Community College	0	1
	Total		**45**	**99**

TABLE 11 (CONT.)

The total number of program completions decreased twenty-six percent between 2015 and 2019. The decline was partially due to the closure of ITT-Portland and ITT-Salem. In 2015, the ITT programs offered three associate programs for TE target industries: Electrical and Electronic Engineering Technologists and Technicians (CIP 15.0303), Electrical and Electronics Repairers, Commercial and Industrial Equipment (CIP 15.0303), Electrical and Electronics Drafters (CIP 15.1301). Together, they accounted for one hundred and thirty-two completions. (Table 11)

Program	Level of Education	Institution	Completions (2015)	Completions (2019)
Automotive Service Technicians and Mechanics (CIP 47.0604)	Associate degree	Chemeketa Community College	25	25
	Associate degree	Clark College	8	21
	Associate degree	Mt Hood Community College	9	20
	Associate degree	Portland Community College	12	12
	Associate degree	Linn-Benton Community College	19	8
	Associate degree	Clackamas Community College	14	7
	Associate degree	Lane Community College	10	7
	Associate degree	Rogue Community College	9	4
	Associate degree	Central Oregon Community College	0	3
	Associate degree	Clatsop Community College	2	3
	Associate degree	Umpqua Community College	6	2
	Associate degree	Klamath Community College	6	2
	Total		**120**	**114**
Electrical and Electronics Repairers, Commercial and Industrial Equipment (CIP 15.0303)	Associate degree	ITT Technical Institute-Portland	39	0
	Associate degree	Portland Community College	35	27
	Associate degree	ITT Technical Institute-Salem	14	0
	Associate degree	Rogue Community College	11	7
	Associate degree	Clackamas Community College	8	8
	Associate degree	Columbia Gorge Community College	8	12
	Associate degree	Lane Community College	7	0
	Associate degree	Pioneer Pacific College	2	0
	Total		**124**	**54**
Electrical and Electronics Drafters (CIP 15.1301)	Associate degree	Chemeketa Community College	15	12
	Associate degree	Linn-Benton Community College	13	10
	Associate degree	Lane Community College	10	6
	Associate degree	Treasure Valley Community College	2	1
	Associate degree	ITT Technical Institute-Portland	13	0
	Associate degree	ITT Technical Institute-Salem	13	0
	Associate degree	Blue Mountain Community College	2	0
	Associate degree	Central Oregon Community College	1	0
	Total		**69**	**29**

TABLE 12

Sixty apprenticeship programs are currently available for TE Target Occupations. Registered apprenticeships allow participants to earn money while completing their education and training. When participants complete the program, they receive a nationally recognized

REGISTERED APPRENTICESHIPS ALLOW PARTICIPANTS TO EARN MONEY WHILE COMPLETING THEIR EDUCATION AND TRAINING.

credential. Apprenticeships for TE Target Occupations are offered in twenty-five communities across the state. The required number of hours range from 2,000 to 8,000. The average wage ranges from $22.07/hr. to $52.46/hr. (Table 12)

TABLE 12: REGISTERED APPRENTICESHIPS FOR TE TARGET OCCUPATIONS, OREGON

Source: Oregon Bureau of Labor and Industries

Note: *Data is not available.

Occupation	BOLI Programs	Committee Name	Location	Hours	Average Wage
Computer Programmers (15-1251)	MA 3011	Apprentice Oregon JATC	Bend	2,000	$28.13
Computer Systems Analysts (15-1211)	MA 3011	Apprentice Oregon JATC	Bend	2,000	$28.13
Electrical And Electronics Drafters (Electrical Meter Repairer) (17-3012)	MA 3009	EWEB Outside Electrical Workers JATC	Eugene	7,000	$50.74
Electrical And Electronics Drafters (Meterman) (17-3012)	MA 1023	Portland Outside Electrical Workers TATC	Portland	6,000	$52.10
	MA 1082	Tillamook County Outside Electrical JATC	Tillamook	6,000	$43.76
Electrical And Electronics Repairers, Powerhouse, Substation, And Relay (Lineman) (49-2095)	MA 1023	Portland Outside Electrical Workers JATC	Portland	6,000	$51.17
	MA 1133	Clatskanie PUD JATC	Clatskanie	6,000	$51.68
	MA 2002	Tillamook County Outside Electrical JATC	Tillamook	6,000	$52.19
	MA 2002	Central Lincoln PUD Local JATC	Newport	7,000	$52.46
	MA 2017	Consumers Power JATC	Philomath	7,000	$51.27
	MA 3007	Eugene/Springfield Utilities JATC	Springfield	6,000	$49.42
	MA 3009	EWEB Outside Electrical Workers JATC	Eugene	7,000	$50.74
	MA 4025	City Of Bandon & IBEW Local 659 JATC	Bandon	6,000	$48.71
	MA 6012	Utility Electrical Workers JATC	Heppner	*	$50.02
Electricians (47-2111)	MA 6007	Baker Technical Institute JATC	Baker City	*	$30.00
	MA 6008	Ontario TATC	Fruitland	*	$28.49
	MA 6013	Area VI Inside Electrical JATC	Pendleton	*	$36.26
	MA 7001	Area VII Inside Electrical JATC	Bend	*	$38.16
Electricians (General Journeyman Electrician) (47-2111)	MA 1004	NECA-IBEW Electrical JATC	Portland	8,000	$50.35
	MA 1046	Area I Inside Electrical JATC	Portland	8,000	$40.65
	MA 1244	North Coast Mech &Electrical Trades JATC	Eugene	8,000	$43.15
	MA 2016	Area Ii Inside Electrical JATC	Tigard	8,000	$37.59
	MA 3001	Central Electrical JATC	Tangent	8,000	$46.19
	MA 3019	Area Iii Inside Electrical JATC	Eugene	8,000	$39.50
	MA 4009	Pacific Inside Electrical JATC	North Bend	8,000	$41.63
	MA 4015	Area Iv Independent Tac	Eugene	8,000	$38.35
	MA 4016	Area Iv Inside Electrical JATC	Roseburg	8,000	$34.07
	MA 4016	Area Iv Inside Electrical JATC	Roseburg	8,000	$34.07

TABLE 12 (CONT.)

Occupation	BOLI Programs	Committee Name	Location	Hours	Average Wage
	MA 4016	Area Iv Inside Electrical JATC	Roseburg	8,000	$34.07
	MA 5001	Crater Lake Electrical JATC	Central Point	8,000	$38.49
	MA 5009	Area V Inside Electrical JATC	White City	8,000	$30.00
	MA 6024	SW Idaho - Malheur County JATC	Boise	8,000	$32.71
	MA 7024	Klamath Basin Inside Electrician JATC	Klamath Falls	8,000	$28.78
Electricians (Limited Residential Electrician) (47-2111)	MA 1004	NECA-IBEW Electrical JATC	Portland	4,000	$50.35
	MA 2016	Area II Inside Electrical JATC	Tigard	4,000	$37.59
	MA 3001	Central Electrical JATC	Tangent	4,000	$46.19
	MA 4009	Pacific Inside Electrical JATC	North Bend	4,000	$41.63
	MA 5001	Crater Lake Electrical JATC	Central Point	4,000	$38.49
Machinists (51-4041)	MA 1081	Boeing Portland JATC	Portland	7,360	$44.11
	MA 1095	Leupold & Stevens of Beaverton JATC	Beaverton	8,000	$29.52
	MA 1142	NW Willamette TATC	Oregon City	6,000	$29.70
	MA 1143	Or Industrial Development Training JATC	Portland	6,000	$28.67
	MA 2009	Mid-Willamette Industrial TATC	Albany	8,000	$34.75
	MA 3012	Lane County Indl Maint Mechanic JATC	Eugene	8,000	$28.84
Network And Computer System Administrators (15-1240)	MA 3011	Apprentice Oregon JATC	Bend	2,000	$28.13
Software Developers (15-1252)					
Telecommunications Equipment Installers and Repairers, Except Line Installers (Limited Energy Technician Class A) (49-2022)	MA 1053	Ltd Energy Electrician JATC	Tigard	6,000	$32.80
	MA 2009	Mid-Willamette Industrial TATC	Albany	6,000	$22.07
	MA 2020	Area II Ltd Energy Electrical JATC	Albany	6,000	$24.94
		Southern Will-Valley Ltd Energy Elec JATC	Salem	6,000	$32.19
		Eastern Oregon Industrial TATC	Pendleton	6,000	$32.19
		Central Or Ltd Energy Electrical JATC	Salem	6,000	$34.14
Telecommunications Equipment Installers and Repairers, Except Line Installers (Limited Energy Technician Class B) (49-2022)	MA 1053	Ltd Energy Electrician JATC	Tigard	4,000	--
	MA 1100	Georgia Pacific Electrical Trades JATC	Clatskanie	4,000	$35.73
	MA 2009	Mid-Willamette Industrial TATC	Albany	4,000	$22.07
	MA 2020	Area II Ltd Energy Electrical JATC	Albany	4,000	$24.94
		State Das Facilities & SEIU 503 JATC	Albany	4,000	$22.65
		Southern Will-Valley Ltd Energy Elec JATC	Salem	4,000	$32.19
		Eastern Oregon Industrial TATC	Pendleton	4,000	$32.19
		Central Or Ltd Energy Electrical JATC	Salem	4,000	$34.14

TABLE 13

Of the TE Target Occupations, the inside electrician apprenticeship programs are the largest. Between 2016 and 2020, nearly 2,000 participants completed the program. (Table 13)

TABLE 13: REGISTRATIONS AND COMPLETIONS, TE TARGET OCCUPATION APPRENTICESHIPS, OREGON, 2016–2020

Source: Oregon Bureau of Labor and Industries

Committee number		Trade Name	Registered 2016-2020	Completed 2016-2020
MA 1023 MA 2007 MA 2009 MA 1082	MA 5007 MA 6012 MA 7003	Meter repairer	31	22
MA 1023 MA 2002 MA 7003	MA 3007 MA 3009	Substation Electricians	43	36
MA 3022		Indl Instrument Tech	2	1
MA 4009		Local telecom Install	1	0
MA 1004 MA 1046 MA 1244 MA 2016 MA 3001 MA 3019 MA 4009 MA 4015 MA 4016	MA 5001 MA 5009 MA 6004 MA 6007 MA 6008 MA 6013 MA 6024 MA 7001 MA 7024	Inside Electrician	4,104	1,877
MA 1053 MA 1099 MA 1100 MA 2009 MA 2020 MA 3001	MA 3019 MA 3022 MA 5001 MA 6016 MA 6026 MA 7026	Ltd Energy Tech A	936	425
MA 1099 MA 1104 MA 1124 MA 2009 MA 2020	MA 3022 MS 6016 MA 6040 MA 7026	Ltd Energy Tech B	204	109
MA 1004 MA 2016 MA 3001	MA 4009 MA 5001	Ltd Res Electrician	151	44
MA 1081 MA 1095 MA 4007	MA 2009 MA 3012	Machinist	39	23
MA 2002		Maintenance Wireman	1	2
MA 1023 MA 1082 MA 1133 MA 2002 MA 2017 MA 3009 MA 4005	MA 4021 MA 4025 MA 5007 MA 6012 MA 6028 MA 7003	Line Repairer (Outside Electrician)	135	84
MA 3002 MA 1062 MA 5004		Sign Electrician	49	13
MA 1040		Stationary Engineer	12	3
MA 3011		Computer Programmers Computer Systems Analysts	28	6
MA 1082 MA 1133	MA 2017 MA 6012	Lineman	24	14
Total			**5,760**	**2,655**

PRELIMINARY FINDINGS

TE WILL DRIVE GROWTH IN EXISTING OCCUPATIONS AND REFOCUS THEM ON ELECTRIC TRANSPORTATION.

Some new occupations may emerge, but most of the TE workforce will continue to be in existing occupations with expanded training and skill development specific to TE technologies. Electricians and utility crews will install charging infrastructure. Auto mechanics will increasingly work on electric cars and busses. Construction managers will oversee the implementation of infrastructure designed by urban planners to accommodate electric vehicles. This industry's growth will not displace existing workers or replace existing good career opportunities, rather, it will lead to the growth of existing opportunities in target occupations and augment and strengthen them with more advanced and specialized training specific to TE.

Growth in occupations responsible for the installation and repair of charging stations is expected to be rapid. ODOT's Transportation Electrification Infrastructure Needs Analysis (TEINA) recommends the addition of more than 1.5 million charging stations across Oregon by 2035[14]. The demand for home charging stations will also increase rapidly as EV market share grows. This new infrastructure will increase demand for multiple professions, most notably electricians.

Public fleet operators stated that they do not foresee a significant need to increase their hiring to address a new electric fleet in the near term. They plan to cross train existing staff in the skills necessary to maintain and service new EVs. Their primary challenge is finding enough mechanics to meet current and future needs. Training those individuals to also service and maintain an EV fleet was a secondary concern, in most cases.

However, not all of the existing workers will have interest in retraining. Some workers will change careers or retire which will open opportunities for new workers to join the field.

14 https://www.oregon.gov/odot/Programs/Documents/Climate Office/TEINA_Final_Report_June282021.pdf

A similar theme emerged for auto sales. Car salesperson is an occupation primarily focused on building trusting relationships with consumers. The EV market presents the challenge of effectively communicating the benefits, challenges, and logistics of purchasing and maintaining an electric vehicle. Dealerships are exploring trainings on communicating the different "fuel type" to consumers to educate prospective buyers and instill confidence in electric vehicles.

The future will look a little different for auto mechanics. Electric vehicles require less maintenance than those with internal combustion engines. More EV trained mechanics will be needed to meet the demand as EV market share grows. Long term, though, the overall demand for mechanics will likely shrink relative to the number of cars on the road.

LACK OF STANDARDIZATION WILL LEAD TO DUPLICATION AND SILOED MANUFACTURER TRAININGS.

The relatively early stage of the electric vehicle industry has meant unstandardized equipment in both vehicles and chargers. Electric vehicles and charging stations are designed independently and can be incompatible. This lack of standardization can lead to duplication of both equipment and training.

Trainings on how to install, use, and maintain the systems and vehicles are generally designed and offered by the manufacturers. Original Equipment Manufacturer (OEM) trainings were referenced in virtually all the employer interviews we conducted. Most employers identified the combination of foundational occupational qualifications (ASE certified technicians and mechanics, licensed electricians, etc.), and OEM training for specific products as their primary training needs related to TE. Most employers also articulated that these new products include training as a part of the procurement package.

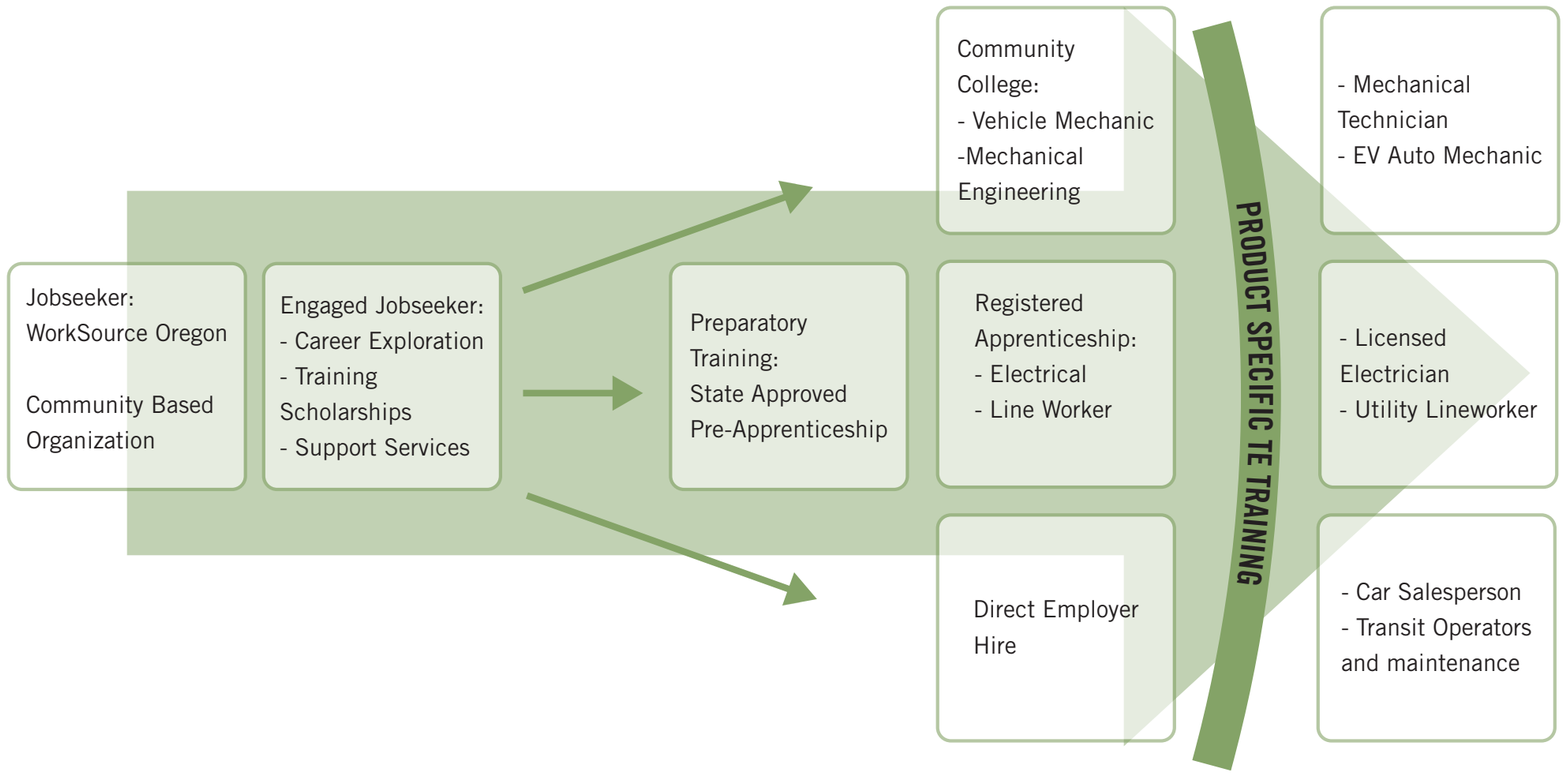
Until EVs and charging equipment are standardized, supplemental and product-specific OEM training may continue as the main avenue for ensuring the workforce has the qualifications necessary to serve the TE industry.

JOB GROWTH IS LIKELY TO EXCEED EXPECTATIONS.

The anticipated job growth for the target expectations is likely an underestimation. There are two reasons for this. First, we anticipate large investments in TE at the local, state, and national levels. The combination of new policies and spending will accelerate growth beyond what is indicated from previous years' growth. Second, the shift to EV from the private sector will increase the number of EVs on the road while reducing the availability of vehicles with internal combustion engines. These factors are not currently reflected in labor market data sources. We expect to see them in future years as the data catches up with shifting market demand and public investments are formalized.

Areas of denser populations will need denser TE systems and will benefit from a density of TE trained available workforce. Small fleet operators who have access to TE qualified mechanics, for example, will have flexibility when it comes to hiring or reskilling in house. A small fleet operator in Eastern Oregon may not have the same flexibility when converting their fleet to EV. This could lead to higher wages to attract qualified workers to rural areas.

FIGURE 4: TRANSPORTATION WORKFORCE: CAREER PATHWAYS



IN OREGON, MOST TE WORKFORCE GROWTH IS ELECTRICIAN-RELATED POSITIONS.

Electricians are in high demand and not just from TE. Of the target industries, electricians have the fourth highest median wage. With the scale of charging stations needed to meet the forecasted demand, demand for electricians is expected to grow. ODOT's TEINA study estimates Oregon will need more than 1.6 million new EV charging ports by 2035[15]. To meet this demand in state, Oregon will need to train an additional 4,400 new electricians over the course of the next ten years just to work on charging station installation. Additional electricians will be needed for maintenance.

TABLE 14: ELECTRICIANS NEEDED TO INSTALL CHARGING STATIONS

Source: TEINA; Interviews

	2025	2030	2035
Additional Charging Ports Needed	216,926	842,279	1,655,249
- Home Charging Ports	200,000	770,000	1,500,000
- Commercial Charging Ports	16,926	72,279	155,249
Additional Electricians Needed to Fill Demand	767	2,317	1,384

Additionally, the employer interviews supported this data. The most pressing hiring needs are for licensed electricians. These individuals come from the Electrical Apprenticeship program, which offers sufficient training for the skills needed to work in the TE industry. The demand for electricians is primarily related to charging station installation and maintenance.

SUPPORTING AND EXPANDING EXISTING ELECTRICIAN TRAINING PROGRAMS IS THE BEST WAY TO SUPPORT TE THROUGH WORKFORCE DEVELOPMENT.

Supporting and expanding existing electrician training programs is the best way to support TE through workforce development. Electrical contractors who help install and maintain both commercial and residential charging equipment must have the support to recruit, hire, and retain their workforce. Investing in existing apprenticeship programs will support high training standards. Industry driven supplemental training for TE specific skill needs can be incorporated into existing programs[16].

Increasing the racial and gender diversity of this craft is a substantive opportunity as TE grows. Supporting and expanding the labor unions' and apprenticeship program's current efforts to recruit and retain women and people of color as electrical workers will advance equitable economic opportunity across Oregon.

INVESTING IN TRAINING OPPORTUNITIES CAN LEAD TO INCREASED WORKFORCE DIVERSITY.

The growth of TE in Oregon presents an incredible opportunity to advance equitable economic development and address clear wage and hiring disparities.

Interviews revealed a clear desire by major employers to increase racial and gender diversity within their workforce. Many did not know how or where to find diverse talent. And despite best efforts, many employers articulated they felt that the challenges stemmed from "upstream" issues, including a perceived lack of interest from women and people of color. This leads to less diversity in training programs such as apprenticeship, mechatronics, service technicians, etc.

INTERVIEWS REVEALED A CLEAR DESIRE BY MAJOR EMPLOYERS TO INCREASE RACIAL AND GENDER DIVERSITY WITHIN THEIR WORKFORCE.

It was clear from the interviews and demographic labor data that strengthening the pipeline for more diverse workers would benefit employers, underrepresented communities, and economic development. By explicitly designing future workforce investments to include a clear focus on outreach, recruitment, and support for women and people of color to consider and be successful in careers in TE, the demographic makeup and employer efforts for increased diversity can improve and be sustained.

15 https://www.oregon.gov/odot/Programs/Pages/TEINA.aspx

16 https://evitp.org/

RECOMMENDATIONS

EXPAND EXISTING TRAINING AND EDUCATION OPPORTUNITIES FOR TE TARGET OCCUPATIONS.

Training and education programs are already available for most TE target occupations. Employers and the workforce system should invest in, and partner with, existing programs to prepare for increased worker demand. To use the electrician occupation as an example, this could include:

- Invest in state-certified pre-apprenticeship programs to grow the pipeline of applicants into the electrical apprenticeship program.
- Partner with the NECA-IBEW Electrical Training Center to recruit more women and people of color into registered apprenticeship programs
- Work with the NECA-IBEW Training Center to supplement their existing curriculum with the training modules needed for TE specific scopes of work.

The State of Oregon Bureau of Labor and Industries can connect employers with existing registered apprenticeship programs. These industry-funded programs are a time tested earn and learn model. As TE scales and technologies standardize, building upon the registered apprenticeship program model will ensure a formalized, industry-led approach to education and training.

Partnerships are also recommended with existing programs outside of registered apprenticeship. For example, many community colleges offer an auto mechanic training program. As the need to enhance mechanic skills with EV-specific knowledge and training grows, partnerships will enhance additional training modules related to EVs. The partnership approach will build on the foundational knowledge and infrastructure of accredited organizations while helping them remain current with employer demand.

PRIORITIZE INCREASING DIVERSITY OF THE TE WORKFORCE.

Now is the time to explicitly include and support the participation of women and people of color in the design phase of potential workforce investments. Increasing diversity across target occupations is an opportunity to advance racial equity through equitable economic opportunity.

National and local best practice models to achieve these goals include enhanced outreach and recruitment efforts in partnership with culturally specific organizations, no-cost relevant preparatory training that sets diverse jobseekers up with competitive credentials and experience to succeed, and ongoing support services such as childcare, transportation, and mentoring. These activities have been shown to increase the racial and gender diversity of similar industries in the region and should be a starting place for the TE industry[17]. But the need to increase the participation of women and people of color in this industry cannot happen without also addressing the culture of these careers, including the work environment of lineworkers, mechanics, and the construction trades[18].

POLICYMAKERS SHOULD INCLUDE WORKFORCE DIVERSITY AND LABOR STANDARDS WITH THEIR PUBLIC INVESTMENTS.

In addition to training and outreach investments on the front end, it is imperative to include mechanisms that trigger the market to conduct more inclusive hiring. To support the hiring and retention of trained diverse workers, policymakers should include workforce diversity and labor standards with their public investments[19]. Opportunities include coordinating outreach to underrepresented communities through job fairs, networking events, and other connection points. By working together, access and opportunity can be realized as Oregon's TE market grows.

17 https://pdxscholar.library.pdx.edu/soc_fac/96/
18 https://pamplinmedia.com/pt/9-news/315454-193161-recruiting-a-better-ending-for-women-in-the-trades
19 https://jobstomoveamerica.org/resource/transforming-transit-realizing-opportunity/

EMBED WORKFORCE PLANNING INTO THE INFRASTRUCTURE NEEDS FOR THE INDUSTRY TO GROW.

Workforce development is an essential piece of growing TE infrastructure. ODOT's TEINA study outlines the infrastructure needed to meet Oregon's TE goals. We used the TEINA study and input from employer interviews to forecast workforce and training needs.

As these efforts continue to develop, our recommendation is for employers, the public workforce system, and the state to work closely to ensure the time horizon for growing a skilled workforce is accounted for in the state planning efforts.

BY PLANNING NOW, OREGON CAN ENSURE THOSE OPPORTUNITIES ARE REALIZED BY RESIDENTS TO SERVE THE NEEDS OF EMPLOYERS AND THE INDUSTRY.

Prioritize including workforce development planning into the infrastructure planning. Training highly skilled workers needed for TE can take years. The electrician apprenticeship program, for example, is five years. Start planning now to ensure the pool of diverse talent needed to install and maintain the TE infrastructure. By planning now, Oregon can ensure those opportunities are realized by residents to serve the needs of employers and the industry. Without this planning upfront, the needed workers will come from out of state and the equitable economic development opportunities may be lost.

EXPLORE FUNDING MECHANISMS TO EFFECTIVELY INVEST IN THE DIVERSE WORKFORCE FOR THE FUTURE.

Industry leaders, especially employers, should partner and plan for their future workforce needs. In the construction industry, contractors have worked together to collectively fund project specific labor needs by setting aside a portion of the project costs to support project specific hiring and training needs[2021]., This could be done by embedding workforce development investments into future TE infrastructure investments. As the TE infrastructure expands, this will ensure corresponding resources to recruit, train, and reskill a local workforce.

Along with these investments, industry leaders should also coordinate their hiring and training needs early and often. A common and noteworthy model is developing a sector strategy centered on an agreed upon "action agenda" to tackle common workforce needs in a high growth industry[22]. Through a series of convenings to support intentional planning, industry leaders, policymakers, and workforce development practitioners can develop focused investment priority areas, leverage available public and private workforce development funds, and have a shared workplan to accomplish the desired workforce outcomes for the market[23].

20 https://www.oregonmetro.gov/public-projects/oregon-convention-center-hotel/jobs-and-job-training
21 https://www.multco.us/multnomah-county/news/county-capital-construction-projects-seeking-workers-striving-toward-workforce
22 https://www.nextgensectorpartnerships.com/for-business-leaders
23 https://www.worksystems.org/news-events/news/worksystems-releases-talent-strategy-tech-industry

FUTURE RESEARCH

The recommendations in this report are based on the current state of transportation electrification in Oregon and near-term projections. As the demand for electric cars, components, and support infrastructure grows, the need for skilled workers will change.

Currently, there is a small niche industry in Oregon that produces electric vehicles and EV components. If a wholesale shift of internal combustion engines to EV accelerates, it is possible we will see this industry grow. It's also possible that the expansion of large multi-national companies in the EV space will force smaller companies out of the market. Either way there will be an impact on the labor market.

As existing workers are retrained to work in the EV space, some will determine they do not have the interest or aptitude to continue in their current professions. If large numbers of workers leave an occupation, either for retirement or to enter another profession, the turnover rates in the occupation will change. This type of churn will need to be continually monitored to anticipate for changing training and education needs.

Future research should consider these rapidly developing factors. Additionally, full engagement from all major industry players could help provide deeper insight into workforce needs and opportunities in the state. Lastly, continuing to track how, even if most EVs may be built where current car factories are located, if and how parts may be manufactured locally to service those factories. As the TE Market rapidly expands, future research could continue to track the workforce impacts along the entire supply chain.

Photo of Union Electrician

APPENDIX I: REFERENCES

Careers in Electric Vehicles. Bureau of Labor Statistics. September 2011, Report 4.

http://www.bls.gov/green/electric_vehicles

Cleaning the Clean Energy Economy: Analysis of the Electric Vehicle Industry. International Economic Development Council. The Power of Knowledge and Leadership.

http://www.iedconline.org/clientuploads/Downloads/edrp/IEDC_Electric_Vehicle_Industry_Summary.pdf

"Continuing to Build a More Diverse Workforce in the Highway Trades: 20" by Lindsey Wilkinson and Maura Kelly (pdx.edu)

https://pdxscholar.library.pdx.edu/soc_fac/96/

County Capital Construction Projects Seeking Workers, Striving Toward Workforce Equity Goals.

https://www.multco.us/multnomah-county/news/county-capital-construction-projects-seeking-workers-striving-toward-workforce

Daimler will convert Portland factory to make electric trucks - oregonlive.com

http://www.oregonlive.com/business/2019/04/daimler-will-convert-portland-factory-to-make-electric-trucks.html

DatabaseUSA. Business-Level Data.

https://databaseusa.com/

Electric Vehicles: The Market and its Future Workforce Needs. Economic & Policy Analysis Group. Los Angeles County Economic Development Corporation. August 2012.

http://www.pacific-gateway.org/ev_pgwin_final.pdf

Electric Vehicle Careers: On the road to charge. Summer 2012. Occupational Outlook Quarterly. National Alternative Fuels Training. West Virginia University.

http://www.bls.gov/careeroutlook/cx2012/summer/art02.pdf

Electric Vehicles Should Be a Win for American Workers: How Federal Policies to Expand Electric Vehicle Production Can Ensure a Good Jobs Future for the United States. Center for American Progress. September 2020.

https://www.americanprogress.org/issues/economy/reports/2020/09/03/489894/electric-vehicles-win-american-workers/

Energizing an Ecosystem: The Electric Mobility Revolution in Southern California. Los Angeles County Economic Development Corporation. Institute for Applied Economics.

http://laedc.org/2020/03/01/laedc-ev-industry-report/

Our Path to an All-Electric Future, General Motors.

https://www.gm.com/electric-vehicles.html

Go Electric Oregon.

https://goelectric.oregon.gov/charge-your-ev

Greenhouse Gas Emissions Data. Oregon Department of Energy.

https://www.oregon.gov/energy/energy-oregon/Pages/Greenhouse-Gas-Snapshot.aspx

HB2180 2021 Regular Session - Oregon Legislative Information System.

https://olis.oregonlegislature.gov/liz/2021R1/Measure/Overview/HB2180

Hyatt Regency Portland at the Oregon Convention Center.

https://www.oregonmetro.gov/public-projects/oregon-convention-center-hotel/jobs-and-job-training

Oregon Department of Transportation: Electric Vehicles and EV Infrastructure: Programs: State of Oregon.

https://www.oregon.gov/ODOT/Programs/Pages/Electric-Vehicles.aspx

State of Oregon: DATA & REPORTS - Oregon Electric Vehicle Dashboard.

https://www.oregon.gov/energy/Data-and-Reports/Pages/Oregon-Electric-Vehicle-Dashboard.aspx

AIE (European Association of Electrical Contractors) (2018), Powering a New Value Chain in the Automotive Sector: Job Potential of Transport Electrification, AIE, Brussels,

https://download.dalicloud.com/fis/download/66a8abe211271fa0ec3e2b07/c572c686-f52f-4c0d-88fc-51f9061126c5/Powering_a_new_value_chain_in_the_automotive_sector_-_the_job_potential_of_transport_electrification.pdf

Transforming Transit, Realizing Opportunity – Jobs to Move America July, 2019.

https://jobstomoveamerica.org/resource/transforming-transit-realizing-opportunity/

Transportation Electrification Infrastructure Needs Analysis (TIENA)

https://www.oregon.gov/odot/Programs/Documents/Climate%20Office/TEINA_Final_Report_June282021.pdf

Volvo says it will be ‘fully electric’ by 2030, move car sales online.

https://www.cnbc.com/2021/03/02/volvo-says-it-will-be-fully-electric-by-2030-move-car-sales-online.html

What are Next Gen Sector Partnerships? Institute for Networked Communities.

https://www.nextgensectorpartnerships.com/for-business-leaders

APPENDIX II: INTERVIEW QUESTIONS

1. Please describe your overall forecasted hiring demands related to the TE field over the next two to five years.

2. What are the top five jobs you expect to do the most hiring for related to TE? Were there any specific occupations in the LMI data list that stood out to you?

3. What are the major skills and training/industry credentials that you look for when hiring for these jobs?

4. Do you have goals and targets to recruit a more diverse workforce? If so, what are they?

5. Have you had any challenges and/or successes with attracting a more diverse workforce? If so, what have they been?

6. Are you usually able to find the trained workers that you need for TE? Where do you most commonly find them?

7. What are the current major market factors involved in your need to grow your workforce?

8. Are these market factors related to current specific policies? If so, what?

9. What policies could most likely lead to growth for your company? Are you familiar with the Oregon's Senate Bill 1044, which outlines goals for zero emission vehicles?

10. If those policies were enacted, what specific occupations would you need to hire?

11. Of those occupations, what major skills and training/credentials would you need for these occupations?

12. Is there anything else you'd like to share regarding workforce needs for your company?