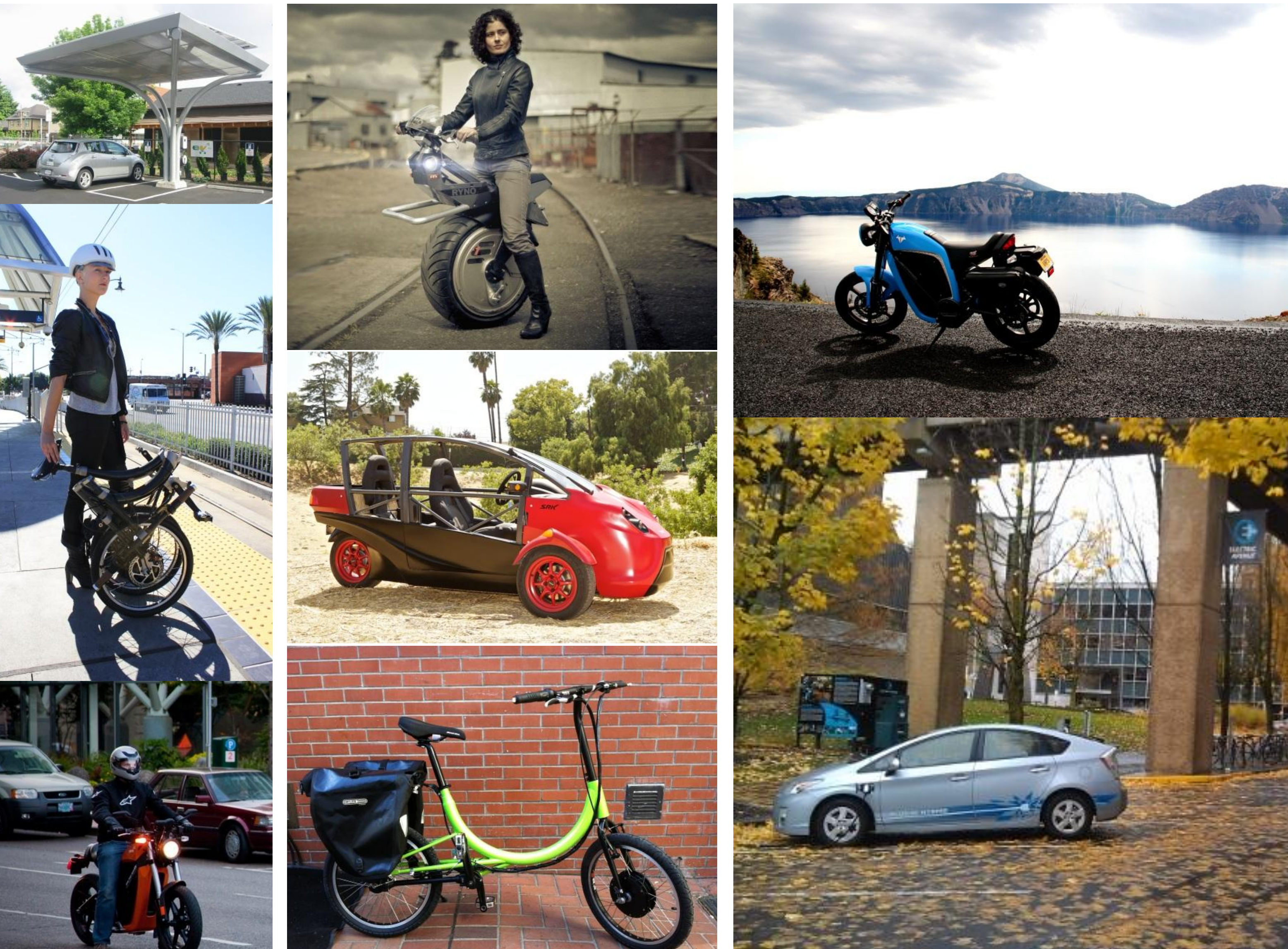

Oregon’s Electric Vehicle Industry

NeRC

Northwest Economic Research Center

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FINAL REPORT

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Portland State University

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PDC strives to create one of the world's most desirable and equitable cities by investing in job creation, innovation, and economic opportunity throughout Portland. Pam Neal, Senior Project Coordinator at PDC, provided valuable feedback and direction for the report.

NERC is based at Portland State University in the College of Urban and Public Affairs. The Center focuses on economic research that supports public-policy decision-making, and relates to issues important to Oregon and the Portland Metropolitan Area. NERC serves the public, nonprofit, and private sector community with high quality, unbiased, and credible economic analysis. Tom Potiowsky is the Director of NERC, and also serves as the Chair of the Department of Economics at Portland State University. The report was researched and written by Dr. Jenny H. Liu, Assistant Director, and Jeff Renfro, Senior Economist. Research support was provided by Scott Stewart, Senior Research Associate, and Hudson Munoz and Toby Sytsma, NERC Research Interns. The report was formatted by Mauryn Quintero, Administrative Assistant.

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Table of Contents

Executive Summary

Over the past few years, transportation electrification has accelerated rapidly due to a combination of high gas prices, technological improvements, and concerns over climate change and national security of importing transportation fuels. While Oregon has long had companies making electric transportation components and equipment, new opportunities for high technology manufacturing and related businesses have arisen with more widespread adoption of electric drivetrains in passenger vehicles. Oregon economic development officials at both the state and local level quickly recognized these opportunities, and identified the electric vehicle industry as a key focus area as early as 2009. In 2011, the Oregon Innovation Council made a significant investment in this industry by funding Drive Oregon to accelerate industry growth.

In 2012, Drive Oregon and the Portland Development Commission (PDC) commissioned the Northwest Economic Research Center (NERC) to undertake a study of Oregon's existing EV cluster. This report has two goals: define what we mean when we talk about an EV cluster in Oregon, and characterize and measure the existing EV cluster in order to identify Oregon's strengths and opportunities.

The EV industry has developed rapidly and has thus outpaced the public institutions tasked with tracking industry data. There are no NAICS designations or categories that correspond directly to the EV industry. The economic data is mixed in with related industries making it impossible to track using publicly available data. Before collecting industry data, NERC needed to define the industry in order to identify possible participants. Using a definition of EVs taken from previous studies, and research on EV and related industries, NERC created a supply chain of raw material and parts/components suppliers, engineering and design firms, charging infrastructure manufacturers and installers, downstream activities that occur after the production of EVs, and ancillary organizations that support the core EV industry. The resulting cluster diagram is on page 4 of this report.

NERC used this industry diagram to identify Oregon EV firms with the help of data from Drive Oregon and PDC, and research performed by NERC. NERC then partnered with the Portland State University Survey Research Lab to develop an online survey which was sent to each identified firm. The survey asked respondents to provide firm information, as well as EV-specific activity information. The survey was sent to close to 300 firms, and NERC received 73 completed responses. After firms with no EV-related activity (or no EV activity in Oregon) were removed, we were left with responses from 54 unique EV companies. The 54 firms surveyed employ an average of 7.78 full-time employees[1] and 1.19 part-time employees who do EV-related work, for a total of 397 full-time and 56 part-time EV workers.

In order to estimate the full impact of the industry NERC used IMPLAN, an input-output software. The economic activity of the EV industry creates additional economic activity in other parts of the economy. Because IMPLAN has not yet classified the EV industry, NERC had to customize its IMPLAN model and use an estimation technique called Analysis by Parts. Based on this analysis, NERC estimates that the economic activity from the Oregon EV industry creates 1,169 jobs, in addition to the 411 full-time jobs

[1] Full-time workers are defined as those who work 35 hours per week or more by the Bureau of Labor Statistics (BLS).

created directly for a total impact of 1,579 jobs. The industry generates gross economic activity of $266.56 million, total value added of nearly $148 million and provides over $89 million in total employee compensation.

In addition to the increase in economic activity, the industry also generates a significant amount of tax revenue for the state and federal governments. NERC estimates total state and local tax revenue of $11.9 million and federal taxes of $20.8 million, as discussed on page 21. With help from the Oregon Department of Revenue, NERC also tracked the EV industry's tax revenue over time. The data shows an EV industry that continued to grow during the Great Recession, while other transportation industries suffered enormous losses. In particular, the Manufacturing and Parts and Components sectors enjoyed large growth during the recession.

The above figures represent a lower-bound estimate of the employment and economic activities generated by the Oregon EV industry. NERC worked with the Oregon Employment Department to identify the number of employees at firms that were missed in the survey process. Using this information, NERC identified 21 additional FTE EV workers. Including these additional workers, NERC estimates that Oregon's EV industry directly employs more than 400 full-time equivalent employees in approximately 100 firms, totaling more than 1,600 jobs when indirect and induced impacts are also considered. The EV industry also contributes over $22 million in federal tax revenues and $12 million in state and local tax revenues.

This analysis defines the Oregon EV industry, the industry cluster and provides a characterization of its total economic impact in 2012. Therefore, this study may be used in establishing a baseline from which to gauge future performance of the industry. Further research may be needed to identify specific opportunities for expansion, and where public investment or policy directives may be most cost-effective.

Part I - The EV Industry Cluster in Oregon

The first electric motor was invented in 1828 by a Hungarian engineer named Ányos Jedlik. It was eventually replaced with the gasoline motor, which was better equipped for long distance travel (Baxter et al. 2009). Rising oil prices, tenuous US relationships with oil exporting countries, and concerns over climate change have generated renewed interest in electric vehicles (EVs). In his 2011 State of the Union address, President Obama called for one million EVs on the road by 2015 with the statement "with more research and incentives, we can break our dependence on oil with biofuels, and become the first country to have a million electric vehicles on the road by 2015" [2]. This statement followed the Economic Stimulus Act of 2008, which invested over $4 billion in electric vehicle manufacturing, research and development, and infrastructure (United States Department of Energy 2011). These national-level policy directives bring the EV industry to the forefront of efforts to promote national energy-security (Greene 2010), to foster sustainability (Samaras and Meisterling 2008) and to curb greenhouse gas emissions (Dowds et al. 2009; Musti and Kockelman 2011). This increased investment and demand has led major car manufacturers and start-up companies to start developing and producing new lines of PHEVs, BEVs and EREVs. National sales of EVs manufactured by the major automotive firms are growing: Nissan sold 9,674 LEAFs (a BEV model) in 2011, compared to 19 in 2010[3]; Forbes recently reported that Chevy Volt (an EREV model) sales spiked in March 2012, moving 277 percent higher than they were in March 2011[4].

NERC will define EVs and the EV industry that fall within the scope of this study in Section 1. Using these definitions, we then characterize the electric vehicle industry cluster in Oregon and identify several driving forces of the cluster in Section 2.

Section 1 – Defining EVs and the EV industry in Oregon

Following Faiz et al. (1996) and Francfort and Karner (2010), we define electric vehicles (EVs) as any vehicle that transports people or freight, and uses…

- (i) a continuous supply of electricity, such as streetcars or light rail,
- (ii) on-board electric generation with internal combustion engine (ICE), such as hybrid electric vehicles (HEVs) , or
- (iii) stored electricity, such as pure battery electric vehicles (BEVs), plug-in hybrid electric vehicles (PHEVs) or extended range electric vehicles (EREVs).

This three-part definition encompasses the main types of vehicles that use purely electric power or rely on assistance from an internal combustion engine (ICE), as is the case with HEVs and PHEVs. The most well-known form of the EV is the four-wheeled electric car, but it is important to note that this definition of EVs also encompasses electric-powered ground transportation vehicles ranging from one- to three-wheel electric motorcycles, short range neighborhood electric vehicles (NEVs), electric bicycles and electric delivery trucks to utility vehicles such as electric forklifts and airport tarmac vehicles.

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[2] 2011 State of the Union Address - http://www.whitehouse.gov/state-of-the-union-2011

[3] Loveday, Eric. "Tally of Nissan LEAF and Chevy Volt Sales for 2011." *plugincars*. http://www.plugincars.com/nissan-leaf-sales-trump-chevy-volt-2011-111308.html (accessed July 24, 2012)

[4] Buss, Dale. "Re-Volting Development: Chevy Volt Sales Surged in March." *Forbes.com*. http://www.forbes.com/sites/dalebuss/2012/04/03/re-volting-development-volt-sales-mount-spring-surge/ (accessed July 16, 2012)

Within this definition of EVs, we then proceed to define the Oregon EV industry and construct an Oregon EV industry cluster diagram that includes not only the end manufacturers of electric vehicles, but also the entire industry supply chain of raw material and parts/components suppliers, engineering and design firms, charging infrastructure manufacturers and installers, downstream activities that occur after the production of EVs, and ancillary organizations that support the core EV industry. The next section describes the background, methodology and development of this extensive supply chain.

Section 2 – Oregon EV Industry Cluster

Portland Development Commission (PDC) identified the EV industry as an emerging cluster in the state of Oregon as early as 2009, based on the identification of "competitive advantage in clean tech, number of trade sector firms, concentration of firms, high growth potential and strong multiplier effect"[5]. PDC developed a cluster strategy as part of their 5-year economic development strategy. Therefore, to accurately characterize the EV industry identified by PDC, our study began with a comprehensive review of the literature on supply chains and clusters. We examined industries related to EV supply chain / cluster development, which included the automobile industry, high tech industries and other green energy or clean tech sectors. The characterization of the EV industry in Oregon combines the literature review with previously collected data from Drive Oregon and PDC and a web-based Oregon EV industry survey, described in more detail in Part II.

2.1 Overview of Cluster / Supply Chain Analysis

Industry clusters are defined as "geographic concentrations of interconnected companies, specialized suppliers, service providers, firms in related industries, and associated institutions" (Porter 1998b). The basic principle behind industry clusters dates back to Alfred Marshall's work in the 1890s, describing the positive "externalities of industrial location" (Kuah 2002). The use of industrial cluster analysis began to take off as a policy tool in the 1990s with the publication of Michael Porter's book, *The Competitive Advantage of Nations* (Porter 1998a), in which Porter explained how cluster analysis could be used as a tool for economic development. Industrial cluster analysis provides a "blueprint" of economic activity in a specific area, and highlights areas of potential growth, allowing policy makers to determine where to allocate resources most effectively. Industry clusters differ from industry sectors because clusters take into account the entire value chain, everything from natural resource suppliers to downstream supporting services are considered in industrial cluster analysis (San Diego Association of Governments).

Traditionally, cluster analysis utilizes the North American Industry Classification System (NAICS) to identify specific actions, activities, or sectors within a given supply chain. NAICS provides six digit codes for many sectors and activities which can be used to track employment data, wages, and other economic indicators (Feser and Bergman 2000). While this approach works well for established sectors, it does not work for emerging sectors. In industries where technological advances move faster than the creation of NAICS codes and in industries that are completely novel, tracking economic indicators can be difficult. For example, during the "dotcom" boom of the early 1990s, the activities and technology used in the Internet commerce sector had not yet been translated into corresponding NAICS codes. Eventually, NAICS codes were created for the high-tech industry, making it feasible to track economic

[5] Pam Neal, personal communication, Dec. 2012.

activity in the sector using standard data sources (Pernick 2011). Because NAICS codes are not yet defined for the EV industry, NERC applied the alternative approach of constructing an industry cluster diagram to characterize the industry supply chain relationships.

2.2 Oregon EV Industry Cluster Diagram

An industry cluster diagram can be thought of as a visual representation of the relationships between different sectors of the cluster (Waits 2000). We constructed the Oregon EV Industry Cluster Diagram using information from our literature review of the automobile industry, high tech industries and other green energy or clean tech sectors, and supply chain data gathered from the Oregon EV Industry Survey and informal interviews with Oregon EV industry participants.

The Oregon EV Industry Cluster Diagram is presented in Figure 1 on the following page. The "Core EV Industry" is represented in the upper portion of the diagram while "Ancillary EV Organizations" that support the core industry are represented at the bottom. At the center of the diagram are the main "Manufacturing" activities of the industry cluster that include both manufacturers of parts/components for EVs and actual vehicle production. Oregon is home to a wealth of firms that manufacture and design parts/components for EVs. These firms supply vehicle drivetrains, electric motor controllers, energy storage options, wire harnesses, plastic or metal materials and other components to the EV industry both within Oregon and out of the state. The existence of a native EV industry provides a local market for these firms, which lowers transportation costs and fosters collaborative development.

Upstream activities are usually shown to the left of center, such as the production of "Raw Materials" that go into EV manufacturing (plastics, metals or other material). The majority of these raw materials are not extracted or produced here in Oregon, but many manufacturers import the raw materials for the production of parts/components here. These upstream activities can be thought of as basic inputs, from raw materials to chemicals or manmade materials, depending on the cluster. Downstream activities are usually portrayed to the right of center; for example, EV maintenance and repair or marketing and retail are downstream activities that result from EV production. Firms that supply conversion kits or build converted ICE vehicles into EVs also fall within the downstream activities sector. EV charging infrastructure is another active element of the core EV industry in Oregon, but its connections to the main manufacturing sector in Oregon may be indirect because many Oregon-produced EVs do not rely on specialized charging equipment.

Below the "Core EV Industry" are ancillary organizations and educational institutions. These institutions may or may not play a direct role in the manufacturing of a good, but their inputs are vital to the cluster. For example, research organizations that develop novel battery storage materials or EV design/manufacturing firms that receive specialized services from Portland State University or University of Oregon or nonprofit groups that promote awareness of EVs are all examples of ancillary organizations. We find that the business activities of firms often overlap several sectors within the industry, particularly between "Ancillary EV Organizations" and the "Core EV Industry". For example, a firm engaged in EV business consulting may also be designing or engineering components for EVs, or a public agency that provides support to the industry may also be active participants in the EV charging infrastructure portion of the industry.

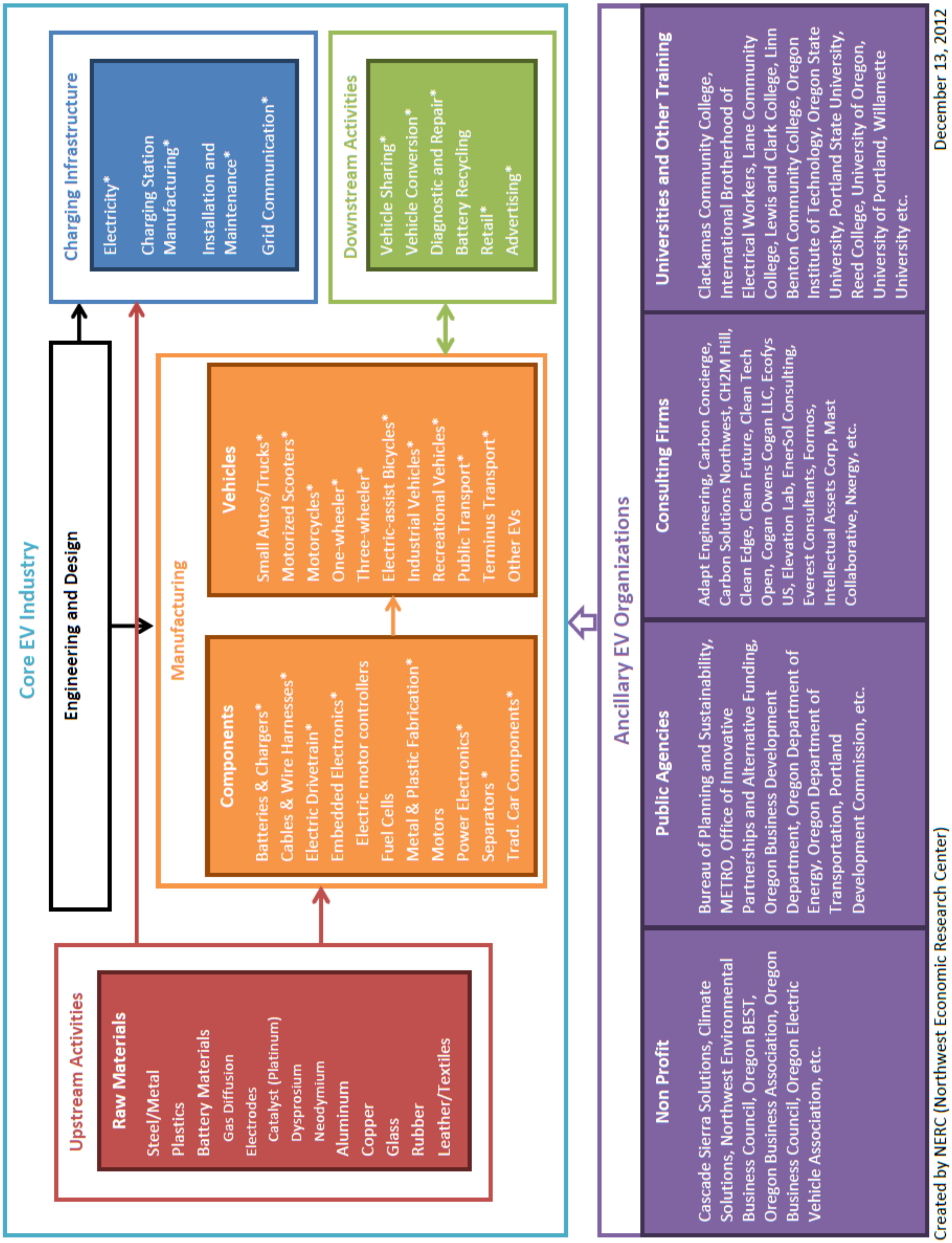


Figure 1 – Oregon EV Industry Cluster Diagram
(Asterisks represent portions of the EV industry that are present in Oregon.)

2.3 Driving Forces of Oregon's EV Industy Cluster

The traditional automotive supply chain is driven by the complexity of the internal combustion engine, and the highly specialized engineering inherent to the car. Most major car manufacturers are vertically integrated, with activities ranging from raw material processing to repair service (Zhou et al. 2010). The electric vehicle, however, uses far fewer components, and requires less collaboration between parts/components manufacturers and vehicle manufacturers. There are also fewer alterations needed when fitting EV parts into vehicles, which means that parts manufacturers can be less specialized and produce generic products used by many actors in the supply chain (Zhou et al. 2010).

Differences between the hierarchies of the two types of vehicles' supply chains are illustrated in Figure 2 on the right. Conventional vehicles typically utilize vertical integration in manufacturing, but this technique may not apply to electric vehicles. Due to the novelty of the industry, we find that many independent suppliers produce both standardized and customized components for EVs. These parts are easily adaptable to multiple EV manufacturers, which means that EV manufacturers do not necessarily need to contract out to specialized suppliers. The relatively horizontal structure (as opposed to the typical vertically-integrated ICE supply chain) of the EV industry reduces entry barriers for small parts manufacturers to enter the market, and for traditional parts manufacturers to branch out into supplying to the EV industry (Zhou et al. 2010). The authors believe that the increased autonomy of parts and components makers not only lower market entry barriers, but also increased competition and innovation.

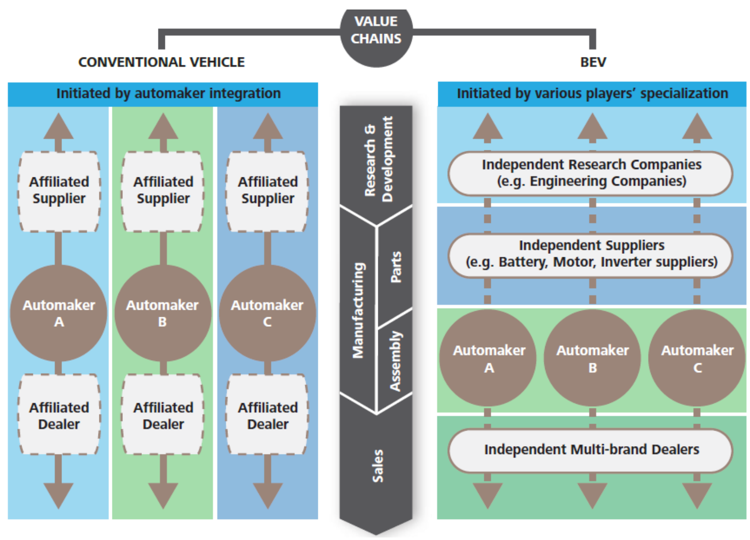


Figure 2 - Differences between the supply chains of conventional vehicles and BEVs (Source: Zhou et al. 2010)

The traditional American automobile industry cluster in Michigan first began to take shape in 1908 with the production of the Ford Model T (Ba et al. 2009). Michigan is one of many states implementing incentive programs similar to those offered in Oregon, hoping to land the new American EV cluster within their boundaries. In *Creating a Plug-In Electric Vehicle Industry Cluster in Michigan: Prospects and Policy Options* (2011), Lyon and Baruffi Jr. point out several key factors that influence an industry's propensity to cluster. Many factors that drove the traditional automotive industry to cluster apply to the EV industry, such as the geographic concentration of bulky/heavy automotive components that are expensive and difficult to ship long distances. Electric vehicles rely heavily on technological inputs and innovations, and the close correlation between the high-tech industry and EV industry is reason to believe they may follow similar patterns when clustering.

The Center for Climate and Energy Solutions[6] laid out an action plan (C2ES 2012) stating that active collaboration between electric utilities, businesses, all levels of government and non-governmental organizations will be necessary to integrate EVs into the US grid. Following Lyon and Baruffi (2011) and C2ES (2012), NERC identified key driving forces that will continue to play a role in pushing Oregon's EV industry forward. Multiple rankings have indicated that Oregon has a competitive advantage on both the supply-side and demand-side of clean energy products and services. According to Pew Environment Group's (2009) most recent report on America's emerging clean energy economy, Oregon ranked at the top of the nation in percentage of jobs in clean energy in 2007. The Pew report also shows that Oregon is home to the most energy efficient buildings per capita, and ranks in the top ten in clean energy patents per employee. This clean tech expertise translates to the EV industry, providing a pool of experienced managers and engineers, familiar with challenges associated with the emerging clean tech industry. In addition, the clean tech comparative advantage in Oregon is one of the main reasons why PDC classified the EV industry as an emerging industry cluster in 2009. When combined with the strong local demand and support from public agencies, Oregon already has the supply and demand factors in place to foster early industry development.

Tacit Knowledge

Tacit knowledge is gained through informal training and social networking. The agglomeration of people working in similar industries, especially high tech industries in which technology changes quickly, can lead to clustering. Silicon Valley is an example of an area where like-minded people gathered and shared ideas, eventually leading to one of the most successful industrial clusters in the country. People discussing their trials and errors, their new projects, and new products can be beneficial for cluster formation. This is especially true when an industry, such as high tech, changes faster than journal articles and research papers are published.

The lack of NAICS codes for activities within the electric vehicle supply chain suggests that the technology and industry practices are moving faster than it can be categorized, or that it is simply too new. In this way the electric vehicle industry shares similarities with the Silicon Valley tech industry. Nonprofit organizations, such as Drive Oregon, are providing ways for those in the electric vehicle industry to communicate with each other, through partnerships, conferences and trade shows. The large infrastructure of Oregon organizations committed to promoting electric vehicle use is essential for communication within the electric vehicle industry, and continued innovation along the electric vehicle supply chain.

Encouraging Public Policies, Investment, and Education

Investing in knowledge creation has positive external effects for communities, especially when knowledge is being created in areas that bring technological advances in energy and environmental-related fields. These types of technological advances contribute greatly to efficiency and sustainability within a community, and can occur through public policy incentives that encourage innovations on the supply side and consumer adoption on the demand side,

[6] The Center for Climate and Energy Solutions (C2ES) was launched in November 2011 as the successor to the Pew Center on Global Climate Change.

direct investments in promising technologies (such as Oregon BEST's Commercialization Program that supports clean tech), or public investments in education.

In the case of the EV industry, public investment in education could help grow the skilled labor pool necessary to support the regional electric vehicle cluster. Oregon is in a good position to encourage highly skilled labor, and to grow mid- to high-skill labor pools, due to the number of major public and private universities located near its I-5 corridor. The Portland Development Commission has identified regional talent linkages to "semiconductor, solar and metals and other clean tech industries"[7]. In addition, federally-funded research programs such as the Oregon Transportation Research and Education Consortium (OTREC) and National Institute for Transportation and Communities (NITC) sponsor research that promote livability and the reduction of transportation emissions to address climate change.

Clean Edge, Inc.'s 2012 report shows that Oregon is ranked 4th in policy support for clean energy, "a clear indication of committed industry support". The sixth edition of American Council for an Energy-Efficient Economy's *2012 State Energy Efficiency Scorecard* (Foster et al. 2012) also ranked Oregon as 4th nationally on energy-efficient policies, programs and activities in transportation, building efficiency, government initiatives, etc. There are currently several policy incentive programs described in Table 1 that encourage consumer and business demand for energy efficient products, investments in infrastructure and increase public awareness.

Policy Incentives & Programs	Details
Alternative Energy Device (AED) tax credit	This offers a 25% tax rebate for the installation of a charging or alternative-fueling station at a residence, up to $750 (Oregon Department of Energy 2012b).
Alternative Fuel Fueling Systems (AFFS)	Oregon offers businesses up to 35% of certified project costs in tax credits which benefit facilities providing EV-charging infrastructure or other alternative fuels (Oregon Department of Energy 2011).
Commercial Electric Truck Incentive Program (CETIP)	This program is offering 200 vouchers worth $20,000 each for the purchase of commercial zero-emission vehicles over 10,000 pounds that will primarily operate in designated areas of Oregon. It narrows the price gap between the zero-emission vehicles and diesel vehicles, and aims to improve air quality as a result (Oregon DOE 2012a).
The EV Project	ECOtality has been deploying both residential and public EV charging infrastructure via grants totaling $230 million from the U.S. Department of Energy starting in 2009. ECOtality also administers the Electric Vehicle Supply Equipment (EVSE) Incentive which offers free

[7] Portland Economic Development Strategy – Electric Vehicle & Energy Storage - http://pdxeconomicdevelopment.com/cluster-cleantech-ev.html

	installation of home EVSE to individuals purchasing EVs in Portland, Eugene, Salem, and Corvallis metropolitan areas.
West Coast Electric Highway	Oregon Department of Transportation (ODOT) has partnered with California, Washington and the province of British Columbia to install EV DC fast charge stations along Interstate 5 (1350 miles long) every 25-60 miles[8]. ODOT also received $2 million from the TIGER II grant program to install up to 20 EV fast charging stations in northwest Oregon along key transportation corridors such as Oregon's coast and interior.
PSU Electric Avenue	Portland State University partnered with the City of Portland, Portland General Electric and EV charging infrastructure manufacturers to install five Level 2 charging stations and two DC quick-charge stations on campus for a two-year demonstration and research project in August 2011.

Table 1 – Policy incentives and programs for energy efficiency, increased infrastructure and public awareness

Sophisticated Local Demand

Regions that adopt technologies early or that create demand for specific goods and services before the rest of the nation invite industries to cluster. While people in every state are interested in energy efficient technology, some states are better positioned to take advantage of demand for EVs. For example, although Michigan has been a leader in conventional automobile production, local demand for EVs in Michigan has been low. The lack of demand could be due to low public interest, and the inability of local governments to encourage EV adoption. When comparing Michigan to a state that pursues innovative energy and automotive policies, like California, the difference in demand for clean technology is striking; California ranks number one in Clean Edge's 2012 Clean Energy Leadership Index[9] with a score of 91.1 out of 100, while Michigan ranks 12th with a score of 48.9 (Clean Edge, Inc. 2012).

On the other hand, Oregon already has relatively high demand for clean energy technologies. In fact, in 2012 Oregon ranked 2nd in the Clean Energy Leadership Index with a score of 79.9, 3rd in the nation in hybrid electric vehicles per capita, 8th in EVs per capita and 1st in the nation in charging stations per capita[10] (Clean Edge, Inc. 2012). In fact, Oregon has more than twice as many EV charging stations per capita when compared to Michigan and California. The report asserts that Oregon's high ranking within this nation-wide index is "largely due to unwavering consumer-driven demand for clean-tech products and services". Edmunds.com's analysis[11] of

[8] West Coast Green Highway – http://www.westcoastgreenhighway.com/electrichighways.htm
[9] The Clean Energy Leadership Index is calculated using indicators from various sources within three large categories: technology, policy and capital. Within these categories, there are subcategories. In the technology category, indicators are calculated within the clean electricity, clean transportation and energy intelligence and green building subcategories. In the policy category, indicators come from the regulations and mandates, and incentives subcategories. The capital category includes financial capital, and human and intellectual capital as subcategories.
[10] Oregon has 95.8 EV charging stations per million people. Washington, Michigan and California trail behind with 76.1, 45.7 and 44.1 stations per million people, respectively. (Clean Edge, Inc. 2012)
[11] "Sales of hybrids, EVs stay brisk in Oregon," Sustainable Business Oregon. URL: http://www.sustainablebusinessoregon.com/articles/2012/11/sales-of-hybrids-evs-stay-brisk-in.html (accessed on November 1, 2012)

new motor vehicle registrations from January 2012 to October 2012 shows that Oregon only has approximately 1.25% of the nation's population, and only accounts for 0.9% of all new vehicle sales, yet Oregon is responsible for 1.9% of all new hybrid vehicle sales and 1.8% of all EV sales. This indicates that although Oregonians tend to purchase fewer vehicles, the vehicles purchased skewed heavily towards alternative fuel vehicles such as hybrid vehicles and EVs. Oregon has been chosen as one of the first test markets for virtually every new electric vehicle introduced in the United States. Oregon has a history of electing officials who support strong energy policies as well. The current governor John Kitzhaber convened the 10 Year Energy Plan Task Force to draft the Governor's 10-Year Energy Action Plan[12], released in December 2012. The Action Plan focuses on three core strategies: increasing energy efficiency and conservation, enhancing clean energy infrastructure and promoting clean transportation. These strategies call for action to accelerate the development and deployment of electric vehicles through electric grid modernization and increased funding for the Oregon Innovation Council.

Reduction in Fixed Cost and Growth of Charging Infrastructure

Electric vehicles usually have high upfront cost (fixed cost), unlike traditional automobiles which have lower upfront costs but higher maintenance and operating/variable costs (CarsDirect 2009)[13]. Oregon EV manufacturers, however, have competitively priced models such as Arcimoto's tandem, low-occupancy SRK starting at $17,500 and Brammo's Enertia electric motorcycle starting at $7,995. In addition to the majority of electric vehicles' relative high cost, many may require installing a home charging station that can cost up to $1,000 or more without government incentives (Freeney 2009). While this may continue to present an obstacle for manufacturers of EV charging infrastructure that service conventional EVs, it may prove to be an advantage for Oregon EV producers that utilize standard 110-120 volt household electrical outlets for charging.

Regardless, widespread adoption of electric vehicles that utilize public charging infrastructure will be contingent upon addressing the limited availability of charging infrastructure compared to traditional automobiles' existing network of fueling stations. A reliable network of charging stations will need to be installed in order for EVs to be a viable option for many consumers, as range capabilities are cited as one of the biggest concerns of those considering electric vehicles (Parker and Brode 2012). Currently, Oregon leads the nation in charging stations per capita and is in the process of installing more through various programs mentioned above, but doing so is expensive. According to the West Coast Green Highway project, each charging station costs between $16,000 and $25,000 for a 240 volt (Phase 2) charger, and $80,000-$110,000 for a 480 volt (Phase 3) charger (Kintner-Meyer et al. 2007), before installation costs.

Implementation of Road User Fees / Gasoline Taxes

Oregon was the first state to adopt a gasoline tax, and its continued leadership in transportation finance presents both an opportunity and a challenge to electric vehicle sales. In an effort to

[12] http://www.oregon.gov/energy/pages/ten_year/ten_year_energy_plan.aspx

[13] The 2012 Nissan LEAF's (BEV) MSRP starts from $35,200, compared to the similarly-sized 2012 Toyota Matrix which starts at $18,845. The 2012 Chevrolet Volt (EREV) starts at a MSRP of $39,145, compared to the similarly-sized compact 2012 Chevrolet Cruze which starts at $16,800.

equitably divide the cost of road repair, both state and federal governments[14] impose gasoline taxes which go toward transportation projects and infrastructure improvements (Nigro 2011). Oregon currently charges a fuel tax of $0.30 per gallon of motor vehicle fuel[15].

However, with increasing fuel efficiency of vehicles, and wider adoption of EVs, states that rely on gasoline taxes for road maintenance and construction may face a transportation financing crisis (Wachs 2010)[16]. In 2001, Oregon established a Road User Fee Task Force through House Bill 3946 to develop an alternative revenue collection system, in part to address the increased fuel efficiency of new vehicles. ODOT implemented a Road User Fee Pilot Program between 2005 and 2007 that demonstrated the Oregon Mileage Fee Concept as a viable alternative to the fuel tax[17]. Vehicle manufacturers have expressed concerns that implementation of a road user fee could reduce demand for EVs. However, if Oregon can lead development of a model for the nation, that could create additional economic opportunities; for example, in the areas of software, telematics, and billing systems.

[14] The Federal government also may use the gasoline tax to curb gasoline consumption and reliance on foreign fuel.

[15] In May 2012 (the most current data available), Oregon collected $38,033,607.40 in motor vehicle fuel taxes, which is categorized as an indirect business tax within the fiscal impact section.

[16] Oregon Department of Transportation budgeted approximately $422 million during the 2011-2013 biennium for the Highway Maintenance program, which pays for maintaining and repairing of existing highways. This is equivalent to about 11% of ODOT's transportation revenues. (http://www.oregon.gov/ODOT/COMM/docs/budgetbooklet_11-13.pdf)

[17] Road User Fee Pilot Program Final Report - http://cms.oregon.egov.com/ODOT/HWY/RUFPP/docs/rufpp_finalreport.pdf

Part II – Oregon EV Industry Economic Impact Analysis

In order to properly characterize the Oregon EV industry's economic impacts, NERC designed and deployed an Oregon EV Industry Survey in consultation with the PSU Survey Research Center from July 2012 to August 2012. The survey methodology is detailed below in Section 1 along with a literature review of comparable studies. An economic impact analysis of the Oregon EV industry is conducted in Section 2, and a methodology for scaling up economic impacts to fully account for industry participants not captured by the survey is described.

Section 1 – Oregon EV Industry Survey

Due to its novelty, few EV industry-specific NAICS codes have been created. In previous studies where exclusive NAICS codes were not available, survey techniques have been utilized to identify the size and impacts of target industries. In a cluster analysis of the green building industry in Portland, Oregon, a survey was employed successfully to provide insight into the industry's employment generation and competitive environment (Allen and Potiowsky 2008). Estimates were made based on interview responses about the industry salaries and competitive structure. The results of the survey showed that firms were hiring workers, sometimes at an exponential rate. Since employment and financial data were not available for the entire supply chain, the researchers conducted follow-up interviews to capture other activities in the cluster.

Puget Sound Regional Council (2009) commissioned a related study that used a similar approach to analyze the region's clean technology cluster. The researchers used survey data from a study, *2008 Washington State Green Economy Jobs,* by Washington State University (Lee et al. 2009) to conservatively estimate the percentage of certain industries counted as part of the clean tech cluster. With this information they were able to scale activities within established NAICS categories to characterize the clean technology cluster, for entities lacking discrete NAICS codes. For example, the study estimated that 20% of firms falling under code 236115 (New Single-Family Housing Construction) were part of the clean tech supply chain. Other categories, such as code 333411 (Air Purification Equipment Manufacturing) were not scaled at all because it was estimated that the entire category was clean tech related.

As green or clean technologies have begun to take off, the Bureau of Labor Statistics released the results of a survey dealing with "Green goods and services jobs" in existing NAICS code industries in May 2012. The results of the BLS survey provided us with a starting point with identified industries that participate in energy efficient technology sectors, including ones that participate in the electric vehicle sector (Pernick 2011; BLS 2012). This survey was just a preliminary step toward creating NAICS codes for the entire clean technology industry, but is very helpful narrowing down current codes. According to our survey of the literature, there have not been any other comparable studies that attempted to characterize the EV industry in the US. NERC's own survey effort, described below, follows the survey methodologies described above to identify the key components of the EV industry in Oregon. The cluster diagram, presented in Section 2.2 below, derives the relationship between various sectors of the Oregon EV industry from literature as well as our Oregon EV industry survey.

NERC developed a web-based survey (Oregon EV Industry Survey[18]) using the Qualtrics survey platform in consultation with the Portland State University Survey Research Lab, following the survey methodologies described above. To broadly capture EV industry participants, the survey was launched via email to a panel of approximately 300 possible EV industry members on July 19th, 2012, which included possible participants in all parts of the Core EV Industry and Ancillary EV Organizations as defined previously. The panel combines contact lists provided by Drive Oregon (both members and non-members) and PDC with NERC's independent research. Data collection through the survey platform concluded on August 20th, 2012, and we received a total of 73 completed responses. Follow-ups via email and telephone were conducted to verify and collect additional information from key industry respondents.

After dropping all respondents who indicated no relationship to the EV industry, duplications and respondents who operated outside of Oregon, we identified 54 unique firms or organizations conducting EV-related business within Oregon. Respondents were asked to indicate their primary and secondary EV-related business activities as well as verbally describe their EV products and services. This allowed us to classify the firms and organizations into categories that allowed us to understand where they fit within the supply chain, and to identify the NAICS codes that are most closely associated with their activities. The table below summarizes the respondents by category:

Firm/Organization Category	Number of Respondents	Percentage of Respondents
Advocacy	3	6%
Charging	6	11%
Consulting	5	9%
Conversion	4	7%
Education	1	2%
EV Manufacturer	11	20%
Parts/Components	18	35%
Public	5	9%

Table 2 – Survey respondents by category

Figures 4 and 5 show the respondents' primary EV-related business areas. Respondents were allowed to choose multiple primary business areas. Within the Manufacturing sector of the EV industry, there were 37 firms that indicated that their primary business area involved either electric vehicle manufacturing or parts/components manufacturing for EVs. Of these 37 firms, 38% (or 14 firms) specified that their primary EV business involved manufacturing small autos or trucks, and 27% (or 10 firms) were involved in electric motorcycles and electric assist bicycles. 27% of these firms (or 10 firms) specified that they manufactured either power electronics or battery management systems for electric vehicles. 14 firms indicated their involvement in the Engineering & Design sector, with 64% (9 firms) concentrating in software. 20 firms are primarily involved in the Charging Infrastructure sector, with the majority operating, manufacturing or installing EV charging stations (75% of the 20 firms, or 15 out of 20 firms).

[18] http://www.pdx.edu/nerc/EVSurvey/

20 and 17 firms fall within the Downstream Activities and Ancillary EV Organizations sectors, respectively. The top primary business activities of the Downstream Activities firms included manufacturing support (45% or 9 firms), vehicle conversions (40% or 8 firms) and existing vehicle final preparation (35% or 7 firms). On the other hand, the majority of firms in the Ancillary EV Organizations sector are involved in consulting or business advisory for EVs (24% or 13 firms).

The high concentration of the Oregon EV industry in the manufacturing sector (69% of the 54 firms surveyed) indicates not only the presence of vehicle manufacturers in the state, but also numerous small parts/components providers which are either specialized EV suppliers or traditional suppliers that have branched into the EV industry due to the compatibility of their capabilities. Figure 3 shows the geographical spread of firms or organizations that responded to Oregon EV Industry Survey[19], by category, and the inset map illustrates the concentration of Portland metropolitan area firms. The majority of EV-related firms are spatially clustered around the I-5 corridor, with particular concentration within the Portland metropolitan area and some concentration around Salem and Eugene.

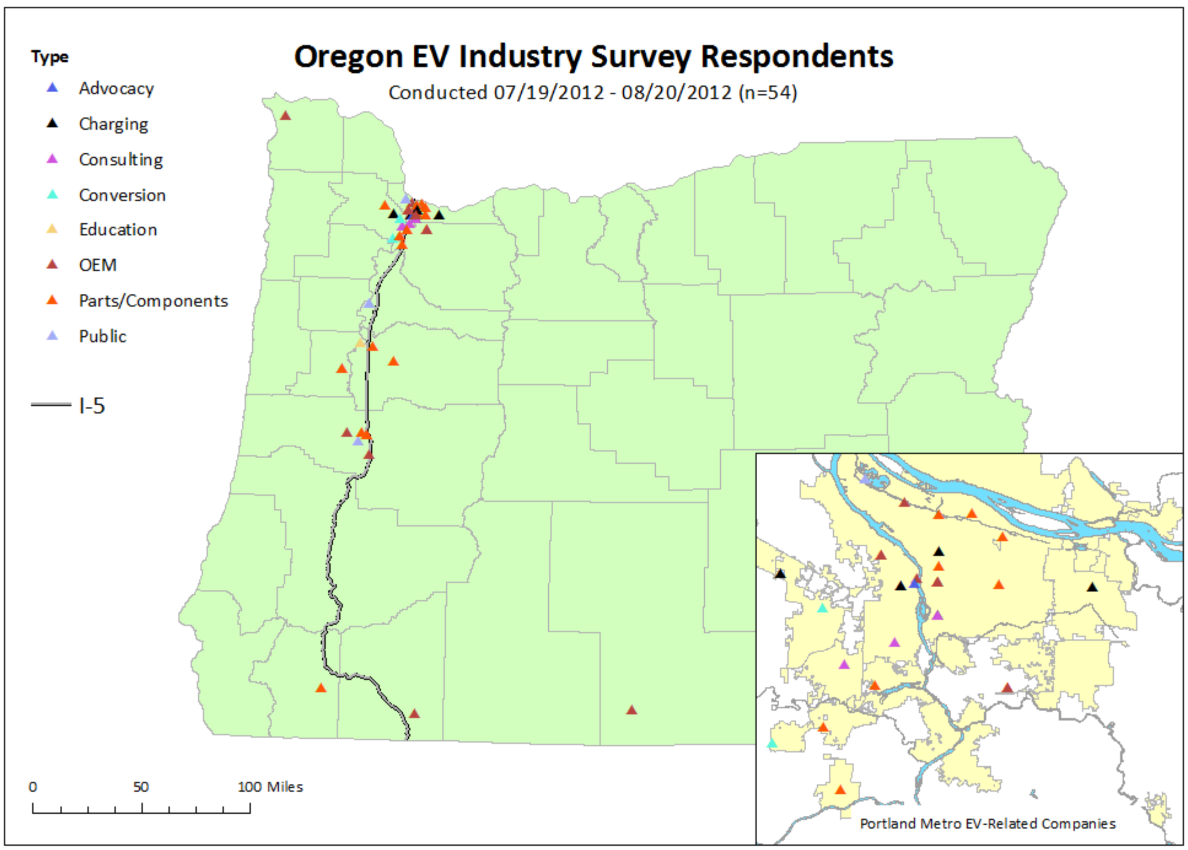


Figure 3 – Oregon EV Industry Survey Respondent Map

[19] There were a total of 54 unique respondents of EV-related firms and organizations.

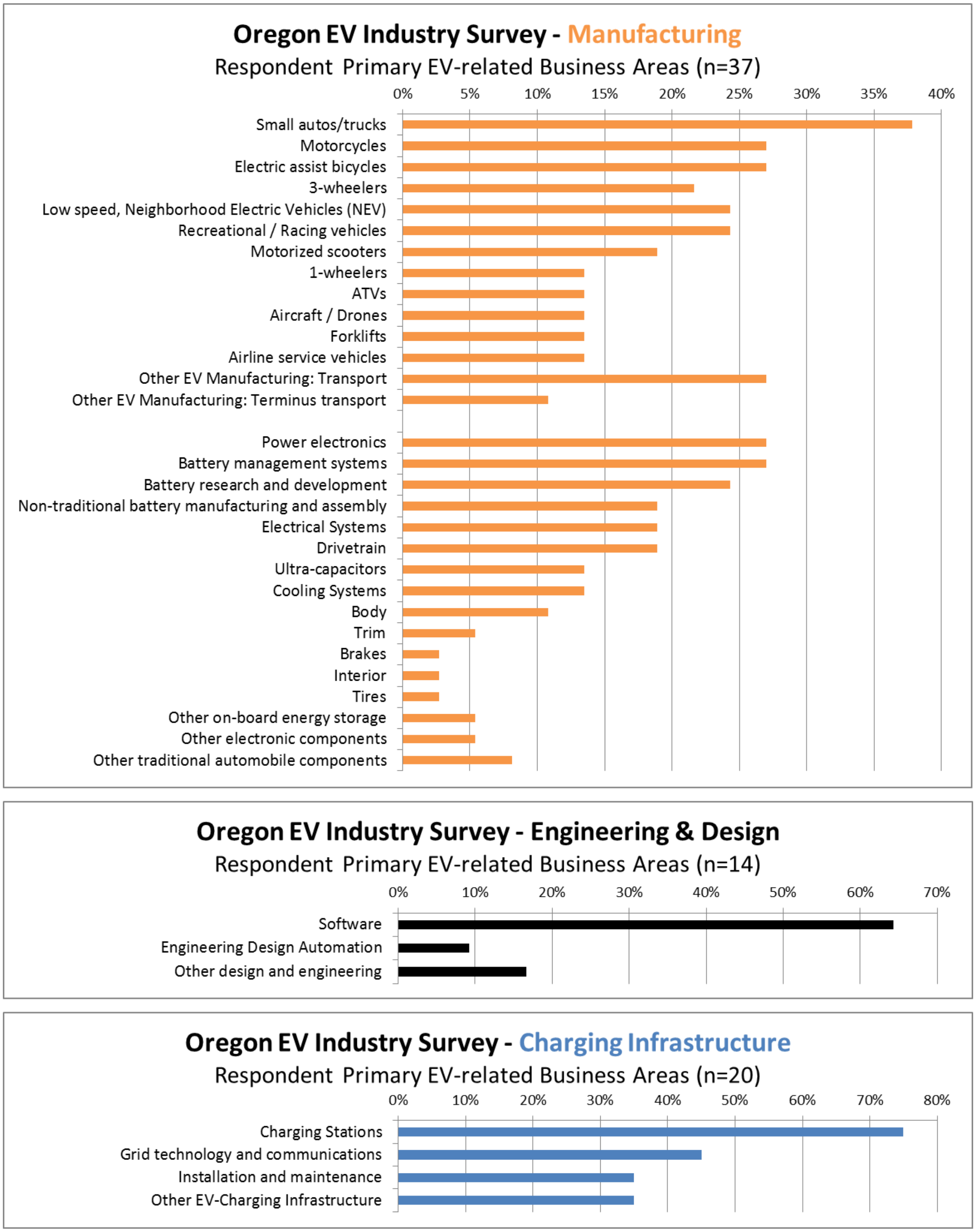
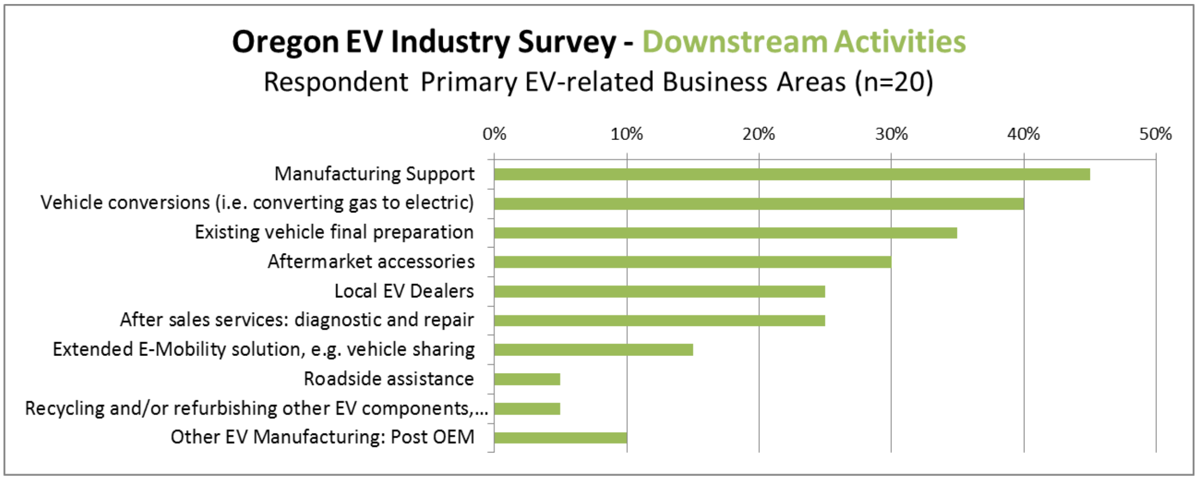


Figure 4 – Respondent Primary EV-related Business Areas
(Manufacturing, Engineering & Design and Charging Infrastructure)



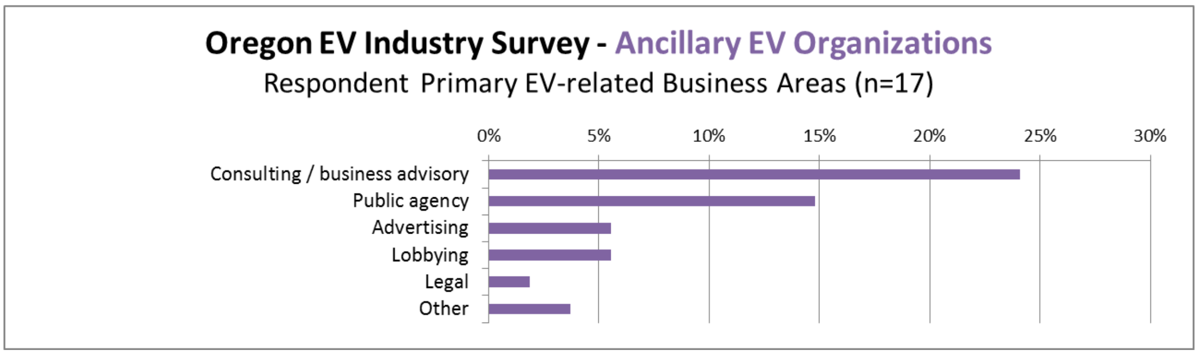


Figure 5 – Respondent Primary EV-related Business Areas
(Downstream Activities and Ancillary EV Organizations)

Of the 54 firms identified as Oregon EV industry participants in the survey, we found that, on average, 50.55% of business activity is EV-related and 50.84% of that EV-related business is conducted in Oregon. These firms employ an average of 7.78 full-time employees[20] and 1.19 part-time employees who do EV-related work, for a total of 397 full-time and 56 part-time EV workers. For the economic impact analysis, we will conservatively assume that each part-time EV employee is equivalent to 0.25 of a full-time employee. Full-time employees working within the surveyed Oregon EV industry have an average wage of $49,513, compared to an overall average wage of $43,090 in Oregon[21]. Although firms within the surveyed Oregon EV industry already employ a number of people, 24% of these firms have yet to commercialize their products and 18% are only starting to generate revenue (see Figure 6).

[20] Full-time workers are defined as those who work 35 hours per week or more by the Bureau of Labor Statistics (BLS).
[21] 2011 Bureau of Labor Statistics (BLS) Quarterly Census of Employment and Wages.

	Percentage of business that is EV-related	Percentage of EV-related business in Oregon	Full-time EV employees in Oregon (> 35 hr/wk)	Part-time EV employees in Oregon	Average wage of full-time EV employee
Mean	50.55%	50.84%	7.78	1.19	$49,512.82
Standard Error	6.61%	6.03%	1.56	0.48	
Minimum	0.01%	1.00%	0	0	
Maximum	100.00%	100.00%	60	20	
Total			397	56	
Count (n)	49	50	51	47	39

Table 3 – Summary statistics of survey respondents (n=54)

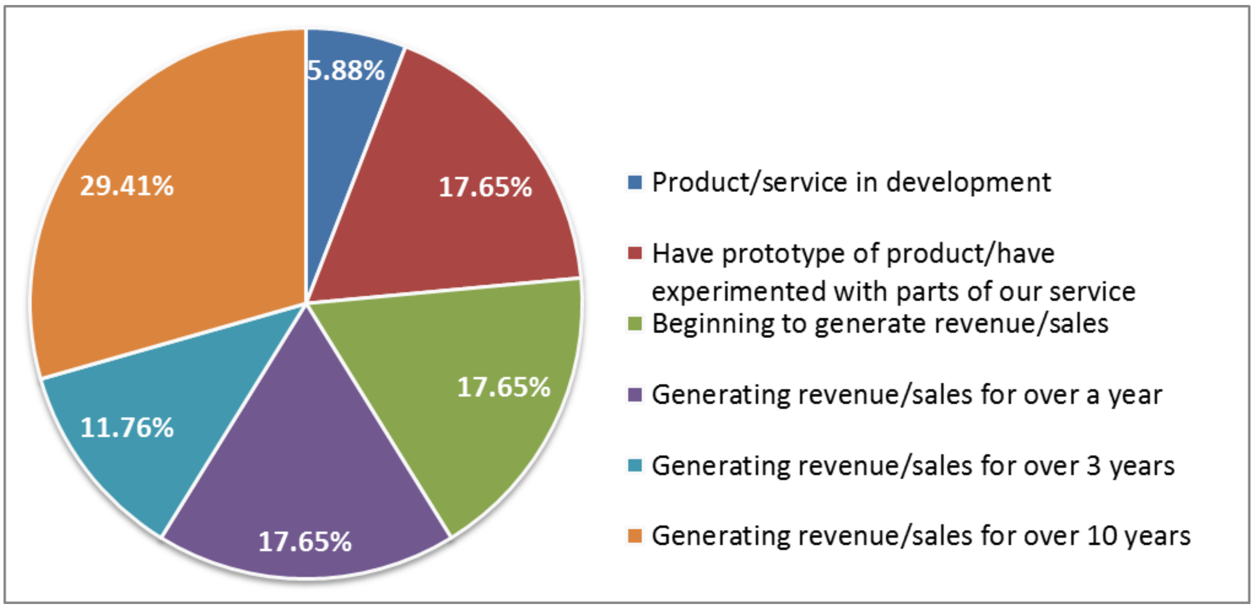


Figure 6 – Oregon EV Industry Survey respondent business stages (n=51)

Section 2 – Economic Impact Analysis

2.1 Background

In order to capture the full economic impact of the Oregon EV industry we used IMPLAN, an input-output software that simulates changes to the economy. NERC customized an IMPLAN model that covers the entire state of Oregon for this analysis. IMPLAN models are constructed using Social Accounting Matrices (SAM) based on spending and purchasing data from the Bureau of Economic Analysis (BEA) supplemented by data from other publicly available sources. SAMs are constructed that reflect the actual industry interactions in a region, and include government activities that are not traditionally reflected in this type of economic analysis.

SAMs create a map showing how money and resources flow through the economy. In a simulation, new economic activity is assumed to occur in an industry or group of industries. Based on past spending and purchasing activity, IMPLAN simulates the purchasing and spending necessary for this new economic activity to occur. IMPLAN tracks this new economic activity as it works its way through the economy. Also included in SAMs are household and government behavior. In addition to following purchasing and spending through the private sector, IMPLAN also estimates the impact of changes in disposable income and tax revenue.

Each industry is modeled using a production function, which reflects the supply chain of the industry and its connections to other industries. The original economic change is multiplied through this process as new economic activity motivates additional economic activity in other parts of the supply chain, and through changes in spending habits.

IMPLAN breaks out analysis results into three types: direct, indirect, and induced.

> **Direct Impacts**: These are defined by the modeler, and placed in the appropriate industry. They are not subject to multipliers. In this case, purchasing, employment, and wage data were

Interpreting economic impact analysis results

The impact summary results are given in terms of employment, labor income, total value added, and output:

Employment represents the number of annual, 1.0 FTE jobs. These job estimates are derived from industry wage averages.

Labor Income is made up of total employee compensation (wages and benefits) as well as proprietor income. Proprietor income is profits earned by self-employed individuals.

Total Value Added is made up of labor income, property type income, and indirect business taxes collected on behalf of local government. This measure is comparable to familiar net measurements of output like gross domestic product.

Output is a gross measure of production. It includes the value of both intermediate and final goods. Because of this, some double counting may occur. Output is presented as a gross measure because IMPLAN is capable of analyzing custom economic zones. Producers may be creating goods that would be considered intermediate from the perspective of the greater national economy. However, these intermediate goods may leave the custom economic zone, making them a local final good.

collected from the sources described above and placed into the appropriate industry.

Indirect Impacts: These impacts are estimated based on national purchasing and sales data that model the interactions between industries. This category reflects the economic activity necessary to support the new economic activity in the direct impacts by other firms in the supply chain.

Induced Impacts: These impacts are created by the change in wages and employee compensation. Employees change purchasing decisions based on changes in income and wealth.

2.2 Methodology for Oregon Impacts

NERC augmented the EV industry survey data with information from Drive Oregon and PDC, and collaborated with the Oregon Department of Revenue to attempt to identify any additional firms who did not respond to the survey. The majority of EV manufacturers concentrated on one-, two-, or three-wheeled EVs which are classified as motorcycles, whereas the remainder of vehicle manufacturers focused on electric utility vehicles, trucks or streetcars. The IMPLAN sector numbering scheme differs from the NAICS version, but the translation between the two is simple. The following table summarizes the IMPLAN sectors that were identified as major parts of the Oregon EV industry:

Firm/Organization Category	IMPLAN Sector	IMPLAN Sector Description
Advocacy groups	424	Grantmaking, giving, and social advocacy organizations
EV Charging	326	Retail stores gasoline stations
Consulting	375	Environmental and other technical consulting services
Conversion	414	Automotive repair and maintenance, except car washes
Education	392	Junior colleges, colleges, universities, and professional schools
EV Manufacturer - heavy trucks	228	Material handling equipment manufacturing
EV Manufacturer - motorcycles	292	Motorcycle, bicycle, and parts manufacturing
EV Manufacturer - streetcars	289	Railroad rolling stock manufacturing
EV Manufacturer - other	294	All other transportation equipment manufacturing
Parts/Components	283	Motor vehicle parts manufacturing
Public	432	Other state and local government enterprises

Table 4 – IMPLAN sectors for Oregon EV industry

Although most associate EVs with the motor vehicle manufacturing sector, we found motorcycle/bike manufacturing to be the existing industry (with an established NAICS code) most closely matched to the Oregon EV industry because of the high concentration in one- to three-wheel vehicles. In interviews conducted with Oregon EV manufacturers, we identified their proportionate breakdown of expenditures. This information was then used to adapt and customize the existing production function to one that reflects the Oregon EV industry.

Because the EV industry does not exist in either the NAICS codes or IMPLAN industry sectors, we conceptualized the industry as a collection of activities performed by supporting industries, a combination of the various types of EV manufacturers, charging infrastructure manufacturers, parts/components suppliers, downstream and supporting activities (e.g. vehicle conversion firms, consulting firms, educational organizations, etc.). In IMPLAN, when a new direct impact occurs to EV manufacturing, the effects are propagated through the economy via multipliers into the various industries and sectors that provide or support the core manufacturing (see left panel of Figure 7 – IMPLAN analysis methodology diagram). However, with the conceptualization of the EV industry as a collection of supporting industries, a typical IMPLAN analysis will overestimate the indirect impacts. IMPLAN would count direct economic activity created by the collection of supporting industries, and then assume additional activity, essentially having the supporting industries make all contributions twice. Because the EV industry is being modeled as a collection of supporting industries, the activities performed by these supporting industries represent the economic activity directly created by the industry. A much smaller additional indirect impact needs to be estimated to represent the activities performed to support these operations.

In order to avoid this double counting, NERC combined the standard methodology of customized production functions for the EV charging infrastructure manufacturers with an IMPLAN technique called Analysis-by-Parts (ABP) for the remaining subindustries to analyze the Oregon EV industry.

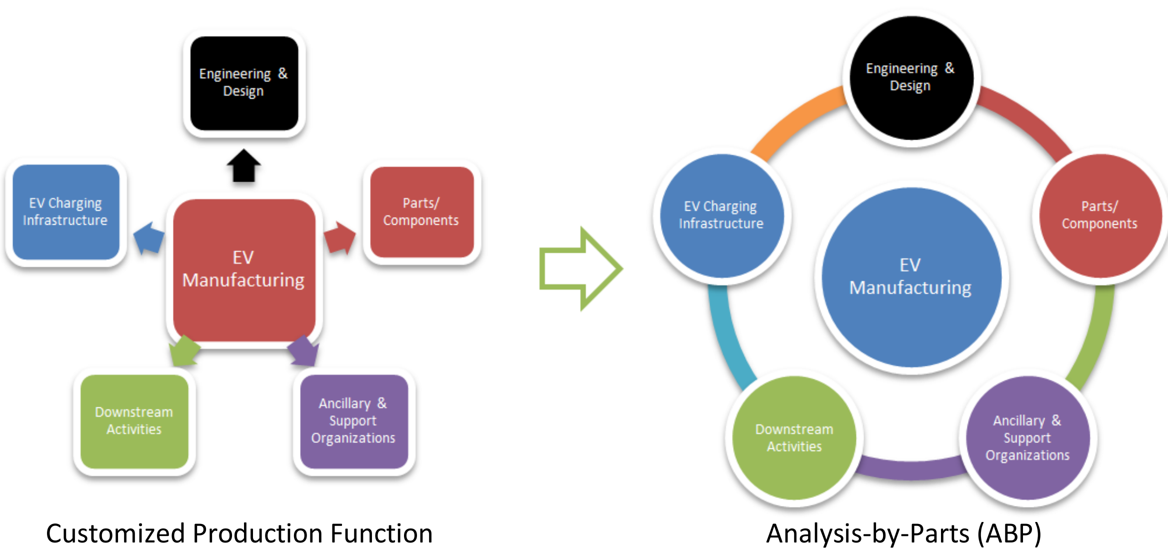


Figure 7 – IMPLAN analysis methodology diagram

In standard IMPLAN modeling, the user defines the direct changes to a specific industry, and the indirect and induced effects are estimated based on these defined impacts. ABP ignores the direct impacts, instead estimating the impacts of the collection of supporting industries and their connections concurrently. The specific mix of subindustries combined to model EV manufacturing effects was created using the expenditure information gathered from research and interviews. Total industry sales are allocated to each of these subindustries according to this map, and all output is conceptualized as indirect support. Additional indirect activity is created based on interactions between the supporting industries. The results give no direct impacts, but instead estimate the total indirect contributions of all subindustries. Based on data collected for this report, we were able to then separate out the direct impacts of the EV industry. Since manufacturers and operators of EV charging infrastructure are defined in the NAICS codes, their total impact was estimated using standard IMPLAN techniques.

2.3 Results

Based on the 54 survey responses received through the Oregon EV Industry Survey, NERC estimates that the economic activity from the Oregon EV industry creates 1,169 jobs, in addition to the 411 full-time jobs created directly for a total impact of 1,579 jobs. The industry generates gross economic activity of $266.56 million, total value added of nearly $148 million and provides over $89 million in total employee compensation. These numbers represent a lower-bound (minimum) of the economic activities generated by the Oregon EV industry.

Impact Summary				
Impact Type	**Employment**	**Labor Income**	**Total Value Added**	**Output**
Direct Effect	411	$18,421,793	$29,855,490	$75,994,399
Indirect Effect	517	$45,754,082	$72,062,281	$116,336,664
Induced Effect	651	$25,498,788	$45,870,654	$74,230,822
Total Effect	1,579	$89,674,663	$147,788,425	$266,561,885

Table 5 – Total Oregon Impacts

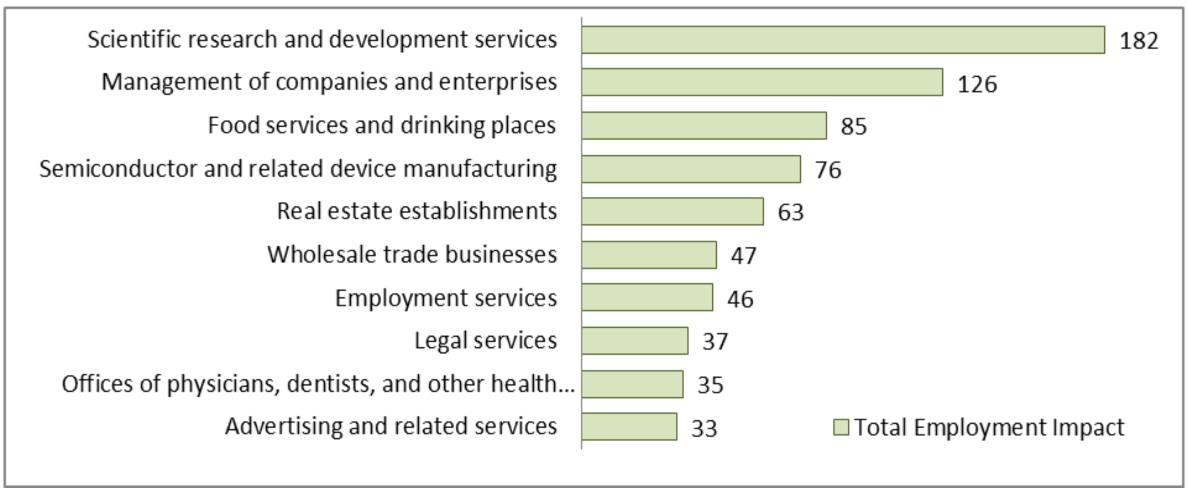


Figure 8 – Top ten affected industries by employment

Figure 8 shows the ten industries most affected by the Oregon EV industry by employment. The increase in disposable income created by new economic activity in most sectors leads to medical and entertainment expenditures. This reflects national economic spending patterns, rather than anything particular to the EV industry. In addition to the effects generated from increased income, we observe 182 jobs created in scientific research and development services and 76 jobs in semiconductor and related device manufacturing. These results are consistent with the expectation that the EV industry generates significant research and development and is closely tied with the high tech industry which may supply or support the electronic components towards EV manufacturing or grid communication with charging infrastructure.

The Oregon EV industry not only contributes to economic output and employment in the region, it also provides tax revenue to both the state and local governments and the federal government. As shown in Table 6, the industry contributes more than $30 million in taxes to all levels of government. Due to Oregon's relatively low corporate income tax burden and the upstart nature of many firms in the industry (many firms currently fall within the research and development or product prototype phases), we only observe $591,676 in corporate income taxes. The EV industry contributes nearly $3 million in personal income taxes and $8 million in indirect business taxes in Oregon. The largest portion of indirect business taxes comes from property taxes, and the remainder consists of motor vehicle registration fees, excise taxes[22] and other taxes.

Fiscal Impact - Federal Government	
Personal Income Tax	$4,694,907
Corporate Income Tax	$3,467,029
Indirect Business Tax	$1,559,347
Social Insurance Tax	$11,073,483
Total Federal Impact	$20,794,483

Fiscal Impact - State and Local Government	
Personal Income Tax	$2,992,541
Corporate Income Tax	$591,676
Indirect Business Tax	$8,166,030
Social Insurance Tax	$170,263
Total State and Local Impact	$11,920,510

Table 6 - Fiscal impacts

Oregon Department of Revenue's most recent data[23] on personal income tax withholding identified 38 firms[24] within the EV industry (excluding public agencies and educational organizations) who contributed approximately $3 million in personal income tax withholding within the last 12 months. The revenue impacts estimated in the input-output model constructed by NERC show results that are highly consistent with Oregon Department of Revenue's (DOR) personal tax withholding data. In addition, the Oregon EV industry's contribution of personal income tax withholding payments grew from 4.11% in September 2003 to 24.40% in September 2012, as a percentage of the overall transportation equipment manufacturing sector in the state (roughly excluding aerospace, railroad, ship and tank-related manufacturing)[25]. In fact, this tax data indicates that the transportation manufacturing sector has grown 5.47% compared to the EV industry's growth rate of 20.45% over the past two years. The overall tax trend also suggests relatively more stable growth in the EV industry.

[22] Oregon charges excise (consumption) tax on gasoline, telecommunication, transient lodging (hotel), tobacco, weight-miles and alcoholic beverages. Although EVs are not currently subject to gasoline taxes, business activities of EV industry participants may include the utilization of conventional vehicles, which are subject to the gasoline tax, or involve freight shipments in heavy vehicles, which are subject to the weight-mile tax.

[23] As of September 2012.

[24] A number of firms were not found within the DOR database of registered companies. In addition, public agencies and educational were excluded from this analysis along with large firms with only minimal participation within the EV industry due to the difficulty of isolating tax payments that come exclusively from EV-related activities.

[25] To compare, the Motorcycle and Bicycle Manufacturing (NAICS 336991) contributes about 6.09% in personal income tax withholding payments as a percentage of the overall transportation equipment manufacturing sector. Note that there may be some overlap of this industry with our defined EV industry, and it is a smaller industry.

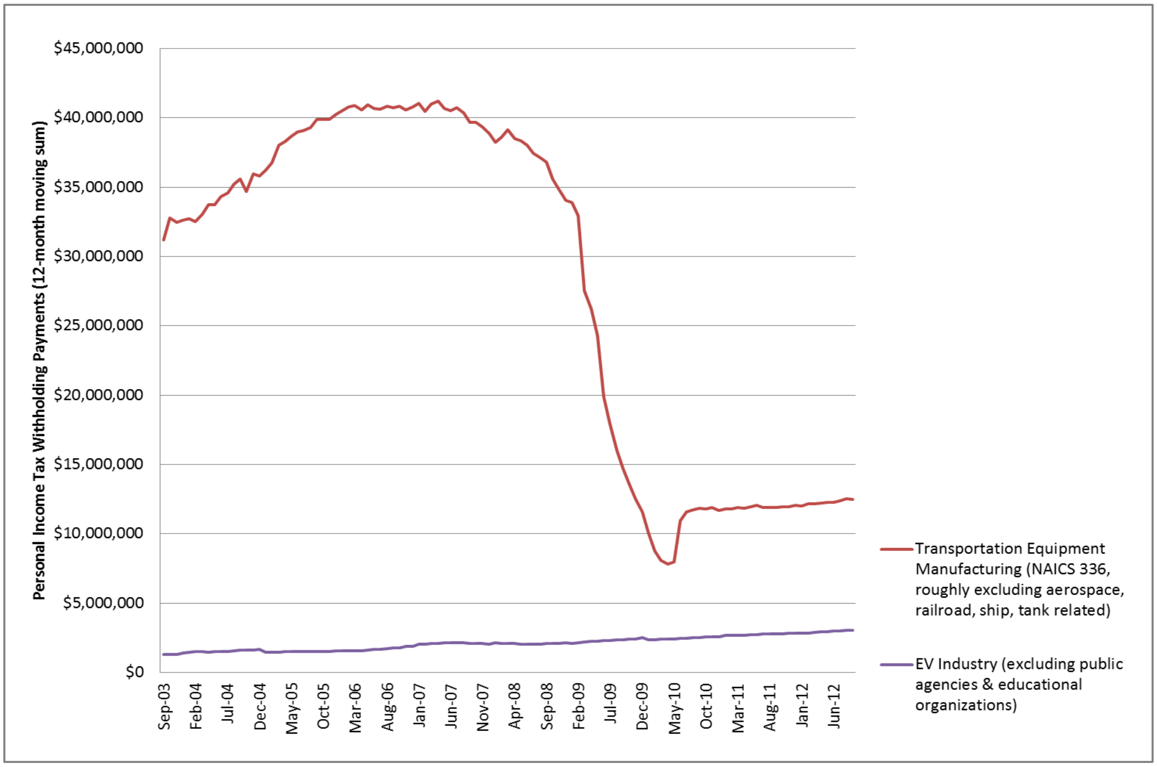


Figure 9 – Oregon personal income tax withholding payments (12-month moving sum)
(Source: Oregon Department of Revenue Research Section)

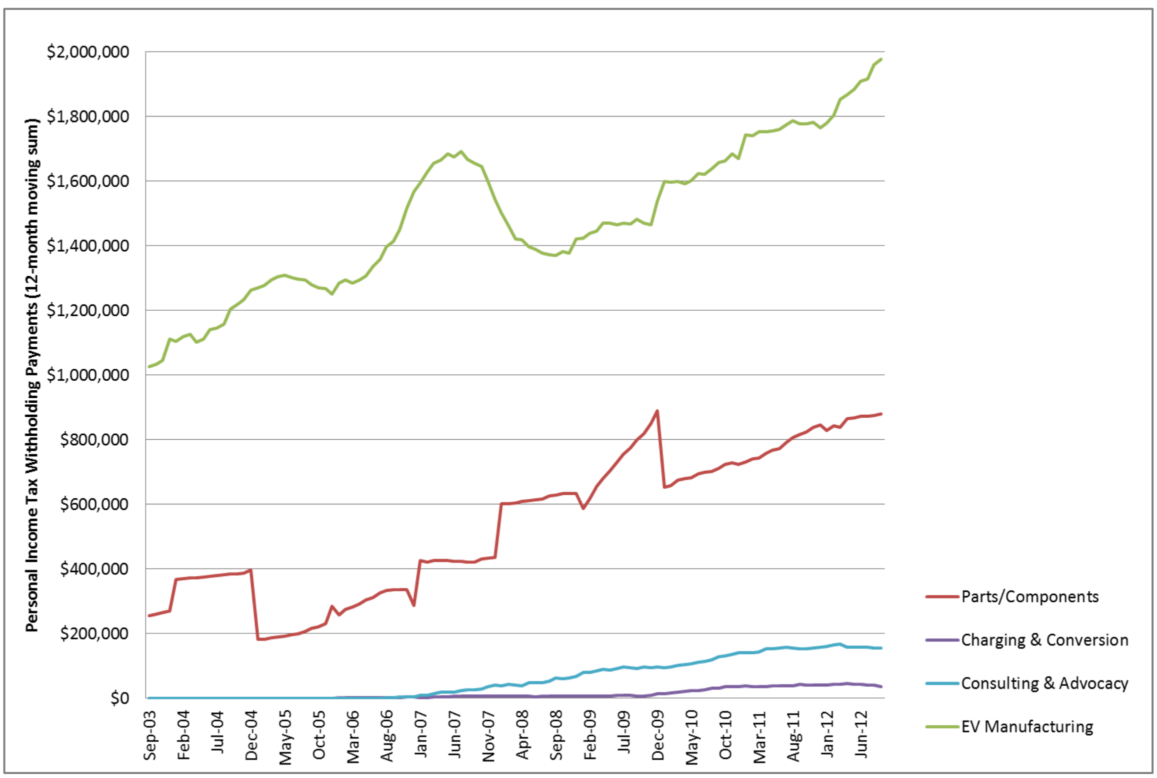


Figure 10 – Oregon personal income tax withholding payments by EV sector (12-month moving sum)
(Source: Oregon Department of Revenue Research Section)

A more detailed examination of the Oregon personal income tax withholding payments reveals that EV Manufacturing and Parts/Components are major employers within the EV industry, and have shown significant growth over the past ten years. Consulting & Advocacy and Charging & Conversion portions of the industry are newer, with withholding tax payments starting to appear in 2006. Although these two portions account for a smaller part of the industry, growth appears to be significant and stable, even through the Great Recession of 2008-2012.

2.4 Scaling of Results

Because it is unlikely that the industry survey captured 100% of the industry, we believe that the above impact estimations represent a lower-bound of the magnitude of Oregon EV industry's economic impacts. Oregon DOR's search of tax-paying entities did not identify any obvious players in this industry. NERC took an alternative approach by utilizing the supply chain section of survey responses. Within these responses, we identified 45 additional Oregon firms which are major suppliers, peers or customers of survey responders[26], including firms in the EV manufacturing, parts and components, charging infrastructure, engineering and ancillary sectors of the industry. Collaborating with the Oregon Employment Department, we obtained September 2012 employment data for 66% of these firms. The aggregate employment numbers were then scaled by the percentage of EV-related business and the percentage of EV-related business in Oregon from the survey responses, by industry sector. We estimate that there are approximately 21 additional full-time employees within the EV industry not captured by our survey.

Impact Summary (with scaling)				
Impact Type	**Employment**	**Labor Income**	**Total Value Added**	**Output**
Direct Effect	432	$19,508,289	$31,658,895	$80,258,189
Indirect Effect	543	$49,430,251	$77,888,434	$120,318,542
Induced Effect	685	$27,377,427	$49,250,288	$79,452,200
Total Effect	1,660	$96,315,968	$158,797,616	$280,028,930

Table 7 – Impact Summary with scaling

After scaling up the Oregon EV industry by 21 full-time employees, NERC estimates that the economic activity from the Oregon EV industry creates 1,228 jobs, in addition to the 432 full-time jobs created directly for a total impact of 1,660 jobs. The industry generates gross economic activity of $280.03 million, total value added of $158.80 million and provides $96.32 million in total employee compensation. The scaled up results are shown in Table 7. Furthermore, the top ten industries with increased employment resulting from the economic activities of the Oregon EV industry are identical, but with additional employment across the board (see Figure 11). Similarly, the fiscal impacts are also increased with scaling as displayed in Table 8.

[26] 17 out of 45 firms were part of NERC's original survey panel, but did not respond to the survey.

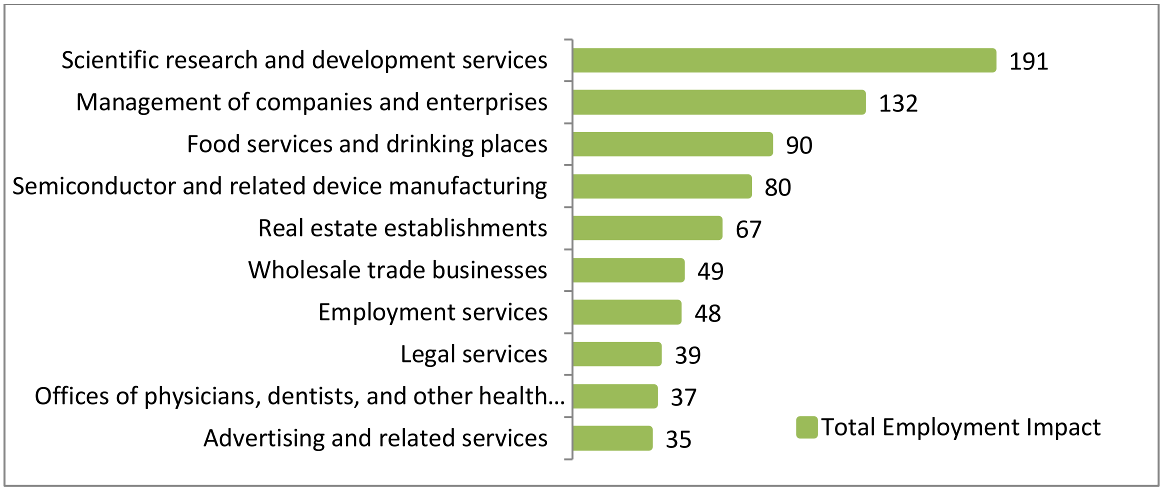


Figure 11 – Top ten affected industries by employment with scaling

Fiscal Impact - Federal Government		
	Original	**With Scaling**
Personal Income Tax	$4,694,907	$5,042,744
Corporate Income Tax	$3,467,029	$3,723,049
Indirect Business Tax	$1,559,347	$1,687,902
Social Insurance Tax	$11,073,483	$11,891,428
Total Federal Impact	$20,794,483	$22,345,123

Fiscal Impact - State and Local Government		
	Original	**With Scaling**
Personal Income Tax	$2,992,541	$3,214,253
Corporate Income Tax	$591,676	$635,368
Indirect Business Tax	$8,166,030	$8,832,362
Social Insurance Tax	$170,263	$182,821
Total State and Local Impact	$11,920,510	$12,864,804

Table 8 – Fiscal Impacts with scaling

Conclusion

The EV industry cluster in Oregon is characterized by a concentration of firms with electric vehicle manufacturing (including all types of EVs) and EV parts/components manufacturing capabilities. In addition, a number of firms are involved in various downstream activities, charging infrastructure and EV industry-supporting sectors. Despite overall stagnant growth and high unemployment in the overall economy, our analysis shows a stable EV industry experiencing significant growth in the past 2 years, particularly in vehicle and parts/components manufacturing.

Oregon's clean tech comparative advantage and skilled labor force coupled with public policies and incentives have contributed significantly to the innovation and investment on the supply side of the EV industry. The diffuse structure of the industry also contributes to the sense of optimism. Unlike the development of the ICE industry, EV's structure is horizontal. Oregon companies can benefit from the positive effect of clustering discussed in the report, and continue to serve demand in other markets. There is no one firm dominating supply chains, or cornering any aspect of the market, leaving opportunities for smaller, developing firms. On the demand side, the state's local demand for EVs has been largely ahead of the general US population. Due to this unique combination of supply and demand conditions, Oregon's EV industry currently employs more than 400 full-time equivalent employees in approximately 100 firms, totaling more than 1,600 jobs when indirect and induced impacts are also considered. The EV industry also contributes over $22 million and $12 million in tax revenues on the federal and state-local levels, respectively.

NERC's analysis represents a snapshot of the Oregon EV industry in mid-2012, establishing a baseline from which to gauge future performance of the industry. Further research may be needed to identify specific opportunities for expansion, and where public investment or policy directives may be most cost-effective.

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