IMPACT Center
WASHINGTON STATE UNIVERSITY

Wenatchee Valley Technology and Innovation Development Analysis

A Comprehensive Overview

A report by Washington State University's IMPACT Center

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Executive Summary

Between Chelan and Douglas counties, an emerging high-tech sector has been evolving. Partly due to spill over from Seattle's growth but primarily due to the natural resources and amenities, intense energy users and data centers have found the Wenatchee Valley to be the idyllic location. Citizens that have been reaping these benefits are now finding the increased demand for their region's water resources both a blessing for growth and expansion of the local tax base, but also a curse in the form of higher prices and loads on the electrical system and regional infrastructure.

This analysis provides an overview of the current market conditions, analyzes the constraints to future growth, and the economic implications of diverting energy exports to local industrial use. We find that the primary barriers to technology growth are factors of time and financial resources for infrastructure and housing expansion. Reduced energy exports result in increased local prices for electricity and may halt technology expansion. In order to keep growth above the state and national levels increased housing availability for high-tech employment needs to be expanded, not to mention increased electrical infrastructure, stable high-speed Internet, water and sewage lines, etc. Movements are underway to address all these issues. Perhaps the more time-intensive issue is one of knowledge, skills, and abilities. Limited local technological training and a shortage of technology skills in the Wenatchee Valley's labor market, will take time to address.

Several support industries are missing in the region, and growth in the primary technology industries will require growth in their support industries if the full gains to growth are to be realized. The diversion of energy for local technology use might expand regional product by between $172.3 million and $216.3 million annually. Where water has historically been more valuable as an electricity input, electricity may be becoming more valuable to the region as a technology input. Data centers in Grant county have already increased assessed property values and greatly expanded the tax base and tax revenues of the region surrounding Quincy, the benefits of which have largely been felt by the Wenatchee Valley itself.

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Introduction

In 2018, the Our Valley Our Future community building initiative determined that research surrounding the development of a technological innovation cluster should be conducted to see if the Wenatchee Valley would benefit from a technological based growth and development strategy. This growth strategy greatly benefits regions when it can be implemented successfully (Moretti 2012). This report represents the beginning research into the viability of developing the technology sector in the Wenatchee Valley and the thresholds necessary for sustaining economic growth.

In order to assess the current state of the tech sector in the Wenatchee Valley, data analysis surrounding the industrial and occupational structures that exist currently must be conducted. This includes assessing the human and physical infrastructure available for driving growth. An analysis of the region's comparative and competitive assets show the types of firms that would benefit from locating and operating in the Wenatchee Valley. A comparison of major technology hubs and the Wenatchee Valley shows where shortages or surpluses (gaps) in the local economy might exist that may prevent further technological development efforts. Lastly it is critical that reallocation of inputs drive up local productivity and prosperity. An impact analysis of the energy and technology sectors provides the primary tradeoffs and threshold values needed to create net gains for the Wenatchee Valley.

The Wenatchee Valley boasts several business and lifestyle amenities that are highly sought after by technology firms and recent research has shown that a favorable business climate is highly dependent on the types of businesses. Freeman and Piore (2012) and Salaghe et. al. (forthcoming), show that technology firms and those paying high wages prefer highly developed infrastructure, easy access to transportation and recreation, and a moderately large population base from which talent may be drawn. These regional assets are often more valuable to tech firms than low tax and incentive driven environments.

Any discussion regarding development and technology must begin by making it clear what is meant by both terms. Development, in an economic context, is not necessarily growth though it often includes growth. Development is not more "stuff," it is more value. A farmer that utilizes drone surveillance for pest and drought management, uses less fertilizer and water but allocates it more efficiently. Thus, even though less fertilizer and water are being used, they provide more value. Often this means less time in the field, and the labor itself generates more value. Often the increased value created through development results in increased consumption and investments, which in turn results in growth.

Technology is a slightly more nuanced term. In the past it may have referred to Eli Whitney's cotton gin, or Alfred Nobel's dynamite. Today it is almost exclusively used to describe computing power. Traditional combustion cars are so ubiquitous in everyday life we don't think of them as technology, but we do think of their onboard computers, wifi capabilities, energy saving break systems, etc., as technology. This concept gets convoluted when we try to identify technology-based industries. Virtually all industries utilize some level of technology. Even counselors may use online calendars, accounting software, e-payment, or web conferencing services.

In order to overcome the difficulty surrounding this first semantic hurtle it is helpful to first look at occupations, as there is a more clear delineation of what is technology laden and what is primarily labor. For example, migrant farmers that harvest apples will have almost no technological component in their job. However, a data analyst that monitors yields and harvest loss will have a limited labor component in their job. In order to identify technology-based occupations three questions should be asked.

1) *Does the occupation directly produce technology? (Programmer)*
2) *Does the occupation facilitate the use of technology by others? (IT Support)*
3) *Would the occupation exist without the technology? (Data Base Manager)*

These questions provide a sound rubric for determining if a particular occupation falls into our technology sector. Once a list of tech occupations has been identified, we can specify the tech sector in Wenatchee by using the standard occupation classification (SOC) system. We can then use Bureau of Labor Statistics industry-staffing matrices to identify the industries that primarily employ those occupations. This will allow us to rank industries by technology intensity and identify the “technology industries.” We will use the North American Industry Classification System (NAICS) for this purpose.

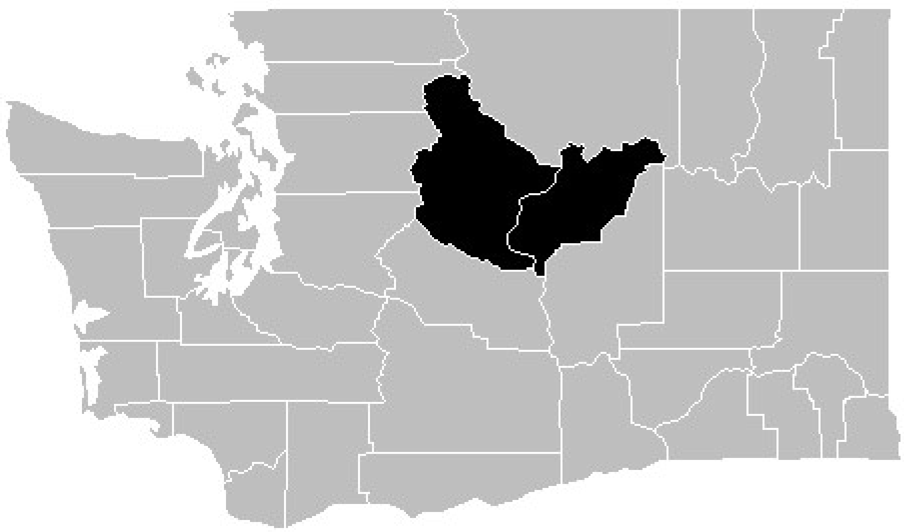
Once the NAICS codes are outlined we will use that set of industries to identify the supply chain and any support industries that would be critical for continued growth. This will also allow us to assess which industries the Wenatchee Valley has a competitive advantage in (Shift Share Analysis) and which industries provide growth opportunities for the region (Regional Industry SWOT).

Chapter 1: Regional Background and Profile

Geography

In order to rightly understand any regional analysis, it is important to first gain an understanding of the regional backdrop. Throughout this report we refer to Wenatchee-East-Wenatchee MSA as "the region" or "the Wenatchee Valley," meaning the entire MSA. Figure 1.1 provides a map of the region. We use this region because it provides a sound basis as a functional economy for which data is readily available. However, the region is based on administrative rather than economic boundaries. Quincy, for example, falls within the catchment area of the cities of Wenatchee and East-Wenatchee. This is shown in Figure 1.2 where a gravitational boundary has been calculated around the central Wenatchee cities.

Figures 1.1: *Wenatchee Valley MSA*

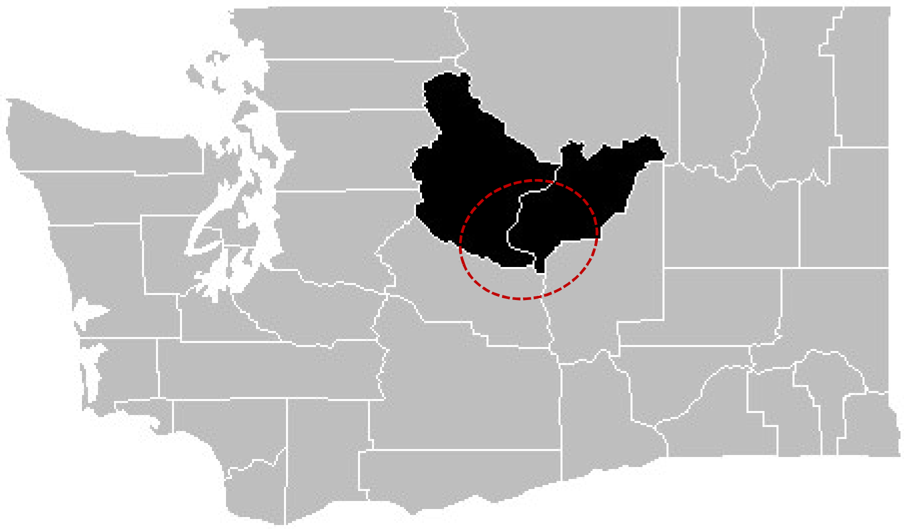


Source: U.S. Bureau of Economic Analysis

Gravity models began being used to create regional economic boundaries in the early 1930s and are still used today because of their ease of implementation and strong predictive power. However, data is collected according to administrative rather than economic boundaries and parsing the data into gravitationally defined regions is cumbersome. What should be clear from Figure 1.2 is that Quincy is within the economic scope of the Wenatchee Valley and a symbiotic relationship exists between them.

As such, focus is placed on the Wenatchee MSA, however the northern portion of Grant County (Quincy) is discussed throughout. The northern portion of Grant County provides a strategic asset to the technology sector of the Wenatchee MSA through the housing of the Quincy data farms.

Figure 1.2: *Gravitational Boundary Around Wenatchee and East Wenatchee*



Source: U.S. Bureau of Economic Analysis

Data Center Growth and Tax Revenues:

The assessed valuation of data center-related property in North Central Washington is now far greater than that of properties owned by companies in the region's agriculture and retail industries, according to an analysis by the Wenatchee Valley Business World publication. Most of the data centers are located in Grant County, and in particular Quincy. They have been attracted to the region by inexpensive power, open land, and low risk of natural disasters. The Wenatchee Valley Business World reported in its May 2019 issue the data centers' presence has brought forth a torrent of revenues for some local governments and jurisdictions. In Grant County, nine of the top 10 taxpayers are tech-related companies, such as Microsoft, Yahoo, Dell, and Sabey. (Microsoft, alone, has more than $1 billion worth of real estate and equipment in Quincy.) In Douglas County, the largest taxpayer is T-Mobile, which has a data center near Pangborn Airport. In Chelan County, there is only one small data center in Olds Station.

This growth has brought in millions of dollars in tax revenues and dropped levy rates for many taxpayers. "If they're [data centers] paying a million dollars in taxes, they're moving it off other people," Douglas County Assessor Jim Ruud told the publication. "It helps increase the tax base and it's beneficial to everybody." Other indirect benefits have followed. In Quincy, for example, the flush of cash has paid for a new fire station, library, city hall and high school. The tradeoff is power usage. Today, Grant County's seven data centers consume enough energy to power about 82,000 homes.

Growth and Industrial Profile

The Wenatchee MSA has seen substantial employment and output growth over the past decade. During that time the Wenatchee Valley grew employment 14%, while Washington state grew 13%, and the United States grew only 11%. Output per capita in the Wenatchee Valley has grown substantially faster than the state and nation since 2015. Table 1.1 shows output per capita and Table 1.2 shows the growth rate in output per capita.

Table 1.1: *Real Gross Regional Product Per Capita (2009-2018)*

Region	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
U.S.	$49,577	$50,428	$50,840	$51,603	$52,191	$53,080	$54,208	$54,660	$55,515	$56,749
Washington	$55,903	$56,541	$56,853	$58,156	$59,047	$60,310	$61,891	$63,071	$64,529	$67,242
Wenatchee	$34,566	$33,841	$33,616	$33,674	$33,071	$33,590	$35,130	$37,198	$38,514	$39,254

Source: Bureau of Economic Analysis

Table 1.2: *Growth Rate in Real Gross Regional Product Per Capita (2009-2018)*

Region	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
U.S.	-3.4%	1.7%	0.8%	1.5%	1.1%	1.7%	2.1%	0.8%	1.6%	2.2%
Washington	-4.1%	1.1%	0.6%	2.3%	1.5%	2.1%	2.6%	1.9%	2.3%	4.2%
Wenatchee	3.0%	-2.1%	-0.7%	0.2%	-1.8%	1.6%	4.6%	5.9%	3.5%	1.9%

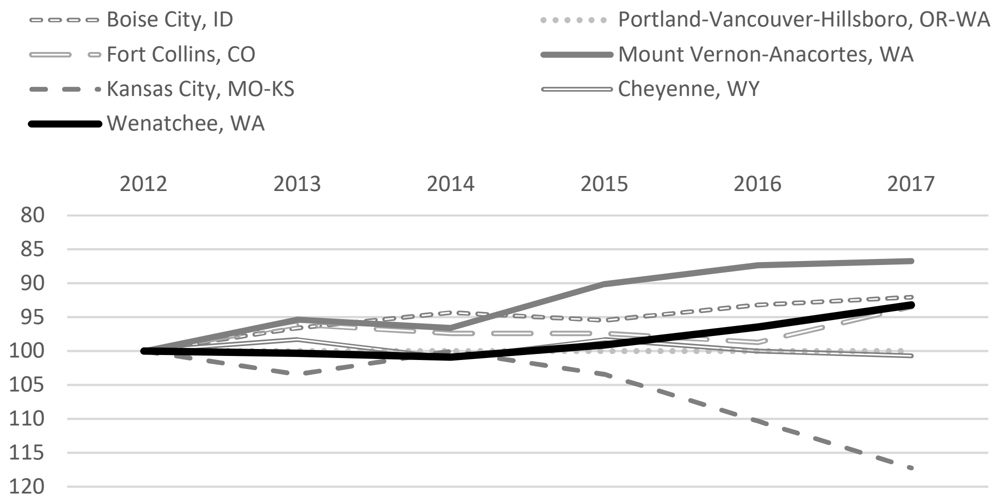
Source: Bureau of Economic Analysis

This data collected from the Bureau of Economic Analysis (BEA) shows that Wenatchee has been on an above average growth trajectory since 2015. Output per capita for the Wenatchee Valley fell between 2012 and 2013 but has matched or exceeded the national growth trajectory since then, and almost tripled the state's growth rate in 2016. The phenomenal rise in output per capita in the Valley in the last five years has led to growth in other metrics as well.

Rankings of MSAs according to their gross regional product are often provided to exhibit the standard Zipf's distribution where output of a region is inversely related to the rank of its output. Many MSAs in these distributions exhibit a static relationship with little movement over time. The New York-Newark-Jersey City, N.Y. MSA, for example, has been ranked number one for many decades. Likewise, the Sebring, FL MSA has been ranked 383rd (last) in the USA for nearly as long. Significant movement in these rankings is difficult to achieve and even harder to sustain. Figure 1.1 shows movement in select MSA rankings from 2012 through 2018. All ranks in 2012 were normalized to 100 so that the movement could be seen without being distorted by scale. The takeaway from this figure shows the large gains Wenatchee has made. Moving in rank from 337th in 2012 to 314th in 2017 might not seem like a large jump, but that puts Wenatchee in the top 11% of MSAs for rank improvement in the nation. MSAs that saw similar growth include Des Moines, IA; Salem, OR; Boise, ID; and several other well-known metropolitan regions.

Between 2008 and 2018, the Wenatchee MSA saw employment grow by 14% — from 65,191 jobs to 74,327 jobs. While agriculture remains the dominate industry in the region, growing 21% to 16,000 jobs, it was the utilities and mining industries that grew the most in percentage terms. Table 1.3 provides the Industries, according to the 2-digit North American Industrial Classification Standards (NAICS) codes. Column one provides the 2-digit NAICS code and column two provides the industry description. Columns three through six provide the 2008 employment, 2018 employment, the change in employment and percent change in employment respectively.

Figure 1.1: *Percent Change in MSA Output Rankings (2012-2018)*



Source: Bureau of Economic Analysis

Table 1.3 provides a reasonable starting point for understanding the economy. However, it does not properly illustrate the strengths or weaknesses in the economy. We can see, for example, that construction employment fell by 7% over the past decade. What we cannot tell from the data is if that fall was because of national trends affecting the local industry. Perhaps construction employment in the rest of the nation fell by 10%. This would suggest that Wenatchee's construction sector was stronger locally than construction nationally. Agricultural industries are losing employment nationally but gaining regionally. This indicates that the region provides a competitive advantage for agriculture. It becomes important when analyzing industries to first understand what industrial sectors the region has a competitive advantage in, and where industrial growth is just meeting or falling short of expectations. Table 1.4 provides such an assessment. Regional economists call the comparison of actual growth to expectations of growth Shift Share Analysis.

Table 1.3: *Industry Employment Change (2008-2018)*

NAICS	Description	2008 Jobs	2018 Jobs	2008 - 2018 Change	2008 - 2018 % Change
11	Agriculture, Forestry, Fishing and Hunting	13,258	16,001	2,743	21%
21	Mining, Quarrying, and Oil and Gas Extraction	167	265	98	59%
22	Utilities	43	69	26	60%
23	Construction	4,109	3,838	(271)	(7%)
31	Manufacturing	2,415	2,749	334	14%
42	Wholesale Trade	2,180	2,914	734	34%
44	Retail Trade	7,091	7,324	233	3%
48	Transportation and Warehousing	1,392	1,035	(357)	(26%)
51	Information	623	680	57	9%
52	Finance and Insurance	1,684	2,056	372	22%
53	Real Estate and Rental and Leasing	2,938	3,406	468	16%
54	Professional, Scientific, and Technical Services	2,326	2,775	449	19%
55	Management of Companies and Enterprises	60	63	3	5%
56	Administrative and Support and Waste Management and Remediation Services	1,755	2,341	586	33%
61	Educational Services	409	572	163	40%
62	Health Care and Social Assistance	6,393	7,964	1,571	25%
71	Arts, Entertainment, and Recreation	1,433	1,486	53	4%
72	Accommodation and Food Services	4,793	6,243	1,450	30%
81	Other Services (except Public Administration)	2,873	2,738	(135)	(5%)
90	Government	9,248	9,809	561	6%
00	**Total**	**65,191**	**74,327**	**9,136**	**14%**

Source: EMSI 2019.2

Table 1.4 takes another look at the industries by controlling for each industry's national growth profile (Industrial Mix Effect) and national growth as a whole (National Growth Effect). Expected changes in regional employment as gauged by the sum of industrial mix and national growth effects are reported in column five. The difference between the expected change and the actual change determines the region's strengths and is captured by the competitive effect in column six. These industries begin to show us the driving or pillar industries in the region.

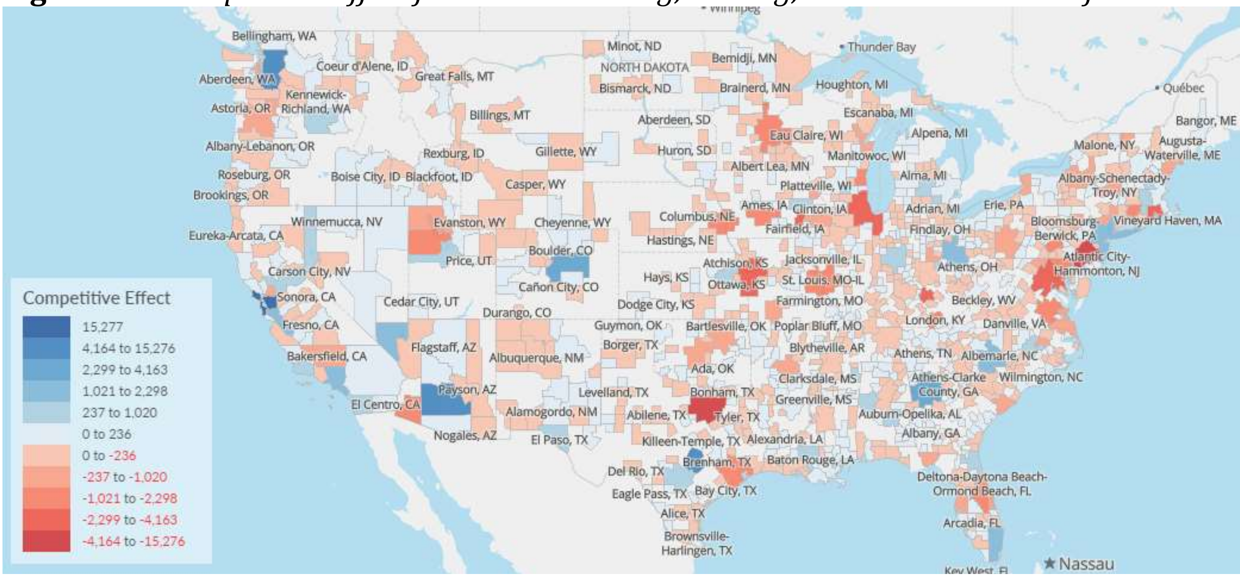
Table 1.4: *Industry Shift Share Analysis (2008-2018)*

NAICS	Description	Ind. Mix Effect	Nat'l Growth Effect	Expected Change	2008 - 2018 Change	Competitive Effect
11	Agriculture, Forestry, Fishing and Hunting	(1,299)	1,469	170	2,743	2,573
21	Mining, Quarrying, and Oil and Gas Extraction	36	19	55	98	43
22	Utilities	1	5	6	26	20
23	Construction	(403)	455	52	(271)	(323)
31	Manufacturing	(349)	268	(81)	334	415
42	Wholesale Trade	(263)	242	(21)	734	756
44	Retail Trade	(509)	786	277	233	(43)
48	Transportation and Warehousing	393	154	547	(357)	(905)
51	Information	(87)	69	(18)	57	75
52	Finance and Insurance	110	187	297	372	75
53	Real Estate and Rental and Leasing	326	326	652	468	(183)
54	Professional, Scientific, and Technical Services	107	258	365	449	84
55	Management of Companies and Enterprises	13	7	20	3	(17)
56	Administrative and Support and Waste Management and Remediation Services	53	195	248	586	338
61	Educational Services	60	45	105	163	57
62	Health Care and Social Assistance	722	709	1,431	1,571	140
71	Arts, Entertainment, and Recreation	119	159	278	53	(225)
72	Accommodation and Food Services	510	531	1,041	1,450	409
81	Other Services (except Public Administration)	(35)	318	283	(135)	(419)
90	Government	(1,059)	1,025	(34)	561	594
0	**Total**	**(1,554)**	**7,225**	**5,671**	**9,136**	**3,464**

Source: EMSI 2019.2

Figure 1.2 shows the competitive effect for the six-digit NAICS code 518210 Data Processing, Hosting, and Related Services. This is a key technology industry in the Wenatchee Valley. Wenatchee had the 66th highest competitive effect for this industry out of a total of 926 metropolitan and micropolitan statistical areas. The Urbana-Champaign, Rochester, and Bellingham MSAs all had competitive effects clustered around Wenatchee for this industry. A clearer way to see this information is through the use of a Regional Industry SWOT analysis, which will be provided in chapter two of the report.

Figure 1.2: *Competitive Effect for Data Processing, Hosting, and Related Services for all MSAs*



Source: EMSI 2019.2

Occupational profile

Tables 1.5 and 1.6 show the employment change and shift share analysis for the two-digit occupations in the Wenatchee Valley. These occupations are captured using the department of labor Standard Occupation Classification system typically referred to as SOCs. In chapter two of the report we focus on the high-tech occupations that are of interest. A key point from Table 1.5 is that there are very few two-digit occupations that are in decline. Table 1.6 shows that even though there is growth several occupation categories are not competitive locally.

Table 1.5: *Occupational Employment Change (2008-2018)*

SOC	Description	2008 Jobs	2018 Jobs	2008 - 2018 Change	2008 - 2018 % Change	Median Annual Earnings
11-0000	Management Occupations	5,516	6,495	979	18%	$53,039
13-0000	Business and Financial Operations Occupations	2,301	2,891	590	26%	$61,707
15-0000	Computer and Mathematical Occupations	507	756	249	49%	$59,900
17-0000	Architecture and Engineering Occupations	585	658	73	12%	$65,004
19-0000	Life, Physical, and Social Science Occupations	733	860	127	17%	$48,652
21-0000	Community and Social Service Occupations	759	851	92	12%	$45,794
23-0000	Legal Occupations	281	315	34	12%	$66,076
25-0000	Education, Training, and Library Occupations	2,853	3,442	589	21%	$43,637
27-0000	Arts, Design, Entertainment, Sports, and Media Occupations	1,389	1,770	381	27%	$30,613
29-0000	Healthcare Practitioners and Technical Occupations	2,446	3,325	879	36%	$71,300
31-0000	Healthcare Support Occupations	1,800	1,966	166	9%	$30,830
33-0000	Protective Service Occupations	844	943	99	12%	$46,524
35-0000	Food Preparation and Serving Related Occupations	4,278	5,617	1,339	31%	$25,190
37-0000	Building and Grounds Cleaning and Maintenance Occupations	2,845	3,038	193	7%	$26,601
39-0000	Personal Care and Service Occupations	2,451	2,572	121	5%	$26,914
41-0000	Sales and Related Occupations	8,006	8,724	718	9%	$31,725
43-0000	Office and Administrative Support Occupations	7,101	7,370	269	4%	$34,905
45-0000	Farming, Fishing, and Forestry Occupations	6,793	7,786	993	15%	$26,462
47-0000	Construction and Extraction Occupations	3,488	3,337	(151)	(4%)	$37,209
49-0000	Installation, Maintenance, and Repair Occupations	2,434	2,730	296	12%	$43,339
51-0000	Production Occupations	2,222	2,526	304	14%	$34,162
53-0000	Transportation and Material Moving Occupations	5,347	6,156	809	15%	$30,788
55-0000	Military-only occupations	179	158	(21)	(12%)	$41,628
00-0000	**Total**	**65,191**	**74,327**	**9,136**	**14%**	**$37,894**

Source: EMSI 2019.2

Table 1.6: *Occupational Shift Share Analysis (2008-2018)*

SOC	Description	Occ. Mix Effect	Nat'l Growth Effect	Expected Change	2008 - 2018 Change	Competitive Effect
11-0000	Management Occupations	537	611	1,148	979	(169)
13-0000	Business and Financial Operations Occupations	247	255	502	590	88
15-0000	Computer and Mathematical Occupations	89	56	145	249	104
17-0000	Architecture and Engineering Occupations	(49)	65	16	73	57
19-0000	Life, Physical, and Social Science Occupations	(21)	81	60	127	66
21-0000	Community and Social Service Occupations	9	84	93	92	(1)
23-0000	Legal Occupations	3	31	34	34	1
25-0000	Education, Training, and Library Occupations	(113)	316	203	589	386
27-0000	Arts, Design, Entertainment, Sports, and Media Occupations	129	154	283	381	97
29-0000	Healthcare Practitioners and Technical Occupations	240	271	511	879	368
31-0000	Healthcare Support Occupations	(14)	200	186	166	(20)
33-0000	Protective Service Occupations	(29)	94	65	99	34
35-0000	Food Preparation and Serving Related Occupations	311	474	785	1,339	554
37-0000	Building and Grounds Cleaning and Maintenance Occupations	(156)	315	159	193	33
39-0000	Personal Care and Service Occupations	592	272	864	121	(742)
41-0000	Sales and Related Occupations	(292)	887	595	718	122
43-0000	Office and Administrative Support Occupations	(873)	787	(86)	269	355
45-0000	Farming, Fishing, and Forestry Occupations	646	753	1,399	993	(406)
47-0000	Construction and Extraction Occupations	(465)	387	(78)	(151)	(72)
49-0000	Installation, Maintenance, and Repair Occupations	(105)	270	165	296	131
51-0000	Production Occupations	(321)	246	(75)	304	378
53-0000	Transportation and Material Moving Occupations	590	593	1,183	809	(374)
55-0000	Military-only occupations	(37)	20	(17)	(21)	(4)
00-0000	**Total**	**951**	**7,225**	**8,176**	**9,136**	**959**

Source: EMSI 2019.2

Educational Attainment

Technology, especially the current state of technology, is inherently the result of human capital and abstract reasoning abilities. As such, educational attainment and the ability to be entrepreneurial are key to technological development and industry growth. Two aspects of technological growth and development for an economy are educational attainment and skills transferability. For example, there is a serious overlap in the HVAC needs of fruit storage and data storage. That knowledge and skills transferability is key in the overlap of both industries' labor supply chains.

Table 1.7 outlines the percentage of the population 25 and over by each education level. The age restriction was chosen by the Census Bureau as a reasonable indication of the education level of the workforce. What is of concern for us is that Wenatchee tends to be weighted towards the lower end of the educational spectrum and may not at present have the abstract reasoning skills needed to grow the technology sector.

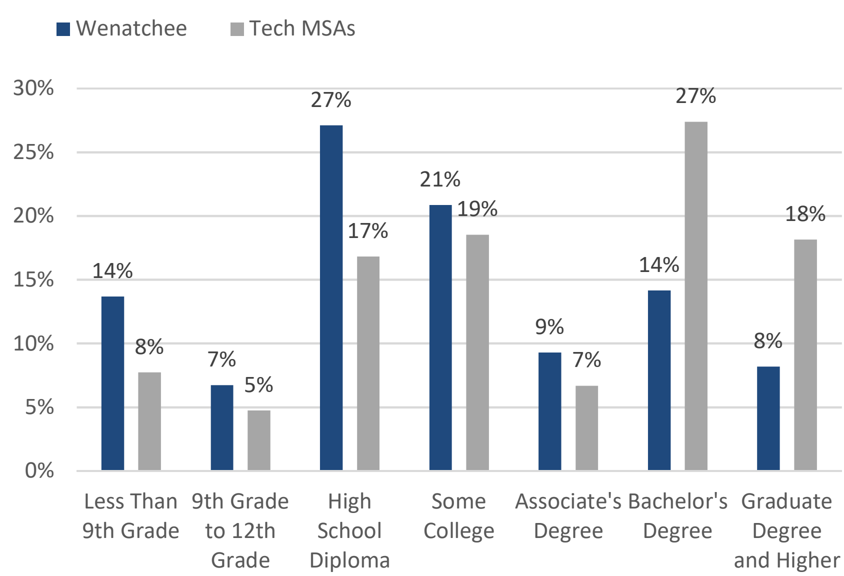
Table 1.7: *Educational Attainment by Education Level, Region, State, and Nation (2018)*

Education Level	2018 Wenatchee % Population	2018 State % Population	2018 National % Population
Less Than 9th Grade	14%	5%	7%
9th Grade to 12th Grade	7%	5%	7%
High School Diploma	27%	23%	28%
Some College	21%	24%	21%
Associate degree	9%	10%	8%
Bachelor Degree	14%	21%	19%
Graduate Degree and Higher	8%	12%	11%

Source: EMSI 2019.2

In order for the technology sector to grow the distribution of the working population will need to start moving towards the higher end of the education spectrum. Three of the most technologically oriented MSAs are Austin-Round Rock-Georgetown, TX; San Francisco-Oakland-Berkeley, CA; and San Jose-Sunnyvale-Santa Clara, CA. If we compare their collective educational attainment levels to the U.S. and Wenatchee, the distribution is more clearly weighted towards the high end of the educational spectrum. Figure 1.3 shows the distinction between Wenatchee and the three major tech MSAs listed above.

Figure 1.3: *Educational Attainment Distributions for Wenatchee and Major Tech MSAs*



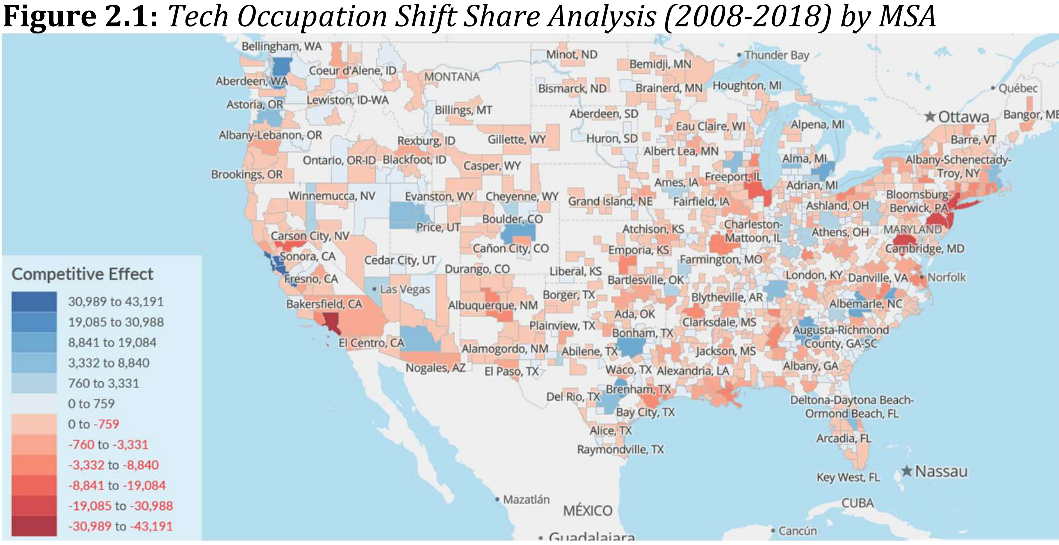
Source: EMSI 2019.2

Chapter 2: Defining the Technology Sector, Technology Intensity, and Key Technology Industries

We use the CompTIA tech occupations[1] to describe the tech sector in the Wenatchee Valley. CompTIA categorizes these occupations as IT; Engineering; Engineering and Audio/Video Technicians; Computer Operations; Electrical, Electronic, and Computer Installers and Repairers; Electrical, Electronics, and Electromechanical Assemblers; and Computer-Controlled Machine Programmers and Operators. This report does not utilize those seven categorical distinctions because our goal is to establish the presence of those occupations in the local industries. The Shift Share analysis for the technology occupations is outlined in Table 2.1 below.

These occupations are flourishing in the Wenatchee area. Figure 2.1 shows the competitive effect of these occupations throughout the United States by MSA. One interesting point here is that the competitive effect of the technology occupations in Wenatchee yields a value of 196, while the same measure in the Boise MSA is -681. Wenatchee is much smaller than Boise in terms of tech employment. However, the growth in the Valley's tech occupations greatly exceeds expectations while growth in Boise tech occupations is below expectation.

Figure 2.1: *Tech Occupation Shift Share Analysis (2008-2018) by MSA*



Source: EMSI 2019.2

Someone might ask why we don't directly utilize the CompTIA technical industry descriptions. The answer comes in two parts. First, a great many of the industries described by CompTIA as "tech oriented" do not currently exist in the Wenatchee Valley. Second, many of the technology occupations in the Wenatchee Valley are employed in industries that CompTIA neglects as tech industries. Appendix 4 shows the industry codes and descriptions from both CompTIA's Tech industry list and the set of industries used for our analysis.

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[1] CompTIA Cyberstates 2018™: the definitive national state, and city analysis of the U.S. tech industry and tech workforce.

Table 2.1: *Tech Occupation Shift Share Analysis (2008-2018)*

SOC	Description	Occ. Mix Effect	Nat'l Growth Effect	Expected Change	2008 - 2018 Change	Competitive Effect
11-3021	Computer and Information Systems Managers	10	4	14	24	10
11-9041	Architectural and Engineering Managers	(1)	2	1	2	1
15-1111	Computer and Information Research Scientists	(1)	2	1	6	5
15-1121	Computer Systems Analysts	5	8	13	30	17
15-1122	Information Security Analysts	6	1	7	Insf. Data	4
15-1131	Computer Programmers	(29)	7	(22)	(15)	6
15-1132	Software Developers, Applications	26	4	30	37	7
15-1133	Software Developers, Systems Software	(2)	3	1	12	10
15-1134	Web Developers	14	3	17	19	2
15-1141	Database Administrators	(2)	2	0	5	5
15-1142	Network and Computer Systems Administrators	(1)	9	8	26	18
15-1143	Computer Network Architects	4	3	7	11	5
15-1151	Computer User Support Specialists	30	9	39	62	22
15-1152	Computer Network Support Specialists	6	2	8	15	7
15-1199	Computer Occupations, All Other	11	3	14	22	8
17-2011	Aerospace Engineers	(1)	1	0	Insf. Data	3
17-2031	Biomedical Engineers	0	0	0	Insf. Data	2
17-2061	Computer Hardware Engineers	(1)	1	0	Insf. Data	(1)
17-2071	Electrical Engineers	2	2	4	24	20
17-2072	Electronics Engineers, Except Computer	(9)	7	(2)	16	18
17-2112	Industrial Engineers	3	2	5	12	6
17-2131	Materials Engineers	0	0	0	Insf. Data	(0)
17-2141	Mechanical Engineers	5	3	8	17	9
17-2199	Engineers, All Other	(9)	4	(5)	6	11
17-3021	Aerospace Engineering and Operations Technicians	0	0	0	Insf. Data	(0)
17-3023	Electrical and Electronics Engineering Technicians	(7)	3	(4)	(2)	2
17-3024	Electro-Mechanical Technicians	(0)	0	0	Insf. Data	(0)
17-3026	Industrial Engineering Technicians	(1)	1	0	Insf. Data	1
17-3027	Mechanical Engineering Technicians	(0)	0	0	Insf. Data	1
17-3029	Engineering Technicians, Except Drafters, All Other	(1)	1	0	(1)	(1)
27-4011	Audio and Video Equipment Technicians	5	1	6	6	(0)
27-4012	Broadcast Technicians	(1)	1	0	Insf. Data	1
27-4014	Sound Engineering Technicians	(1)	0	(1)	Insf. Data	(1)
43-9011	Computer Operators	(10)	2	(8)	(8)	(1)

49-2011	Computer, Automated Teller, and Office Machine Repairers	(11)	5	(6)	1	7
49-2021	Radio, Cellular, and Tower Equipment Installers and Repairs	1	0	1	Insf. Data	1
49-2022	Telecommunications Equipment Installers and Repairers, Except Line Installers	1	3	4	12	8
49-2091	Avionics Technicians	(1)	1	0	Insf. Data	(0)
49-2092	Electric Motor, Power Tool, and Related Repairers	(2)	0	(2)	Insf. Data	(1)
49-2093	Electrical and Electronics Installers and Repairers, Transportation Equipment	(1)	0	(1)	Insf. Data	1
49-2094	Electrical and Electronics Repairers, Commercial and Industrial Equipment	(12)	6	(6)	6	13
49-2095	Electrical and Electronics Repairers, Powerhouse, Substation, and Relay	0	0	0	Insf. Data	1
49-2096	Electronic Equipment Installers and Repairers, Motor Vehicles	(3)	1	(2)	Insf. Data	(1)
49-2097	Electronic Home Entertainment Equipment Installers and Repairers	(5)	1	(4)	Insf. Data	(1)
49-2098	Security and Fire Alarm Systems Installers	5	3	8	5	(2)
51-2021	Coil Winders, Tapers, and Finishers	(1)	0	(1)	Insf. Data	3
51-2028	Electrical, Electronic, and Electromechanical Assemblers, Except Coil Winders, Tapers, and Finishers	(4)	3	(1)	6	6
51-4011	Computer-Controlled Machine Tool Operators, Metal and Plastic	(1)	2	1	1	0
51-4012	Computer Numerically Controlled Machine Tool Programmers, Metal and Plastic	0	0	0	Insf. Data	0

Source: EMSI 2019.2

In order to map these occupations to their associated industries in the local economy we utilize a detailed staffing matrix developed nationally by the Bureau of Labor Statistics. It is calibrated to the local economy using a regionalization technique implemented by Economic Modeling Specialists International. Appendix 3 provides the 2-digit SOC code mapping for data processing, hosting, and related services industry as an example of how industries employ occupations at different rates. The staffing matrix is designed to see how occupations are distributed among various industries. Total technology occupations in an industry divided by total industry employment yields the technological intensity in an industry.

As was stated earlier, technology is endemic in all industries. Industries with a 15% or higher tech-intensity are captured as a technology-oriented. Having identified both the CompTIA and domestic technology-oriented industries, we are able to conduct a technology industry SWOT (Strength, Weaknesses, Opportunities, and Costs) analysis.

In this analysis we look at the concentration of each industry regionally and compare it to the concentration of the industry nationally. If an industry has a concentration higher than one it is more concentrated regionally than it is nationally, suggesting a regional competitive effect. If the concentration is growing for an industry with an already high concentration the industry represents a strength for the regional economy. A highly concentrated industry that is becoming less concentrated is a threat, as it acts as a pillar of the economy but is beginning to show signs of collapse. An opportunity for the region is defined by an industry that is under concentrated regionally but growing. A weakness refers to an under concentrated industry that is shrinking.

Table 2.2: *Industry Technology Intensity*

NAICS	Description	TOTAL Tech Employment	Total Industry Employment	Technology Intensity
541512	Computer Systems Design Services	51	77	66%
541519	Other Computer Related Services	41	62	66%
541511	Custom Computer Programming Services	14	20	66%
335311	Power, Distribution, and Specialty Transformer Manufacturing	44	74	59%
334417	Electronic Connector Manufacturing	85	157	54%
334519	Other Measuring and Controlling Device Manufacturing	27	54	50%
518210	Data Processing, Hosting, and Related Services	49	101	48%
517312	Wireless Telecommunications Carriers (except Satellite)	28	64	43%
517311	Wired Telecommunications Carriers	39	89	43%
811212	Computer and Office Machine Repair and Maintenance	8	17	43%
561621	Security Systems Services (except Locksmiths)	8	24	32%
541330	Engineering Services	24	97	24%
423420	Office Equipment Merchant Wholesalers	5	24	22%
336411	Aircraft Manufacturing	12	58	21%
333993	Packaging Machinery Manufacturing	34	216	16%
333922	Conveyor and Conveying Equipment Manufacturing	4	29	16%
541380	Testing Laboratories	3	19	15%
551112	Offices of Other Holding Companies	3	18	15%
551114	Corporate, Subsidiary, and Regional Managing Offices	6	39	15%

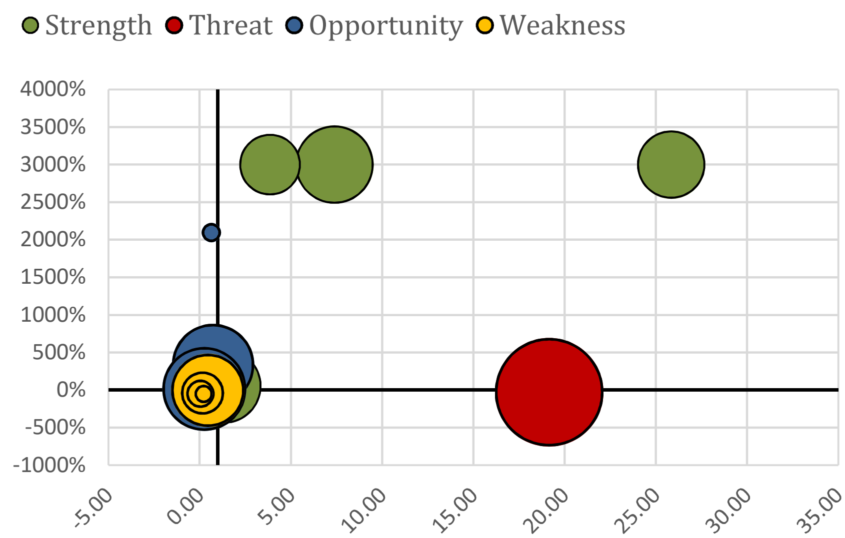
Source: EMSI 2019.2

Before such a SWOT can be conducted, the concept of location quotient (LQ) must be discussed. An LQ is a measure of the concentration of an industry relative to the national average. If an industry is highly concentrated in a region it will have an LQ greater than 1. If it is as concentrated as the national average it will be equal to 1, and if it is less concentrated it will be less than 1. Equation 1 shows the equation for calculating the LQ.

$$LQ = \left(\frac{E_{i,r}}{E_r}\right) \Big/ \left(\frac{E_{i,N}}{E_N}\right) \quad (1)$$

Here E stands for employment and is indexed by the industry, i, and region or nation, r or N respectively. If no industry is identified as is the case in the denominators of each fraction, then total employment is assumed. Tracing the changes in LQ over time allows us to identify the industries that are growing or declining in concentration. Industries that have increasing concentration, like those with a positive competitive effect, are industries for which the region demonstrates a competitive advantage. Figure 2.2 shows the SWOT chart for the tech industries outlined in Table 2.1. To read Figure 2.2 anything in the first quadrant is labeled green and represents a tech industry with a strong presence in the Wenatchee Valley (i.e., it has an LQ greater than one and the LQ is growing). The size of each bubble represents the volume of tech employment for the industry. The weak technology industries in the region are those with an LQ less than one and falling. Weaknesses are represented as yellow bubbles. The tech industries representing an opportunity to the region are those with an LQ less than one, but where the LQ is growing. Opportunities are represented by the blue bubbles. Lastly, there is only one weak technology industry from a concentration standpoint. Electronic Connector Manufacturing represents a threat to the economy because it is relatively large, employing 85 technology driven jobs. But the industry is losing concentration relative to the nation.

Figure 2.2: *SWOT of tech industries in the Wenatchee Valley*



Source: EMSI 2019.2

Often the strength industries are referred to as economic drivers or economic pillars of the economy. They provide larger than average employment within the region and continue to gain prominence and influence. When those pillars start to decline in output or employment, regional economists become warry that this pillar may be going through a structural change. That poses a threat to economic stability. This is not always the case. It may be that the industry is stable and growing but that other regions in the nation are causing employment in the industry to grow more rapidly than in the local economy. In that case the economy is sound, but, losing a competitive edge that it once had.

Weaknesses are industries that exist in the economy but provide little employment and continually decline in importance to the region's overall health. Building up these tech sectors is often very costly and generates little in terms of external benefits. Often public investments must continually be made to sustain these industries. Opportunities are the industries that are small but moving towards becoming pillars. Several categories stand out in the Wenatchee Valley as moving in that direction — for example, Data Processing, Hosting, and Related Services; Computer System Design Services; and Engineering Services.

Table 2.3: *SWOT of tech industries in the Wenatchee Valley*

SWOT Class	NAICS	Description	TOTAL Tech Employment	2018 Location Quotient	Change in Location Quotient
Strength	333993	Packaging Machinery Manufacturing	34	25.84	3000%
Strength	335311	Power, Distribution, and Specialty Transformer Manufacturing	44	7.39	3000%
Strength	334519	Other Measuring and Controlling Device Manufacturing	27	3.86	3000%
Strength	517312	Wireless Telecommunications Carriers (except Satellite)	28	1.22	256%
Strength	811212	Computer and Office Machine Repair and Maintenance	8	1.16	180%
Strength	333922	Conveyor and Conveying Equipment Manufacturing	4	2.44	91%
Strength	541519	Other Computer Related Services	41	1.33	54%
Weakness	517311	Wired Telecommunications Carriers	39	0.45	-4%
Weakness	561621	Security Systems Services (except Locksmiths)	8	0.37	-29%
Weakness	517911	Telecommunications Resellers	2	0.44	-37%
Weakness	541511	Custom Computer Programming Services	14	0.16	-40%
Weakness	551114	Corporate, Subsidiary, and Regional Managing Offices	6	0.04	-49%
Weakness	519130	Internet Publishing and Broadcasting and Web Search Portals	2	0.22	-51%
Opportunity	551112	Offices of Other Holding Companies	3	0.64	2096%
Opportunity	518210	Data Processing, Hosting, and Related Services	49	0.74	335%
Opportunity	336411	Aircraft Manufacturing	12	0.72	219%
Opportunity	423420	Office Equipment Merchant Wholesalers	5	0.82	191%
Opportunity	511210	Software Publishers	5	0.12	86%
Opportunity	541380	Testing Laboratories	3	0.31	33%
Opportunity	541512	Computer Systems Design Services	51	0.26	15%
Opportunity	541330	Engineering Services	24	0.36	0%
Threat	334417	Electronic Connector Manufacturing	85	19.16	-28%

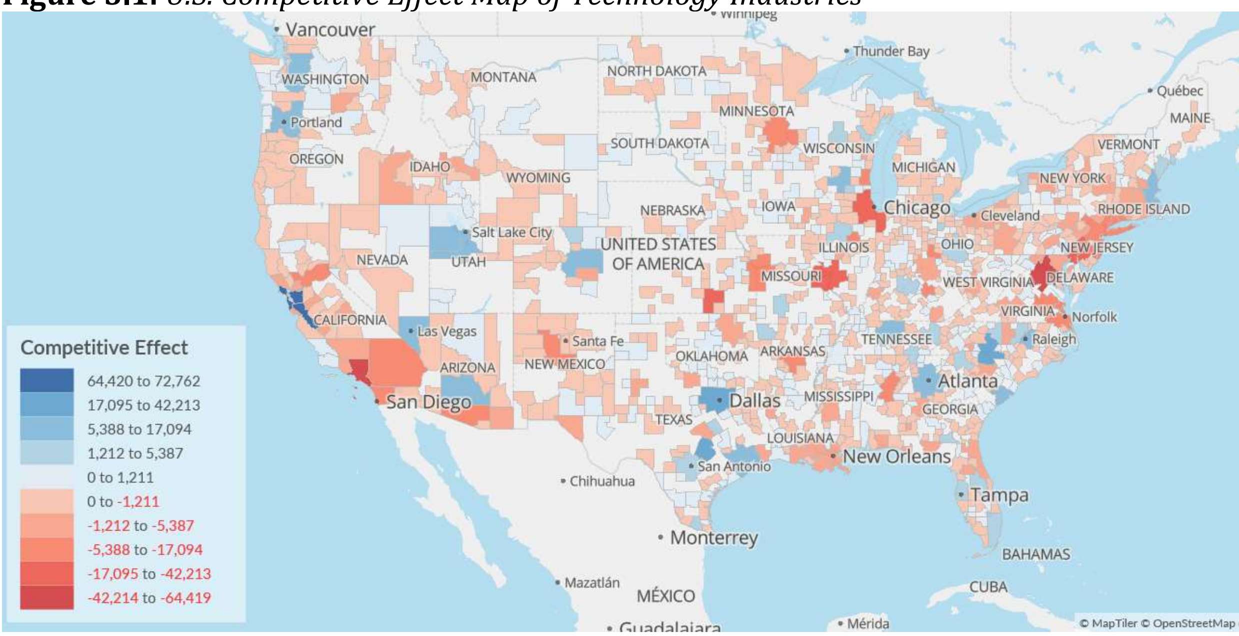
Source: EMSI 2019.2

Chapter 3: Regional Comparison

In order to define peer regions for comparison, we use the tech industries defined in the previous chapter and compare the competitive effects by MSA. It does not make sense to compare Wenatchee today with San Francisco. Not only because the regions differ so greatly in size but because their industrial makeup is so different. Wenatchee has a total competitive effect for their key technology industries of 403. This falls within the 0-1,211 competitive effect decile. It is within that decile that we look for peer MSAs for comparison.

Part of the rational for using deciles is that it provides attainable goals. It is not currently feasible for Wenatchee to seek to become San Francisco because San Francisco's competitive effect for the identified tech industries (72,762) is approximately the size of Wenatchee's entire workforce. However, comparing the Wenatchee Valley to Fort Collins, CO (1,288) or Knoxville, TN (1,266) is not out of the question. Figure 3.1 provides the U.S. Competitive Effect Map for the Tech industries Identified in Table 2.2.

Figure 3.1: *U.S. Competitive Effect Map of Technology Industries*



Source: EMSI 2019.2

Figure 3.1 provides a good visual for regions similar to the Wenatchee Valley, but the data is more helpful. Table 3.1 provides the associated Shift Share results for select MSA's similar to the Wenatchee Valley. If we think of the Shift Share in terms of efficiency, defined here as the competitive effect of the tech industry divided by total regional employment, Wenatchee is near the top of the list, only surpassed by Pueblo, CO. Another way to look at this is to say that in order to move from where the Wenatchee Valley is currently to where Pueblo is, the competitive effect needs to grow by 36 percent while employment only needs to grow by 23 percent. Holding the ratio of the competitive effect and employment level constant would set the Wenatchee Valley on a trajectory not unlike Ames, IA, which has double the employment and double the competitive effect of the Wenatchee Valley.

Table 3.1: *Shift Share Analysis in Selected Regions for Tech Industries*

MSA Name	2018 Jobs	Ind. Mix Effect	Nat'l Growth Effect	Expected Change	Competitive Effect
Columbus, OH	81,064	5,934	7,314	13,248	1,826
Fort Collins, CO	9,468	613	755	1,368	1,288
Knoxville, TN	21,625	1,525	1,879	3,404	1,266
Ames, IA	3,211	175	216	391	873
San Luis Obispo-Paso Robles, CA	5,441	344	425	769	841
College Station-Bryan, TX	3,689	228	282	510	639
St. George, UT	2,182	121	149	270	572
Burlington-South Burlington, VT	7,382	510	629	1,139	570
Pueblo, CO	1,851	98	120	218	547
Bend, OR	3,951	257	317	574	517
Asheville, NC	5,846	406	500	906	430
Wenatchee, WA	**1,509**	**83**	**102**	**185**	**403**
Monroe, LA	4,950	347	428	775	312
Cheyenne, WY	1,854	120	147	267	257
Boise City, ID	16,282	1,343	1,655	2,998	(1,644)

Source: EMSI 2019.2

Pueblo, CO has been seeing technology growth through several initiatives in transportation, wind turbine manufacturing, testing of Amtrak's electric trains, etc. In addition, Pueblo Community College is partnering with NextEra Energy to start a program in solar technology. UTC Aerospace Systems has been expanding their carbon break manufacturing facilities in Pueblo as well. In many ways Pueblo has been a leader in moving from a one-industry town focused on their steel mill to a multi-faceted technology hub.

In addition to being a military hub for the Air Force, Cheyenne, WY boasts a number of technology intensive firms including housing: Dish Broadcasting's satellite uplink center, several oil refineries, chemical and fertilizer manufacturing plants, and Magpul Industries firearm accessories manufacturing, which does a great deal with materials science. Several health providers are also located there, as well as Taco John's headquarters and data analytics teams.

One of the most prominent things that stands out when looking at the peer regions is the high presence of educational training facilities within the associated MSAs. Table 3.2 provides a list of the primary public institution by peer MSA as well as the number of public 2 and 4-year higher education institutions. Every MSA in this group has either a university, community college, or both.

Table 3.2: *Primary and volume of Public Higher Educational Institutions by Peer MSA*

MSA	Primary Public Institution	Number of Public Institutions
Ames, IA	Iowa State University	1
Asheville, NC	University of North Carolina at Asheville	2
Bend, OR	Oregon State University-Cascades Campus	2
Boise City, ID	Boise State University	3
Burlington-South Burlington, VT	University of Vermont	2
Cheyenne, WY	Laramie County Community College	2
College Station-Bryan, TX	Texas A & M University	2
Columbus, OH	Ohio State University	9
Fort Collins, CO	Colorado State University	2
Knoxville, TN	The University of Tennessee-Knoxville	4
Monroe, LA	University of Louisiana at Monroe	2
Pueblo, CO	Colorado State University-Pueblo	2
San Luis Obispo-Paso Robles, CA	California Polytechnic State University-San Luis Obispo	2
St. George, UT	Stevens-Henager College	1
Wenatchee, WA	Wenatchee Valley College	1

Source: National Center for Education Statistics

Chapter 4: Gap Analysis

This chapter provides information on the Wenatchee Valley's labor and capital "gaps" (i.e., shortages or surpluses) in key occupations and infrastructure. In the labor market analysis, we look at the critical tech occupations and compare the annual job openings in those occupations against the completion rates for the associated training programs. These training programs are identified by the National Center for Education Statistics Classification of Instructional Programs (CIP) codes.

Capital Gaps were more difficult to identify but were based off the information obtained from focus groups, PUD planning reports, and municipal government data sources. While we identify what we see as key areas for capital and infrastructure expansion, this section could be expanded if detailed needs from specific technology firms were able to be obtained. We also look at the amenities that exist in the Wenatchee Valley in light of recent research that shows that high-tech employment is attracted to amenity-rich areas.

Educational Gaps

Tables 2.1 and 2.3 show the occupations and industries that compose our technology sector. The goal of the educational gap analysis is to determine which occupations are in demand by the technology sector and what local educational programs exist for supplying that trained labor. If local training is not available for those in demand jobs, then the industry will need to recruit people to move into the region in order to fill those jobs.

The other concern is that many programs exist that may be oversupplying trained individuals for jobs that are not in demand for the technology sector. This oversupply creates a surplus of trained individuals that will need to exit the region and find employment outside the Wenatchee Valley. This would represent a loss of skills to the region and the investments made in the training of those individuals will not generate a return to the local economy. Negative returns on the investment may be just as detrimental to local skills gaps as training shortages.

Table 4.1 shows the high-tech occupations by SIC code and description as well as their new annual job openings that stem from growth in demand for such occupations, and replacement job openings that stem from employees that are retiring or migrating out of the region and thus leaving occupational holes in the firms they operate in. The final column shows the total annual increase in demand for these occupations. We have removed occupations for which data is unavailable or has been suppressed (e.g., Aerospace Engineers, Materials Engineers, etc.) Table 4.2 shows the program completions from Wenatchee Valley College (WVC) for 2017.

Table 4.1: *New and Replacement Jobs by Technology Occupation*

SOC	Description	New Annual Jobs	Annual Replacement Jobs	Annual Job Openings
11-3021	Computer and Information Systems Managers	3	4	7
11-9041	Architectural and Engineering Managers	1	1	2
15-1111	Computer and Information Research Scientists	1	1	2
15-1121	Computer Systems Analysts	5	5	10
15-1131	Computer Programmers	1	3	5
15-1132	Software Developers, Applications	4	3	8
15-1133	Software Developers, Systems Software	2	2	4
15-1134	Web Developers	3	3	6
15-1141	Database Administrators	1	1	2
15-1142	Network and Computer Systems Administrators	3	5	9
15-1143	Computer Network Architects	2	2	4
15-1151	Computer User Support Specialists	7	8	15
15-1152	Computer Network Support Specialists	2	2	4
15-1199	Computer Occupations, All Other	4	2	7
17-2071	Electrical Engineers	3	1	4
17-2072	Electronics Engineers, Except Computer	6	5	11
17-2112	Industrial Engineers	2	2	3
17-2141	Mechanical Engineers	2	2	5
17-2199	Engineers, All Other	2	3	4
17-3023	Electrical and Electronics Engineering Technicians	1	2	3
27-4011	Audio and Video Equipment Technicians	1	1	3
43-9011	Computer Operators	1	2	3
49-2011	Computer, Automated Teller, and Office Machine Repairers	2	4	6
49-2022	Telecommunications Equipment Installers and Repairers, Except Line Installers	3	4	8
49-2094	Electrical and Electronics Repairers, Commercial and Industrial Equipment	2	4	7
49-2098	Security and Fire Alarm Systems Installers	4	3	7
51-2028	Electrical, Electronic, and Electromechanical Assemblers, Except Coil Winders, Tapers, and Finishers	3	4	6
51-4011	Computer-Controlled Machine Tool Operators, Metal and Plastic	1	1	2
Total High-Tech Job Openings		***72***	***82***	***154***

Source: EMSI 2019.2

From Tables 4.1 and 4.2, it may seem that the demand of 154 jobs would be easily filled by the 1,147 graduates. However, the single largest program at WVC in terms of graduates is their Liberal Arts and Science program. The programs related to computing, CIP 11, only has 46 graduates for 2017.

Table 4.2: 2017 *Wenatchee Valley College Completions by Program*

CIP Code	Program Name	Award Level	Completions
01.0104	Farm/Farm and Ranch Management	Awards of less than 1 academic year	32
01.0301	Agricultural Production Operations, General	Associate's degree	14
01.0309	Viticulture and Enology	Awards of less than 1 academic year	27
01.0399	Agricultural Production Operations, Other	Awards of less than 1 academic year	19
03.0101	Natural Resources/Conservation, General	Associate's degree	5
11.0601	Data Entry/Microcomputer Applications, General	Awards of at least 1 but less than 2 academic years	2
11.0803	Computer Graphics	Awards of at least 1 but less than 2 academic years	5
11.0901	Computer Systems Networking and Telecommunications	Awards of at least 1 but less than 2 academic years	17
11.0901	Computer Systems Networking and Telecommunications	Associate's degree	22
13.1210	Early Childhood Education and Teaching	Awards of less than 1 academic year	94
13.1210	Early Childhood Education and Teaching	Awards of at least 1 but less than 2 academic years	2
13.1210	Early Childhood Education and Teaching	Associate's degree	8
15.1301	Drafting and Design Technology/Technician, General	Awards of less than 1 academic year	8
24.0101	Liberal Arts and Sciences/Liberal Studies	Associate's degree	448
40.0101	Physical Sciences	Associate's degree	7
43.0102	Corrections	Awards of at least 1 but less than 2 academic years	12
43.0107	Criminal Justice/Police Science	Associate's degree	12
43.0203	Fire Science/Fire-fighting	Associate's degree	4
47.0101	Electrical/Electronics Equipment Installation and Repair, General	Associate's degree	2
47.0105	Industrial Electronics Technology/Technician	Awards of at least 1 but less than 2 academic years	3
47.0105	Industrial Electronics Technology/Technician	Associate's degree	8
47.0201	Heating, Air Conditioning, Ventilation and Refrigeration Maintenance Technology/Technician	Awards of at least 1 but less than 2 academic years	7
47.0201	Heating, Air Conditioning, Ventilation and Refrigeration Maintenance Technology/Technician	Associate's degree	11

47.0604	Automobile/Automotive Mechanics Technology/Technician	Awards of at least 1 but less than 2 academic years	13
47.0604	Automobile/Automotive Mechanics Technology/Technician	Associate's degree	16
48.0501	Machine Tool Technology/Machinist	Awards of at least 1 but less than 2 academic years	1
48.0501	Machine Tool Technology/Machinist	Associate's degree	3
48.0508	Welding Technology/Welder	Awards of less than 1 academic year	4
48.0508	Welding Technology/Welder	Awards of at least 1 but less than 2 academic years	1
50.0409	Graphic Design	Associate's degree	3
51.0801	Medical/Clinical Assistant	Awards of at least 1 but less than 2 academic years	45
51.0802	Clinical/Medical Laboratory Assistant	Associate's degree	17
51.0810	Emergency Care Attendant (EMT Ambulance)	Awards of less than 1 academic year	18
51.0911	Radiologic Technology/Science - Radiographer	Associate's degree	12
51.1501	Substance Abuse/Addiction Counseling	Associate's degree	4
51.3801	Registered Nursing/Registered Nurse	Associate's degree	55
51.3901	Licensed Practical/Vocational Nurse Training	Awards of at least 1 but less than 2 academic years	53
51.3902	Nursing Assistant/Aide and Patient Care Assistant/Aide	Awards of less than 1 academic year	95
52.0101	Business/Commerce, General	Associate's degree	16
52.0201	Business Administration and Management, General	Awards of at least 1 but less than 2 academic years	2
52.0201	Business Administration and Management, General	Associate's degree	4
52.0204	Office Management and Supervision	Associate's degree	6
52.0302	Accounting Technology/Technician and Bookkeeping	Awards of at least 1 but less than 2 academic years	2
52.0302	Accounting Technology/Technician and Bookkeeping	Associate's degree	6
52.0406	Receptionist	Awards of less than 1 academic year	2
Total Completions from Wenatchee Valley College			***1,147***

Source: IPEDS

Several programs can map to various occupations so merging the two tables requires us to match potential programs to occupations based on curriculum and occupation requirements. We use Emsi's CIP-to-SOC crosswalk to determine whether the occupational openings can be filled by the local program completions. Table 4.3 shows that there are a vast number of shortages for the high-tech occupations and that is almost entirely because there are no local programs for training individuals in those occupations. The programs that do exist are splitting their graduates across multiple occupational demand centers.

The unfortunate reality is that the local labor force is not being trained to grow and enhance the local technology sector and any home grown talent is likely going to occur through on-the-job-training and employers who are willing to give uncredentialed talent a chance to prove themselves.

Table 4.3: *Wenatchee Valley's Annual High-Tech Openings, Completions, and Gaps*

SOC	Description	Annual Openings	Annual Completions	Annual Gaps
11-3021	Computer and Information Systems Managers	7	0	(7)
11-9041	Architectural and Engineering Managers	2	0	(2)
15-1111	Computer and Information Research Scientists	2	0	(2)
15-1121	Computer Systems Analysts	10	39	29
15-1131	Computer Programmers	5	5	0
15-1132	Software Developers, Applications	8	0	(8)
15-1133	Software Developers, Systems Software	4	0	(4)
15-1134	Web Developers	6	39	34
15-1141	Database Administrators	2	0	(2)
15-1142	Network and Computer Systems Administrators	9	0	(9)
15-1143	Computer Network Architects	4	39	35
15-1151	Computer User Support Specialists	15	39	24
15-1152	Computer Network Support Specialists	4	39	35
15-1199	Computer Occupations, All Other	7	0	(7)
17-2071	Electrical Engineers	4	0	(4)
17-2072	Electronics Engineers, Except Computer	11	0	(11)
17-2112	Industrial Engineers	3	0	(3)
17-2141	Mechanical Engineers	5	0	(5)
17-2199	Engineers, All Other	4	0	(4)
17-3023	Electrical and Electronics Engineering Technicians	3	0	(3)
27-4011	Audio and Video Equipment Technicians	3	0	(3)
43-9011	Computer Operators	3	0	(3)
49-2011	Computer, Automated Teller, and Office Machine Repairers	6	0	(6)
49-2022	Telecommunications Equipment Installers and Repairers, Except Line Installers	8	0	(8)
49-2094	Electrical and Electronics Repairers, Commercial and Industrial Equipment	7	11	4
49-2098	Security and Fire Alarm Systems Installers	7	0	(7)
51-2028	Electrical, Electronic, and Electromechanical Assemblers, Except Coil Winders, Tapers, and Finishers	6	11	5
51-4011	Computer-Controlled Machine Tool Operators, Metal and Plastic	2	0	(2)

As can be seen from Table 4.3, total shortages sum to 99 jobs annually. Total surpluses sum to 167 annual jobs. These two gaps represent a severe impediment to technological growth in the region. The Wenatchee Valley will need to import some skills and export others resulting in an ambiguous net change in local tech employment. A shortage in some specific jobs may prohibit firms from deciding to locate in the region. Firms that are dependent on the labor where the Valley has a surplus may locate in the area, but because of the surplus they might pay below market wages for those occupations. In both cases there is a technological skills issue the Valley must address if it wishes to grow the tech-sector.

Continued growth of The Bridge Research and Innovation District, based in the Wenatchee area, is a key to seeing a closure of the labor and skills gaps. It has become the center of private-public partnerships in developing and guiding research and innovation, but it requires alignment between the individual's intellectual focus, training opportunities, and the growing needs of industries. Those three factors need to coalesce for the local labor market not to be replaced by outside talent. It is only in this way that the local labor market will see the benefits of growing the technology sector.

Capital Gaps

The largest capital gap for the region presently is land availability and the physical constraints the geography has imposed on the Wenatchee Valley. Development of capital infrastructure appears to be developing more quickly on the Chelan County side of the Columbia River. Residential housing is expanding on the Douglas County side. The majority of the data farms and technological infrastructure has been in Douglas and northern Grant counties, but the tide appears to be shifting, or perhaps balancing out.

This section of the report outlines information provided by the PUDs and county development offices. Currently the Chelan County PUD and other regional stakeholders have reviewed the infrastructure of nine commercial sites for potential development into industrial hubs: Apple Blossom Center, Cashmere Investments LLC, Entiat 97A, GBI Holdings Malaga, Goodfellow Brothers, Port of Chelan County, Stemilt, Wilbur-Ellis, and Willmorth Drive. These sites range in capacity from residential use to high-demand electrical use.

Table 4.4: *Chelan PUD Development Prospects*

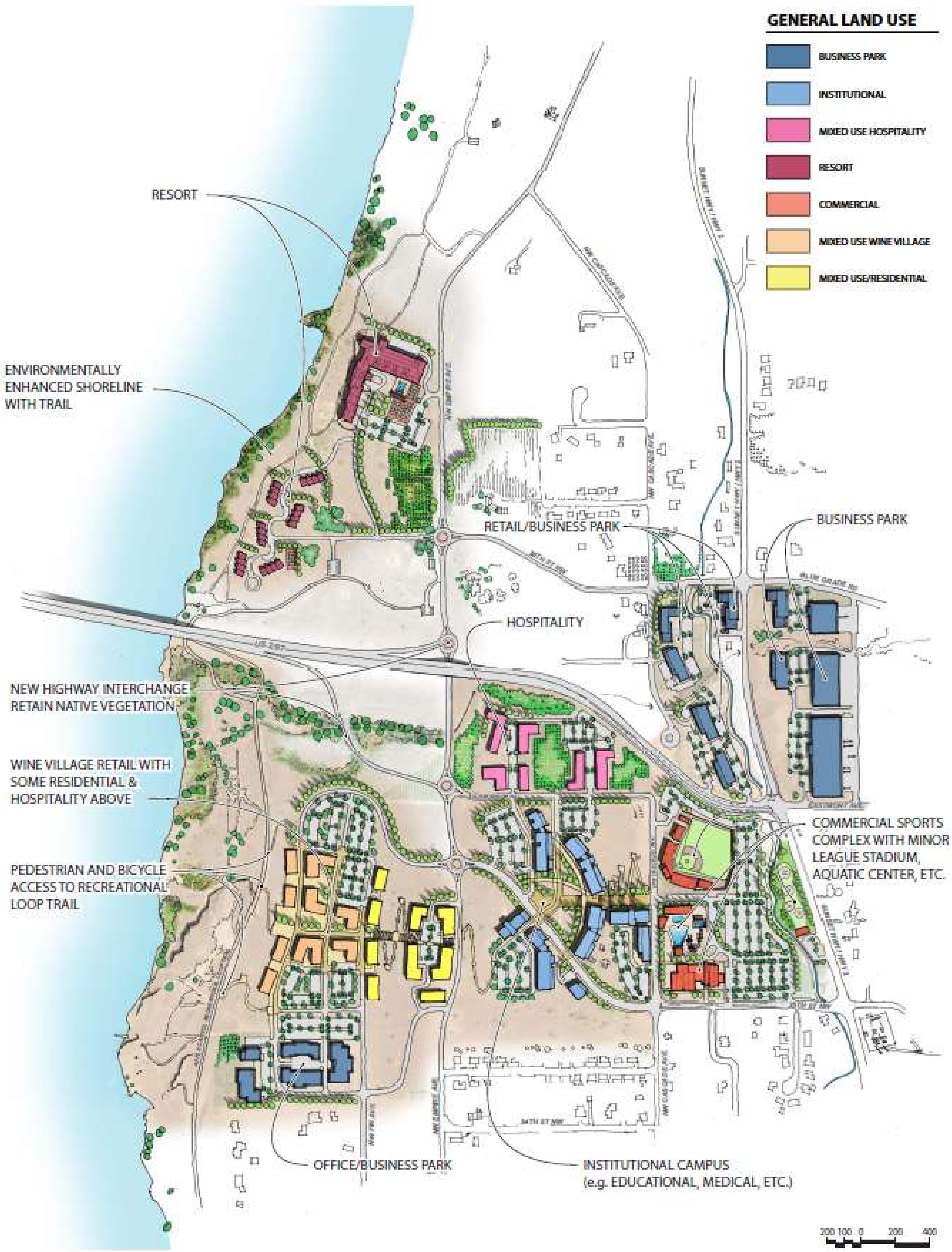
Site	Assessed Value	Acreage	Electrical capacity
Apple Blossom Center	$627,264	1.8	Retail
Cashmere Investments LLC	$3,113,741	17.9	Commercial
Entiat 97A	$334,474	3.9	Commercial
GBI Holdings Malaga	$99,810	24.6	High Demand
Goodfellow Brothers	$1,458,558	7.4	Wholesale Commercial
Port of Chelan County	Public Land	21.1	Commercial
Stemilt	$1,755,286	11.3	Industrial Mixed-Use
Wilbur-Ellis	$44,580	0.17	Wholesale Commercial
Willmorth Drive	$62,618	8.2	Retail

Source: Chelan PUD

Given the rate of technological growth in the region these prospective investments will support such continued growth. The primary capital gap on this front is financial capital. Investing in new substations and transmission lines requires as much private investment as public.

From conversations with the Douglas County PUD, expansion plans of this nature either have not been developed or were not provided. However, infrastructure for the delivery of surplus electricity is constrained in certain parts of Douglas County. This suggests expanded retail sales, though it is unclear if that is coming from more intensive use by their current industrial sector such as the data centers or expanded use from the infrastructure expansions of Wenatchee Landing.

Figure 4.1: *Wenatchee Landing Development Site*



Source: Douglass County Site Plan

The Douglas County Sewer District has been following a "growth must pay for itself" philosophy suggesting that the district follows growth rather than anticipating it. That is not to say that infrastructure investments are not subsidized but, in some sense, the current infrastructure must be reaching capacity before those investments are made. With the exception of the Malaga area across from Rock Island, the region's water infrastructure is in sound condition.

Housing infrastructure is problematic as there is little current room to develop large areas for housing several hundred families that would be required to see sufficient technology expansion for consuming the proposed local electricity expansion. The Wenatchee area is currently growing at roughly 1,000 jobs per year. The proposed technology expansion may increase that employment growth figure to as much as 2,764 jobs per year once all the multiplier impacts are included.

Lastly, we want to mention one area where there are very few infrastructure gaps and that is in the type of culture and amenities that are highly sought after by technology professionals. In a forthcoming paper on business climate, Salaghe et al. find that business relocation and expansion of high-wage firms is highly correlated with natural amenities such as robust K-12 education, availability of fiber optics, and high-speed Internet. Access to passenger air transport within 30 minutes was also a statistically significant variable in determining a company's willingness to relocate or expand in a given geography. While this last item is more of a shortage for the region — Pangborn Memorial Airport has very low enplanements — the other amenities are well in hand. The main finding of their paper is that, while businesses do prefer a lower tax environment (all else being equal) high-wage industries prefer the amenities provided by higher taxes more than they are repelled by the high taxes. It is the opposite for low wage industries like telemarketing.

Summary

There are severe gaps in both the labor market and capital infrastructure fronts. Though efforts are under way to remedy both issues, it will take some time before these gaps are closed entirely. Enhanced technology training and transportation infrastructure are struggling to make headway. Geography and housing also pose constraints for immediate and prolonged growth. Infrastructure expansions are being planed and budgeted for, but financial resources are preventing some of these efforts. Nonetheless, the region boasts numerous attractions for technology expansion. Low-cost electricity, a vibrant community, an untold number of natural resource amenities, and The Bridge Research and Innovation District all make the region appealing to the technology generation.

Chapter 5: Impact Analysis

Impact analysis is the process of seeing how a change in a regional market structure or performance might alter the economic activity and employment in the region. Technically an impact measures the "net change in new economic activity associated with an industry, event, or policy in an existing regional economy." Watson et al. (2007). The net change we are analyzing here results from two simultaneous shocks: 1) a reduction in energy exports, and 2) an expansion of the technology sector and its exports resulting from increased local energy consumption.

It is important to recognize the strengths and shortcomings of such an analysis. Because we need to be able to model how different industries interact with one another, it is vital that we use a general equilibrium framework, i.e., a model that analyzes all markets simultaneously rather than independent of one another. The input-output model allows explicitly for such an analysis. However, the model is not capable of analyzing price structures and that must be done outside of the modeling framework itself. Alterations in energy rates that must occur for the PUDs to remain financially unharmed cannot be explicitly calculated by these models.

An understanding of the PUDs' pricing structures is critical. The effective wholesale, or export price, per megawatt hour (MWh) is much higher than the effective retail, or local, rates. The reason local businesses and households are able to pay rates lower than actual production costs, is because the higher wholesale rates are, in effect, able to subsidize local electricity use.

Understanding Local Rates:

It is useful to think through how the pricing of electricity in the Public Utility Districts occur. Just as any business, electricity generation has many costs. There are capital costs incurred for the purchase of concrete, turbines, lubrication, gasoline for vehicles, electric cables, transformers, etc. The highly skilled labor necessary for operating the plants is another large expense. All of these inputs to the utility sector's production are paid for through the sale of the electricity being produced. Suppose the costs for generating the electricity amount to $100 million (these are just hypothetical numbers).

If the PUD generates two million MWh to sell, it needs to receive a price of $50 per MWh in order to break even ($100 million / 2 million MWh). If the PUD is able to sell one million MWh to buyers on the wholesale market at $70 per MWh, they receive $70 million in revenue and are able to cover 70% of their expenses. Now, in order to break even, the PUD only needs to charge $30 per MWh for the remaining 1 million MWh of electricity they have available to sell. In other words, the high price from the wholesale market enabled the Utility to sell to the retail market at a lower "subsidized" rate.

If sales to the wholesale market decrease, rates to the retail market must increase to cover the production costs.

The Douglas County and Chelan County PUDs export roughly 4 million MWh of electricity on the wholesale market. Those exports amount to slightly under $160 million. Those are new dollars entering the economy, paying incomes, and generating employment. Table 5.1 outlines the electricity production and sales regionally.
This analysis assumes that 5% of current exports, roughly 197,000 MWh of electricity, are going to be converted from exports to retail sales. Those 197,000 MWh would generate $7.9 million in revenue for the PUDs at the current effective wholesale rate but only generate $6.0 million at the current effective retail rate. There is an additional cost to providing that electricity locally as well.

Table 5.1: *Regional Electricity Sales and Rates*

Wenatchee Valley PUDs	Revenues ($)	Volume (MWh)	Effective Rates ($/MWh)
Wholesale	$158,411,087	3,941,042	$40.2
Retail	$70,744,113	2,310,801	$30.6
Total	***$229,155,200***	***6,251,843***	***$36.7***

Source: Chelan and Douglas County PUDs

The additional costs for providing retail sales results from the increased costs for infrastructure to handle the larger loads. New transmission lines and larger substations would be required. All of that would require additional infrastructure construction, which we are ignoring momentarily. Even if the infrastructure were in place the costs from additional maintenance, transmission loss, etc., generates an additional overhead cost of approximately $17 per MWh. Again, we are going to ignore those costs momentarily.

The model here is designed to provide a short-run analysis. It is not able to determine if the growth in the tech sector will result in clustering effects that will begin a self-propagating cycle. We can assess what the likely impacts of a policy shift would be over the next year, but not how such a policy will affect the long run growth trajectory of the economy. It is also unclear how large the technology sector must become in order to achieve such self-propagating growth, as in the cases of Seattle or the Silicon Valley.

The rest of this chapter outlines the expected impacts from the energy transfer under two different sets of assumptions. The first covers the "lower-bound" assumption. The assumption in this case is that the PUDs will see revenue losses but needs to provide the same volume of electricity, moving 5% of their current exports to local use, primarily by the technology intensive industries. This scenario, because it is designed to handle the financial realities of revenue losses for the PUDs, will show potential damages. It is important to note that because the PUDs will not be laying off employees, they must produce the same amount of energy after all, the employment effects in this scenario are less reliable. The second scenario makes the same assumption on volume of electricity but assumes the technology sector will pay increased rates so that the PUDs are not made worse off from a revenue standpoint. In this scenario, the tech sector's production, including exports, must increase sufficiently to purchase all the roughly 197,000 MWh at a rate that will keep the PUDs "whole." This scenario is designed to test whether the technology sector is capable of expanding sufficiently to justify such a reduction in the region's electricity exports.

However, before we run any impacts, it is critical to understand a few things about the region and the technology sector's electricity use. Total employment in the technology industries is 3,907 jobs. Current utility spending from those industries amounts to $24.7 million and their regional exports are $459.2 million. These tech-intensive industries, see Table 2.2, currently consume 807,593 MWh of electricity, 35% of all the PUDs' retail sales. Those same industries employ only 5% of the total regional workforce. In aggregate for these industries, each MWh of electricity purchased ultimately results in $569 in exports. In order for an additional 197,052 MWh of electricity to be consumed within the region, the technology sector will need to expand its exports between $220.6 million and $275.3 million. Employment in those industries will need to increase by between 479 and 600 direct jobs. Employment growth regionally, that is throughout the Wenatchee MSA, has averaged just under 1,000 jobs per year.

In order to consume the amount of electricity being held back from exports, the region would need to see nearly all of its employment growth occur in the technology sector. Growing the technology sector, even at a more reasonable rate, wouldn't require a large deviation in electricity from the wholesale to retail markets. In other words, growing the technology sector doesn't require a "big hit" to the public utility. As discussed in the Infrastructure Gap Analysis, it is the transmission and distribution infrastructure that is the more pressing constraint to technology expansion.

Lower-Bound Impact Estimates

Economic Losses from Energy Export Reductions

The first shock to the economy that we want to analyze is the reduction in energy exports. As stated above the reduction in the 197,052 MWh of electricity reduces energy exports from the Wenatchee Valley by $7.9 million dollars. However, this reduction in revenue means less money spent on production inputs that are purchased from other businesses. Reductions in business-to-business transactions (PUD-to-vender transactions) are captured in the indirect impact effects. It also means the PUDs will have less money to pay in wages. Employee households will then have less money to spend in the economy, resulting in lower expenditures at the grocery stores, malls, movie theaters, etc. The loss in employee spending and the cascading reduction in local transactions is captured in the induced effects.

Total losses to the economy include the direct losses from the reduction in exports, the indirect losses from the reduced business-to-business transactions sometimes referred to as the backwards linked effects, and the reduction in employee generated induced effects. The indirect and induced impacts are referred to collectively as the multiplier impacts. Table 5.2 shows the lost sales in the economy from the reduction in energy exports.

Table 5.2: Lost Sales ($1,000's) *in the Wenatchee Valley from energy export reductions*

	Direct Effect	Indirect Effect	Induced Effect	Total Effect
Local PUDs	-$7,921	-$1,546	-$53	-$9,520
Technology Sector	$0	-$34	-$154	-$188
Other Industries	$0	-$367	-$2,068	-$2,435
Total	***-$7,921***	***-$1,947***	***-$2,275***	***-$12,143***

Source: IMPLAN 2018 and author's calculations

Total losses to the economy would amount to $12.1 million dollars. The bulk of which ($9.5 million) would be felt by the local PUDs. The burgeoning tech sector would decline by nearly $190,000 and other industries would lose another $2.4 million. What is important to see here is that the loss in exports is not the only loss seen by the PUDs because their business expenditures and their employees' expenditures decline, local businesses and households are buying less electricity, further exacerbating the losses to the PUDs.

Sales are not always the best measure for analyzing losses. Losses in employment, income, and value-added (Gross Regional Product) provide a more wholistic view of the economic damages. Table 5.3 shows the losses by each economic metric for the Wenatchee Valley as a whole.

Table 5.3: *Losses in Sales, Value Added, Income, and Employment for the Wenatchee Valley*

	Sales	Income	Value Added	Jobs
Direct	-$7,921	-$1,822	-$3,178	-13
Indirect	-$1,947	-$465	-$793	-5
Induced	-$2,275	-$752	-$1,359	-17
Total	***-$12,143***	***-$3,039***	***-$5,330***	***-35***

Source: IMPLAN 2018 and author's calculations

Sales vs. Value-Added:

Often, sales figures are reported due to their large size and imposing rhetorical effect. However, those figures represent a great deal of double counting. Imagine a wheat farmer selling wheat to a flour mill, the mill selling the flour to a bakery, and the baker selling bread to an individual. If we sum up the sales, the value of the wheat is being counted three times. Those transaction are happening, but the productivity of the economy is overstated through the triple counting. That is why best practices in Impact Analysis require impacts to be reported on a value-added basis.

When measuring value-added, or gross regional product, we are measuring only the value of the new activity. So the flour mill only gets to count the increased value added to the wheat through the milling process. This avoids the double, triple, and quadruple counting. The results are less imposing, but far more indicative and accurate of the impacts from the economic shock.

Wenatchee Valley's total gross regional output is $5.2 billion. The loss in gross regional product of $5.3 million represents a decline of just over 0.1% of the economy. $3.3 million in income would be forgone and roughly 38 full-time equivalent jobs would be lost.

Economic Gains from Technology Sector Expansion

The flip side of a reduction in electricity exports is that this electricity is being made available for retail use by the technology sector. The associated expansion of the technology sector results in expanded technology exports. Current technology sector exports amount to $459 million dollars. With the additional access to electricity, direct technology sector exports would need to increase by $554.8 million. This new money in the economy will be circulated in new transactions. Technology firms will pay for more inputs to their production process, including the additional energy purchased from the PUDs. They will hire new employees, who will likewise buy other goods and services.

Table 5.4 shows the growth in sales activity that would occur from a technology sector expansion if the effective retail rate were held constant but local electricity consumption absorbed all of the 197,052 MWh of electricity. Table 5.5 summarizes the economic consequences of the technology sector expansion in terms of the major economic metrics Sales, Income, Value Added, and Employment.

Table 5.4: Increased Sales ($1,000's) *in the Wenatchee Valley from Technology Expansion*

	Direct Effect	Indirect Effect	Induced Effect	Total Effect
Local PUDs	$0	$5,821	$1,811	$7,632.031
Technology Sector	$220,695	$9,246	$5,505	$235,447
Other Industries	$0	$25,645	$77,266	$102,911
Total	***$220,695***	***$40,712***	***$84,583***	***$345,990***

Source: IMPLAN 2018 and author's calculations

Table 5.5: *Gains in Sales, Value Added, Income, and Employment for the Wenatchee Valley*

	Sales	Income	Value Added	Jobs
Direct	$220,695	$45,330	$103,567	491
Indirect	$40,712	$12,072	$21,021	286
Induced	$84,583	$31,971	$53,057	664
Total	***$345,990***	***$89,373***	***$177,645***	***1,442***

Source: IMPLAN 2018 and author's calculations

Net Impacts from Energy Reallocation

Even though the direct effects stemming from the transfer of electricity from wholesale to retail markets results in a net increase in regional exports, the PUDs experience nearly a $1.9 million loss due to the price differential between the wholesale and retail rates. Tables 5.6 through 5.9 show how total economic activity and regional output improve but at the expense of the PUDs' operations.

Table 5.6: *Net Sales in Wenatchee Valley from a Wholesale to Retail Energy Transfer*

	Direct	Indirect	Induced	Total
Local PUDs	-$7,921	$4,275	$1,757	-$1,888
Technology Sector	$220,695	$9,212	$5,352	$235,259
Other Industries	$0	$25,277	$75,198	$100,476
Total	***$212,775***	***$38,765***	***$82,307***	***$333,847***

Source: IMPLAN 2018 and author's calculations

Net sales in the Wenatchee Valley would increase by $333.8 million, but this metric includes a large volume of double counting. It also shows the net reduction in revenues to the PUDs resulting from the differential in effective wholesale and effective retail prices. Overall sales activity would increase by roughly 0.01% of total regional sales.

Table 5.7: *Net Income in Wenatchee Valley from a Wholesale to Retail Energy Transfer*

	Direct	Indirect	Induced	Total
Local PUDs	-$1,822	$983	$404	-$434
Technology Sector	$45,330	$2,653	$1,601	$49,584
Other Industries	$0	$7,971	$29,213	$37,184
Total	***$43,508***	***$11,608***	***$31,218***	***$86,334***

Source: IMPLAN 2018 and author's calculations

Income in the region would increase by $86.3 million while employment would rise by 1,407 jobs (see Table 5.9). This means the average job being added to the economy will have a wage of roughly $61,350. This would represent a slight reduction in the average regional wage, which is currently $63,500. Total income and employment metrics for the PUDs would be losses of $434,000 in wage payments and a total loss of three full-time equivalent jobs.

Table 5.8: *Net Value Added in Wenatchee Valley from a Wholesale to Retail Energy Transfer*

	Direct	Indirect	Induced	Total
Local PUDs	-$3,178	$1,715	$705	-$757
Technology Sector	$103,567	$4,859	$3,148	$111,575
Other Industries	$0	$13,654	$47,844	$61,498
Total	***$100,389***	***$20,228***	***$51,698***	***$172,315***

Source: IMPLAN 2018 and author's calculations

Value-added is the most common economic measure of productivity and is synonymous with the concept of Gross Regional Product (GRP). This measure avoids double counting and is a more accurate depiction of the economic consequences of the energy transfer. We would expect a net increase in value-added of $172.3 million. Under both this scenario and the upper bound scenario, such gains would result in increased tax revenues that may be used to offset losses to the PUDs or facilitate infrastructure expansion. Value-added includes labor income (wages paid for services rendered), non-labor income (rent paid to capital, including owners' retained earnings), and taxes on production and imports.

Table 5.9: *Net Employment in Wenatchee Valley from a Wholesale to Retail Energy Transfer*

	Direct	Indirect	Induced	Total
Local PUDs	-13	7	3	-3
Technology Sector	491	48	23	563
Other Industries	0	226	621	848
Total	***479***	***281***	***647***	***1,407***

Source: IMPLAN 2018 and author's calculations

Again, the employment gains seen in the economy are coming at the expense of the PUDs. It is also questionable if the technology sector would be able to grow fast enough to consume all of the electricity being held back from exports. A growth of 1,407 jobs would require much faster human capital and infrastructure investments. Many of these jobs would need to be the results of recruitment and resulting immigration to the region. Recall we are talking about employment expansion and not employment reallocation. Such growth may exacerbate the housing and infrastructure issues currently straining city resources. However, such growth often pays for itself in the long run. Table 5.10 summarizes the results from Tables 5.6 through 5.9.

Table 5.10: Net *Gains in Sales, Value Added, Income, and Employment in Wenatchee Valley*

	Sales	Income	Value Added	Jobs
Direct	$212,775	$43,508	$100,389	479
Indirect	$38,765	$11,608	$20,228	281
Induced	$82,307	$31,218	$51,698	647
Total	***$333,847***	***$86,334***	***$172,315***	***1,407***

Source: IMPLAN 2018 and author's calculations

Upper-Bound Impact Estimates

In this scenario we alter our assumption that the PUDs see a revenue reduction from selling the electricity locally. In this scenario the PUDs still lose the revenues from electricity exports but entirely make that revenue up from their retail sales to the technology sector. This causes the local electricity rates paid by the technology sector to be higher than they otherwise would have been and results in higher regional multiplier effects.

Because the losses in electricity exports remain the same there is no need to repeat Tables 5.2 and 5.3. However, the gains from the increased expenditures by the technology sector are not the same. Table 5.11 shows the gains that might be realized under this broader assumption of technology spending and electricity usage.

Table 5.11: Increased Sales ($1,000's) *in Wenatchee Valley from Technology Expansion*

	Direct	Indirect	Induced	Total
Local PUDs	$0	$7,261	$2,259	$9,520
Technology Sector	$275,289	$11,533	$6,867	$293,690
Other Industries	$0	$31,988	$96,380	$128,368
Total	***$275,289***	***$50,783***	***$105,506***	***$431,578***

Source: IMPLAN 2018 and author's calculations

Table 5.12 shows the net change in sales using this set of assumptions. The key takeaway from this table is that total PUD sales are zero. Even though the direct losses in PUD exports are still $7.9 million the growth in the technology sector and the associated multiplier effects result in indirect and induced gains to the PUDs that offset their losses completely.

Table 5.12: Increased Sales ($1,000's) *in Wenatchee Valley from Technology Expansion*

	Direct	Indirect	Induced	Total
Local PUDs	-$7,921	$5,715	$2,205	$0
Technology Sector	$275,289	$11,499	$6,713	$293,502
Other Industries	$0	$31,621	$94,312	$125,933
Total	*$267,369*	*$48,835*	*$103,231*	*$419,435*

Source: IMPLAN 2018 and author's calculations

Another important thing to understand is that the technology sector in this case is either paying higher than the effective retail rate and passing that cost through to their non-local consumers, or they have to export more product per MWh than they are presently. Either of these options are causing the PUDs to be no worse off than at present, but it is increasing the overall activity of the region even above the lower bound scenario. This can be seen by the fact that the direct effects in the upper-bound scenario are much larger than in the lower-bound scenario ($275.3 million in direct exports as opposed to the $220.7 million assumed in the lower-bound). In this scenario each industry, and the region, is better off, in part because the PUDs and their retail consumers are kept whole. However, it assumes the technology sector is able to grow its exports by $55 million dollars more than in the lower bound estimate.

Gains and losses should be kept in the context of the entire economy. Current revenues for the PUDs are over $229.2 million. Their expected losses from a 5% reduction in their exports volume, provided they could sell that electricity at current retail rates, would be $1.9 million, or -0.8% of their current revenues. In the upper-bound scenario, a gain of $216.3 million in gross regional product would represent regional economic growth of 4%. That growth is substantial, especially if it is on top of the region's current growth. Table 5.13 summarizes the economic metrics of the upper-bound scenario.

Table 5.13: *Gains in Sales, Value Added, Income, and Employment for in Wenatchee Valley*

	Sales ($1000)	Income ($1000)	Value Added ($1000)	Jobs
Direct	$267,369	$54,721	$126,009	600
Indirect	$48,835	$14,594	$25,428	352
Induced	$103,231	$39,127	$64,822	812
Total	***$419,435***	***$108,442***	***$216,259***	***1,764***

Source: IMPLAN 2018 and author's calculations

Tax Implications

Impact models, like the one utilized in this analysis, struggle to capture the intricacies of local tax policies and tax rates, so fiscal results from such models should be viewed with a cautious eye. Another aspect of impact models are that they are not designed to measure alterations in assessed property values. As such, changes in property values and property tax revenues are likely understated by this assessment. Table 5.14 provides the net changes in tax revenues derived from the impact model under the lower-bound assumptions.

Table 5.14: *Lower-Bound Net Tax Impacts for the Wenatchee Valley ($1000)*

	Tax on Production and Imports	Households	Corporations
Social Ins Tax	$0	$686	$0
Sales Taxes	$10,443	$0	$0
Property Taxes	$5,836	$33	$0
Other Taxes	$1,923	$422	$97
Total	***$18,201***	***$1,141***	***$97***

Source: IMPLAN 2018 and author's calculations

Individual households are likely to see a reduction in their overall tax burden because we are moving from higher- to lower-wage employment. The increase in overall employment and incomes will ultimately increase total tax collections. Taxes on production will likely increase because of assumed growth in the technology industry and the added tax payments they will make as a result of their expansion. Corporate dividends are expected to increase as well. All of this was reflected by the expansion of the data centers in Quincy as can be seen in a report produced by the Port of Douglas County, utilizing state Department of Revenue data. See Appendix 2. The upper-bound net tax impacts are similar to those from the lower and are reported in Table 5.15.

Table 5.15: *Upper-Bound Net Tax Impacts for the Wenatchee Valley*

	Tax on Production and Imports	Households	Corporations
Social Ins Tax	$0	$846	$0
Sales Taxes	$12,809	$0	$0
Property Taxes	$7,158	$41	$0
Other Taxes	$2,358	$520	$119
Total	***$22,325***	***$1,406***	***$119***

Source: IMPLAN 2018 and author's calculations

Chapter 6: Supply Chain Analysis

The purpose of this supply chain analysis is to outline for the reader where the PUDs and the technology sectors are spending their money and what industries their inputs are coming from. More importantly it shows which inputs must be imported to meet the production levels of the technology sector. If, for example, aircraft and aircraft parts manufacturing must source a large portion of their aluminum inputs from Iceland, these imports world represent financial leakages from the economy and lower the multiplier effects from that portion of the technology sector.

By identifying industries that create leakages for the technology sector, we can identify where "economic holes" in the economy are. Filling those holes will stop the leakages and increase the multiplier effects, growing the internal health and stability of the local technology sector. We will start by discussing the primary components of the tech sector's industrial purchases (not their wage payments and taxes, etc.).

The technology sector in total spends approximately $186.6 million dollars locally on goods and services. This pales in comparison to their spending on value-added inputs like income payments to employees, taxes, and property income ($549.7 million). They also spend another $304.7 million on imported goods for their production processes. Table 6.1 outlines the main spending categories.

Table 6.1: *Primary Technology Sector Spending Categories*

TOTAL Industry spending	**$186,639,236**
Wholesale trade	$24,520,246
Real estate	$24,487,899
Professional Services	$60,079,793
Other	$77,551,297
Total Value-Added Spending	**$549,666,301**
Employee Compensation	$257,919,864
Owners Income	$17,295,667
Property Type Income	$144,187,305
Taxes on Production and Imports	$130,263,464
Total Import Spending	**$304,719,655**
Foreign Imports	$58,290,736
Domestic Imports	$246,428,919

Source: IMPLAN 2018 and author's calculations

A key takeaway from table 6.1 is that of the entire spending on inputs to production, the technology sector in Wenatchee spends far more in imported inputs than on local inputs. This is part of the reason why the technology sector has a lower indirect multiplier effect than other industries. Roughly 38% of the technology sector's total spending on inputs to its production process (local industrial spending and imports) is spent locally. The remaining 62% of inputs must be imported from outside the Wenatchee Valley. Table 6.2 shows the key industries the technology sector must import product from and the potential gains in local productivity that might be realized if those industries had a larger presence locally.

Of the 19 industries in Table 6.2, the technology sector spends roughly $34.1 million locally and $81.5 million on importing goods from those industries. One of the key industries of note here is Data Processing, Hosting, and Related Services. Even with the growth of the industry (server farms) locally, these tech companies still import $2.9 million. The "big-ticket" items include Legal Services ($10.2 million), Administrative Management Consulting ($8.7 million), Office of Administrative Services ($7.1 million), and Computer Systems Design Services ($6.1 million). Growing those industries locally would serve to reduce the money flowing out of the economy and help retain the revenues the technology sector brings into the region, further enhancing the multiplier effects of the technology sector.

Table 6.2: *Primary Industries Inputs the Wenatchee Technology Sector Imports*

NAICS	Description	In-region Purchases	% In-region Purchases	Imported Purchases	% Imported Purchases	Total Purchases
524126	Direct Property and Casualty Insurance Carriers	$74,829	0.4%	$18,879,264	99.6%	$18,954,093
541110	Offices of Lawyers	$3,851,875	27.4%	$10,189,636	72.6%	$14,041,511
531210	Offices of Real Estate Agents and Brokers	$8,634,255	62.6%	$5,165,073	37.4%	$13,799,328
541611	Administrative Management and General Management Consulting Services	$3,178,785	26.8%	$8,687,289	73.2%	$11,866,074
561110	Office Administrative Services	$3,668,795	34.2%	$7,047,808	65.8%	$10,716,603
541512	Computer Systems Design Services	$930,867	13.3%	$6,084,139	86.7%	$7,015,007
621511	Medical Laboratories	$249,072	4.7%	$4,994,596	95.3%	$5,243,668
518210	Data Processing, Hosting, and Related Services	$1,980,651	40.8%	$2,871,175	59.2%	$4,851,826
541613	Marketing Consulting Services	$3,066,432	76.9%	$919,081	23.1%	$3,985,512
541690	Other Scientific and Technical Consulting Services	$1,880,985	48.3%	$2,009,879	51.7%	$3,890,864
541990	All Other Professional, Scientific, and Technical Services	$1,856,770	51.6%	$1,738,174	48.4%	$3,594,944
541330	Engineering Services	$1,473,149	49.3%	$1,515,792	50.7%	$2,988,941
541511	Custom Computer Programming Services	$115,152	4.3%	$2,532,815	95.7%	$2,647,967
481111	Scheduled Passenger Air Transportation	$97,371	4.1%	$2,269,180	95.9%	$2,366,551
541519	Other Computer Related Services	$1,057,221	46.3%	$1,227,768	53.7%	$2,284,989
561720	Janitorial Services	$899,169	40.6%	$1,315,808	59.4%	$2,214,978
561612	Security Guards and Patrol Services	$968,643	44.7%	$1,196,480	55.3%	$2,165,123
621512	Diagnostic Imaging Centers	$28,679	1.4%	$2,027,332	98.6%	$2,056,011
423610	Electrical Apparatus and Equipment, Wiring Supplies, and Related Equipment Merchant Wholesalers	$51,774	5.8%	$834,233	94.2%	$886,007
	TOTAL	***$34,064,473***	***29.5%***	***$81,505,523***	***70.5%***	***$115,569,997***

Source: EMSI 2019.2

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Appendix 1: An Input-Output Primer

The Basic Input-Output model

Before jumping into the Social Accounting Matrices (SAMs) it will be helpful to discuss a system of accounts embedded in the SAM. The system of accounts known as Input-Output (I-O) represents an economist's version of double-entry bookkeeping for industries. Figure A.1 below shows a simplified version of an I-O matrix with just a hand full of industries.

Figure A.1: Aggregated form Input-Output Matrix

		Producers as Consumers						**Final Demand**			
		Agric.	Min.	Const.	Manuf.	Services	Other	Households	Investment	Government	Net exports
Producers	Agric.										
	Min.										
	Const.										
	Manuf.										
	Services										
	Other										
Value Added	Labor							Gross Domestic Product			
	Returns to Capital										
	Taxes										

Reading down a column of this table shows you what inputs an industry is buying in order to produce their output. If we look at the Agriculture column, they may buy seed from themselves, fertilizer and farm equipment from the manufacturing sector, and legal and accounting services from the service sector. Payments to their employee are captured in the "Labor" row, they receive the returns to the capital that they own, and they pay taxes to the government. Reading across a row tells us where an industry's income originates. Sticking with agriculture, they sell seed to others in the agricultural sector; their crops may be sold to processing plants in the manufacturing sector, or perhaps directly to consumers. A portion of a household's expenditures will go to buying agricultural goods, and even government may purchase agricultural goods. Lastly, the agricultural industry will sell its output abroad via the "Net exports" column.

Summing all of the labor, capital, and tax payments for all industries gives the sum of all value added and will equal the Gross Domestic Product (GDP) of the region. Similarly summing all of the expenditures of households, government, investment, and net exports yields the GDP of the region. These two methods of calculating GDP are known as the Income and Expenditure approaches, respectively, and they represent a check for ensuring all accounts balance. It is through the I-O system that we are able to trace the dollars through the economy and calculate multiplier effects.

The Social Accounting Matrix

The social Accounting Matrices (SAMs) are a bit more robust than the I-O tables. SAMs can be extremely detailed, embedding commodity purchases, occupations staffing matrices, detailed government accounts, and even demographic information. The social accounting framework used for this report was derived from the IMPLAN data software and has a structure as follows.

		A	C	F	INST	T(FT)	T(DT)
		1	2	3	4	5	6
A	1		MAKE				
C	2	USE			IUSE	CEXPRT	CEXPRT
F	3	FD				FEXPRT	FEXPRT
INST	4		IMAKE	FS	TRNSFR	IEXPRT	IEXPRT
T(FT)	5		CIMPRT	FIMPRT	IIMPRT	TRNSHP	TRNSHP
T(DT)	6		CIMPRT	FIMPRT	IIMPRT	TRNSHP	TRNSHP

The interpretation of this matrix is slightly different than that of the I-O model. Here the rows and columns match so that the entire matrix is square. In this case A represents the set of industries, C is the set of commodities, F is the set of factors used in production (these are synonymous with the value added components of the I-O table), INST represents institutions such as households, governments, and other non-industry organizations, T(FT) represents foreign trade and T(DT) represents U.S. or domestic trade.

Segments of the SAM that are gray represent regions where there are no transactions. For example, in the SAM industries do not buy from other industries, they buy commodities and this shows up as the “USE” table. Industries also purchase land, labor, capital, and government services. Those purchases are displayed in the “FD” or factor demand segment of the SAM. Industry output is reported in the “MAKE” matrix, though institutions such as government can produce commodities as well. State run power facilities are a good example of institutions producing a commodity. Commodities may also be imported from other parts of the U.S. and from abroad via the CIMPRT tables. Institutions also buy commodities and transfer wealth amongst themselves. Those activities are captured in the “IUSE” and “TRNSFR” tables. Factors available for productive use are supplied by institutions, “FS”, and may be imported in some cases “FIMPRT”. The “FEXPRT” and “IEXPRT” represent factors of production and institutional output that are sold outside of the regional economy.

Appendix 2: Port of Douglas County report on Fiscal Impacts of Data Centers[2]

ECONOMIC IMPACT OF DATA CENTERS

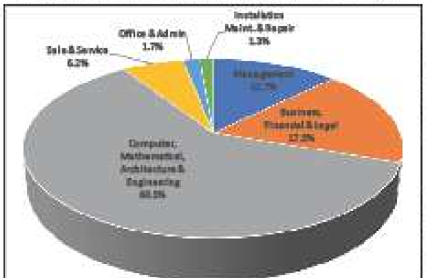
In 2016 18 firms filed reports with the Washington State Dept. of Revenue for the Data Center Sales and Use Tax Exemption. Of those 2 reported no employees in Washington State, 2 (Boeing and Alaska Airlines) reported total employment across multiple tax exemptions on the same report. The remaining 14 firms reported direct employment of *821 employees.

Distribution of Employees by Occupation and Wage - CY 2016

Occupational Class	# of Employees	% of Employees	Min. Wage to $10	$10.01 to $15	$15.01 to $20	$20.01 to $30	$30.01 & Over
Management	104	12.7%	0	0	0	5	199
Business, Financial & Legal Operations	144	17.5%	0	0	3	7	134
Computer, Mathematical, Architecture & Engineering Legal Operations	497	60.5%	7	8	52	63	367
Sales and Service	51	6.2%	0	0	0	0	51
Office & Administrative Support	14	1.7%	1	0	0	4	9
Installation, Maintenance & Repair	11	1.3%	0	0	0	7	4

Source: Washington State Dept. of Revenue Tax Incentive Report Summays

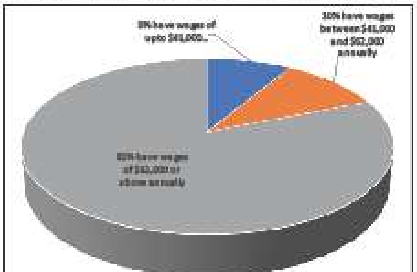
*Data Center employment information excludes Alaska Airlines and Boeing



Data Center Employment by Occupation

Of the 821 jobs 664 (80.8%) pay more than $62,000 per year, 96% were full time and eligible for medical and retirement benefits.

Note: This does not include contracted labor such as security, HVAC, building and grounds maintenance...


Data Center Employment by Wage

Grant County Top 10 Property Owners by Value

The top 10 property owners by assessed value (both real and personal) in 2006, prior to the data centers, comprised 6.40% of the total county asssessed value and totaled $312,997,310. In 2018 that number had changed to 26.35%. In 12 years, the total assessed value of the top 10 property owners in Grant County increased by 664.75%.

2006 Property Tax (prior to data center investments)

Top Companies 2006	Assessed Value	% of Tax
JR Simplot	$51,612,385	1.1%
Lamb Weston	$42,840,855	1.0%
Inflation Systems	$50,343,735	0.9%
Chemi-Con Materials	$38,072,695	0.8%
EKA Chemicals	$28,661,160	0.6%
Basic American Foods	$24,184,160	0.5%
Columbis Colstor	$20,882,130	0.4%
Solar Grade Silicon	$20,107,815	0.4%
Advanced Silicon	$18,411,340	0.4%
National Frozen Foods	$17,861,035	0.4%
Totals for Top Ten	$312,977,310	6.40%

2018 Property Tax (after data center investment)

Top Companies 2018	Assessed Value	% of Tax
**Microsoft*	$1,407,124,080	11.79%
Yahoo Holdings	$202,302,630	1.69%
Boeing Co.	$125,281,700	1.05%
Oath Holdings	$117,697,370	0.99%
U. S. Services	$107,238,140	0.90%
RES Silicon	$96,537,395	0.81%
Vantage Data Centers	$90,000,000	0.75%
Intergate Quincy	$83,320,960	7.00%
Intergate Quincy II	$82,679,000	0.69%
H5 Data Centers	$81,310,110	0.68%
Totals for Top Ten	$2,393,491,385	26.35%

Grant County's data centers had a combined assessed value of $2,179,219,745... $2,163,173,825 is located within Quincy's Taxing District. The combined tax contribution to the county was $24,449,678 of which $14,902,744 went to support schools.

Produced by the Port of Douglas County

[2] Contact Tim Nadreau at timothy.nadreau@wsu.edu to request a PDF of the Port of Douglas County findings.

Appendix 3: *2-Digit Staffing matrix for NAICS 518000 Data Processing, Hosting, and Related Services*

SOC Code	Title	Employment (1,000)	Percent of industry	Percent of occupation
11-0000	Management occupations	28.5	9.5%	0.3%
13-0000	Business and financial operations occupations	30.8	10.3%	0.4%
15-0000	Computer and mathematical occupations	123.5	41.2%	2.8%
17-0000	Architecture and engineering occupations	2.3	0.8%	0.1%
19-0000	Life, physical, and social science occupations	0.2	0.1%	0.0%
23-0000	Legal occupations	1.3	0.4%	0.1%
25-0000	Education, training, and library occupations	0.1	0.0%	0.0%
27-0000	Arts, design, entertainment, sports, and media occupations	3.7	1.2%	0.1%
29-0000	Healthcare practitioners and technical occupations	1.1	0.4%	0.0%
33-0000	Protective service occupations	0.3	0.1%	0.0%
37-0000	Building and grounds cleaning and maintenance occupations	0.2	0.1%	0.0%
41-0000	Sales and related occupations	23	7.7%	0.1%
43-0000	Office and administrative support occupations	79.5	26.5%	0.3%
47-0000	Supervisors of construction and extraction workers	0.1	0.0%	0.0%
49-0000	Installation, maintenance, and repair occupations	2.1	0.7%	0.0%
51-0000	Production occupations	1.5	0.5%	0.0%
53-0000	Transportation and material moving occupations	0.8	0.3%	0.0%
00-0000	**Total, all occupations**	**299.6**	**100.0%**	**0.2%**

Source: Bureau of Labor Statistics

This staffing matrix for Data Processing, Hosting, and Related Services shows the mix of 2-digit SOC codes. The first and second columns provide the occupations and titles. The third column provides the number of employees for that occupation employed within NAICS 518000. The fourth column is the percent of industry employment composed by the occupation and the final column shows the percent of the occupation employed by the industry. If I read the row for SOC 15-0000, I see that Data Processing, Hosting, and Related Services employs 123.5 thousand people in Computer and Mathematical Occupations and that occupation represents 41.2% of total employment in the industry. However, of all the individuals employed in Computer and Mathematical Occupations, only 2.8% show up in this particular industry.

Appendix 4: *Technology Industries from CompTIA and for Wenatchee*

A one indicates industries included as part of the tech sector and a zero indicates exclusion from the tech sector. Only 9 industries appear in both tech sector descriptions: Electronic Connector Manufacturing; Other Measuring and Controlling Device Manufacturing; Data Processing, Hosting, and Related Services; Engineering Services; Testing Laboratories; Custom Computer Programming Services; Computer Systems Design Services; Other Computer Related Services; Computer and Office Machine Repair and Maintenance.

NAICS	Description	CompTIA Tech Industries	Wenatchee Valley Tech Industries
333242	Semiconductor Machinery Manufacturing	1	0
333922	Conveyor and Conveying Equipment Manufacturing	0	1
333993	Packaging Machinery Manufacturing	0	1
334111	Electronic Computer Manufacturing	1	0
334112	Computer Storage Device Manufacturing	1	0
334118	Computer Terminal and Other Computer Peripheral Equipment Manufacturing	1	0
334210	Telephone Apparatus Manufacturing	1	0
334220	Radio and Television Broadcasting and Wireless Communications Equipment Manufacturing	1	0
334290	Other Communications Equipment Manufacturing	1	0
334310	Audio and Video Equipment Manufacturing	1	0
334412	Bare Printed Circuit Board Manufacturing	1	0
334413	Semiconductor and Related Device Manufacturing	1	0
334416	Capacitor, Resistor, Coil, Transformer, and Other Inductor Manufacturing	1	0
334417	Electronic Connector Manufacturing	1	1
334418	Printed Circuit Assembly (Electronic Assembly) Manufacturing	1	0
334419	Other Electronic Component Manufacturing	1	0
334510	Electromedical and Electrotherapeutic Apparatus Manufacturing	1	0
334511	Search, Detection, Navigation, Guidance, Aeronautical, and Nautical System and Instrument Manufacturing	1	0
334512	Automatic Environmental Control Manufacturing for Residential, Commercial, and Appliance Use	1	0
334513	Instruments and Related Products Manufacturing for Measuring, Displaying, and Controlling Industrial Process Variables	1	0
334514	Totalizing Fluid Meter and Counting Device Manufacturing	1	0
334515	Instrument Manufacturing for Measuring and Testing Electricity and Electrical Signals	1	0
334516	Analytical Laboratory Instrument Manufacturing	1	0
334517	Irradiation Apparatus Manufacturing	1	0
334519	Other Measuring and Controlling Device Manufacturing	1	1

334613	Blank Magnetic and Optical Recording Media Manufacturing	1	0
334614	Software and Other Prerecorded Compact Disc, Tape, and Record Reproducing	1	0
335311	Power, Distribution, and Specialty Transformer Manufacturing	0	1
336411	Aircraft Manufacturing	0	1
336414	Guided Missile and Space Vehicle Manufacturing	1	0
336415	Guided Missile and Space Vehicle Propulsion Unit and Propulsion Unit Parts Manufacturing	1	0
336419	Other Guided Missile and Space Vehicle Parts and Auxiliary Equipment Manufacturing	1	0
423420	Office Equipment Merchant Wholesalers	0	1
423430	Computer and Computer Peripheral Equipment and Software Merchant Wholesalers	1	0
511210	Software Publishers	1	0
517311	Wired Telecommunications Carriers	0	1
517312	Wireless Telecommunications Carriers (except Satellite)	0	1
517410	Satellite Telecommunications	1	0
517911	Telecommunications Resellers	1	0
517919	All Other Telecommunications	1	0
518210	Data Processing, Hosting, and Related Services	1	1
519130	Internet Publishing and Broadcasting and Web Search Portals	1	0
541330	Engineering Services	1	1
541380	Testing Laboratories	1	1
541511	Custom Computer Programming Services	1	1
541512	Computer Systems Design Services	1	1
541513	Computer Facilities Management Services	1	0
541519	Other Computer Related Services	1	1
541713	Research and Development in Nanotechnology	1	0
541714	Research and Development in Biotechnology (except Nanobiotechnology)	1	0
541715	Research and Development in the Physical, Engineering, and Life Sciences (except Nanotechnology and Biotechnology)	1	0
551112	Offices of Other Holding Companies	0	1
551114	Corporate, Subsidiary, and Regional Managing Offices	0	1
561621	Security Systems Services (except Locksmiths)	0	1
611420	Computer Training	1	0
811211	Consumer Electronics Repair and Maintenance	1	0
811212	Computer and Office Machine Repair and Maintenance	1	1
811213	Communication Equipment Repair and Maintenance	1	0
811219	Other Electronic and Precision Equipment Repair and Maintenance	1	0