Renewable Energy Industry Trends and Workforce Development in Washington State

Prepared By:
Alan Hardcastle &
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EXTENSION ENERGY PROGRAM

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About the WSU Extension Energy Program

The Washington State University Extension Energy Program (WSU Energy Program) is a recognized leader in energy research, development and technology transfer. The WSU Energy Program works with government agencies, power marketers, utility consortiums, educational institutions, private businesses and industries on projects that promote energy conservation, research, development of renewable energy sources, and economic and workforce development.

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Executive Summary

The renewable energy industry globally, nationally, and in Washington State is in the midst of tremendous change. Significant growth in the renewable energy sector has occurred in recent years, and forecasts show that this trend is likely to continue. Forty-eight percent of planned generating capacity additions in Washington through 2011 are renewables. Washington is on the leading edge of new developments in renewable energy, and the state is well positioned to accelerate the shift toward a clean energy economy to support state environmental and economic goals. But future growth in renewables will also depend on our ability to supply a well-qualified workforce to design, build, operate and maintain renewable energy plants and equipment.

Chapter One provides background and an overview of renewable energy growth at the global, national and state levels. The current status of renewable energy in Washington is discussed, including the opportunities and challenges for further development of six of Washington's renewable energy resources: Hydropower, bioenergy, wind, solar, geothermal, and ocean/tidal energy (see also Appendix A).

Chapter Two addresses some of the key workforce development and training issues identified through a detailed interview survey of 27 state renewable energy employers and experts in four renewable sectors: wind, solar, bioenergy, hydro efficiency upgrades and small hydro. Analytical summaries for each sector are provided that describe respondents' perspectives on industry growth, the renewable energy workforce, education and training, and related issues. State renewable energy education and training programs as well as related technical programs are identified (see also Appendix B), and a summary analysis of the renewable energy industry for the Pacific Mountain Workforce Development Area is provided in Appendix C.

Conclusions

<u>State policies driving renewable growth</u>: Chapter One shows that environmental concerns, market circumstances and the state's interest in developing a clean energy-based economy are spurring the development of government policies that encourage growth in renewable energy sectors. These policies are having a visible impact on development of the state's renewable resources. Hydropower represents 75 percent of Washington's electricity generation. However, large hydropower sites have been fully developed across the state (and the U.S.) thus the potential for expanding hydropower is limited to efficiency upgrades at existing facilities and selective additions of small hydro facilities, both of which are resources targeted for development by state policies. Bioenergy accounts for about six percent of the state's primary energy use, followed by wind energy, which is the state's fastest-growing renewable sector. Solar and geothermal provide small amounts of renewable energy, and there is currently no ocean/tidal energy production in the state. These uneven patterns of development exist for several reasons, including differences in the provision of various financial incentives for businesses and consumers (in the form of tax rebates, discounts, etc.), consumer awareness and support for specific renewables, and the commercial availability of technologies in each sector.

The state's renewable portfolio standard (I-937), which requires major utilities to boost the proportion of renewable energy they provide to consumers, is a key driver for growth in renewables. In some sectors, such as solar, I-937 has had a moderate impact on renewable growth. Industry forecasts show that growth in renewables is likely to continue well into the future. Recent federal legislation and investment in renewable energy will serve to reinforce and accelerate private-sector investment and new public and private-sector development of renewables in Washington State.

Renewable energy employers optimistic: Chapter Two shows that most renewable sector employers report they are optimistic about the prospects for future growth in their sectors. Nearly all agreed that the national recession had some negative effects, but these effects were generally viewed as temporary setbacks to planned growth and development. Most employers believe that growth will resume as federal stimulus investments are made and the economy improves. Biopower employers are faced with an acute shortage of feedstock, which is a direct consequence of the recession and sharp declines in industries such as manufacturing and construction that are important sources of biomass.

Growth in renewable energy uneven: The expansion of wind has been steady and is forecast to continue to be strong for the next several years. But fluctuating tax incentives, integration and transmission constraints, existing regulations and codes, and lack of experience with some energy resources have limited broader acceptance of some renewables. In other instances, the technologies are rapidly evolving, however consumers—including utilities and the general public—are waiting for technology advances and lower costs before investing in some renewables, especially solar, hydroelectric efficiency upgrades and small hydro.

Future workforce shortages: While nearly all employers reported acute shortages of qualified workers in some occupations, the overriding concern was the availability of qualified new workers to support future growth in the four renewable sectors. Weak preparation among new applicants, a general lack of interest in energy careers by young people, and declines in secondary vocational programs and some college programs are among the leading concerns of employers. Anticipated employee retirements and the work conditions of many renewable occupations are viewed as added challenges to recruiting and retaining a qualified energy workforce.

A multi-skilled renewable workforce: Employers identified a range of occupations and skills needed to support renewable energy operations at their companies. There were a number of similarities in occupational types, functions and specialty areas. Employers also identified information systems, business, financial, legal, and environmental and biological sciences as increasingly important skill sets for their sector. Many employers emphasized the value-added of employees who had skills in more than one craft or related area of expertise, such as electrical, mechanics and electronics. Multi-skilled employees are more versatile and able to quickly adapt to new technologies and work processes. Some employers noted the need for engineers to develop financial management and regulatory skills in addition to technical expertise. While specialists such as technicians or engineers are highly-valued, many employers emphasized the benefits of developing a multi-skilled workforce for their companies and for the career mobility of their employees.

Core skills often lacking: Most employers reported that the foundational skills, abilities and work required of employees in renewable jobs are very similar for most types of craft-level occupations. Indeed, many employers described the core work of craft-level employees as fundamentally the same as the job functions and tasks of employees in related non-renewable energy jobs and other industrial sectors. Employers were also consistent in their description of the core skills needed for craft-level jobs, identifying them in terms of the academic, general employability, and technical skills that they expect of their current employees and future workers. Many employers reported serious academic skill gaps among new hires and job applicants, especially among younger and less-experienced workers and job applicants. Basic math, writing and communication skills were often described as inadequate for entry-level employment.

While all employers expect employees to have the requisite technical skills needed to perform their jobs—especially electrical and mechanical skills—many employers noted the need for technicians to advance their knowledge and skills using electronics, as the use of computer-driven controls, networks and databases, diagnostic equipment and software is becoming more prevalent. Some employers said that the emphasis on electronics and computer-based systems meant it is harder to find new employees with experience using basic hand tools and instruments.

General employability skills—including teamwork, interpersonal communications, problem solving, and understanding the components of energy generation as a system—were frequently identified by employers as essential for ensuring employee productivity, but also as a key safety factor. New job applicants and younger workers were often described as lacking some of these employability skills. Similarly, several employees expressed a concern that younger job applicants and employees lack the levels of 'work ethic' that they want. While not a skill per se, work ethics were viewed as important as they reflect employee values, attitudes and behaviors that effect work performance, commitment and a willingness to acquire new skills.

Workforce education and training capacity limited: One of the most common issues raised by employers was the lack of post-secondary programs in the region that offer training specifically in renewable sector occupations. Employers often expressed an interest in having additional training options in the region for upgrading the skills of existing workers, and especially to help prepare and expand the future pool of new craft workers. The desire to expand sector-specific renewable training in the state was echoed by employers in all renewable sectors. Many respondents noted that vocational programs and applied technical courses in secondary schools and some colleges that prepare students for careers in the energy industry have been consolidated or eliminated over the years. Employers view these programs as providing an important educational foundation and future platform for the core skills needed in most renewable energy jobs and careers. For some renewables, particularly solar and small hydro, new technological advances may significantly alter the training and education needs of the industry. Emerging "plug and play" components and systems may ease installation, but they may also require more specialized education and training programs for a broader range of employers and occupations.

Analysis of renewable sector training in Washington State shows that there are very few postsecondary programs or courses specifically designed for renewable sectors or occupations, and a number of these consist of short-term certificates intended as upgrade training for individuals with experience in related technical areas. Yet many post-secondary education and training institutions are already providing much of the core training needed by the renewable industry. The general nature of these foundation skills is noteworthy because it means that employers are able to leverage relevant training offered through an infrastructure of postsecondary energy technology programs and registered apprenticeships that already exists and could be expanded. Many of these programs provide training in transferrable skill areas that are relevant to renewable sectors and occupations.

Training delivery options: All employers identified multiple ways in which training was delivered to employees, ranging from internal on-the-job training (OJT), apprenticeship programs and community and technical colleges, to training provided by equipment vendors and manufacturers and professional associations. By far the most common model for delivering training to technician-level employees was some form of OJT. Applied learning approaches that combine learning and doing were viewed as a critical training feature by all employers.

Employers find it difficult to secure adequate time and resources to provide training for employees, and OJT is the most feasible option for many small employers. Some employers send employees off-site for training as needed, but for all employers the costs associated with travel and lost productivity are a concern. Online training options are becoming more common among employers in each sector, and the majority of employers reported that they plan to increase their use of online training delivery as it offers many advantages. But some employers reported several reasons that may limit their use of online training delivery, including employees' lack of computer skills or the need to integrate computer-based learning with applied experiences, especially for craft-level occupations.

Many employers expressed keen interest in seeing an expanded number of renewable training options through regional community and technical colleges, but there were some concerns about colleges' ability to provide up-to-date equipment and provide flexible scheduling for their employees. Some employers wondered whether college-based programs would be sufficiently tailored and standardized for their renewable sector to ensure that future programs meet the skill needs of employees.

Implications

Industry forecasts noted in this report and feedback from employers suggests that while progress in developing renewable energy is somewhat uneven, overall growth in the state's renewable energy industry is likely to continue and accelerate in the future. The state is a national leader in renewable energy development and has enacted policies and regulations that position renewable energy as a central strategy for achieving energy security and environmental protection goals, however many challenges remain. A central question is whether Washington State will be prepared to effectively support and sustain growth in this important industry.

Policies and incentives for growth: A concern expressed by several renewable employers is that federal and some state policies regarding long-term incentives for renewables are not stable, which makes it difficult for new businesses to start up, and hard for existing companies to grow. Faced with an uncertain state policy or regulatory structure, anticipating employment and skill needs is also difficult, and these businesses may be reluctant to add new employees, or invest in education and training needed to upgrade and expand the skills of incumbent workers. Analyses of federal and state policies and input from industry and other stakeholders should be collected to determine the specific effects of existing policies and incentives for each renewable sector in the state to determine what combination of future policies and investment incentives hold the most promise for Washington's renewable energy industry, and how best to create and implement those changes.

Renewables as an integrated system: Each sector is part of a broader state portfolio of clean energy resources that are best viewed as an integrated system rather than as a collection of independent actors; the success or failure of any one renewable sector will affect our ability to grow a clean energy economy. Thus one implication is that the state should support the development of a deliberate strategic plan in which renewable energy sectors are examined as integrated resources for which a systematic state policy framework and supportive incentive structure is developed.

State leadership and strategy development that taps the collective wisdom of industry, labor, education and economic development stakeholders is also needed to arrive at informed decisions about investments of federal stimulus funds for renewable energy. Federal ARRA funding provides a unique, one-time opportunity to make significant investments in research and development, and the commercialization of clean technologies, to support new business startups and expansions, and to make strategic investments in the state's education and training infrastructure. Collectively, these investments off great potential for stimulating new job growth and jump-starting our state's clean energy economy, especially if we simultaneously invest wisely in education and training policies and programs that will be needed to ensure that growth in the state's renewable energy sectors are sustained well into the future. Washington's recently convened Clean Energy Leadership Council, created with the passage of Senate Bill 5921, provides an excellent vehicle for developing a clean energy strategy for the state that addresses the important role that the state's education and training system can and should play in supporting future growth in the renewable energy industry.

Renewable energy education and training: Available studies on the renewable energy workforce and feedback from the employers suggest that growth in renewable sectors will generate many new jobs, and that the demand for qualified workers will continue to grow. While most employers said they now have some acute shortages in some positions, most respondents are anticipating serious labor shortages as the market for renewable energy expands. Many employers emphasized that there are too few sector-specific programs, and that more training capacity is needed. They want new education and training programs that are responsive to their needs, and they want these programs to be based on industry-defined standards to ensure they are relevant to the needs of their employees, their companies, and the industry as a whole.

Analyses of existing renewable programs in the state suggest that employers' concerns are warranted, as very few sector-specific postsecondary training programs now exist. Although more programs are being developed, it is unclear whether these new programs will be sufficient to meet future demand. Additional research is needed to estimate job growth in the state's leading renewable sectors. These forecasts should be used to strategically align new program development to anticipate and meet future needs.

Currently, most employers rely on a number of sources to get their employees the education and training they need. Many new employees coming into the renewable industry have backgrounds and experience in energy-related industry sectors, including relevant postsecondary education and training in key technical occupations. Most employers reported that the majority of technician-level jobs in renewable energy rely on core skills and abilities that are common to many related occupations and industries. In short, these core technical programs—even if non-specific to renewable sectors—are important because they impart foundational skills that are already required by employers. These foundational programs also provide students and incumbent workers with transferrable skills that increase their employment and career options.

Existing technical education and training programs should also be targeted for expansion, but in specific ways that can directly respond to the skill requirements of renewable energy jobs. Rather than creating entirely new programs, education and training providers should collaborate to integrate existing technical training programs with a series of new specialty courses and certificate programs that would give students the sector-specific knowledge and skills needed to qualify them for entry-level employment. These specialty courses and programs should be developed in partnership with sector employers and subject-matter experts to ensure buy-in from the industry and consensus about the standards for course content. A secondary option is to integrate specific renewable content into existing foundational courses or programs, however this approach may require modifications to an entire sequence of courses and the new content may be less evident to industry employers.

Expanding program delivery options using online and other communications technologies will continue to be an attractive option for companies, students and incumbent workers. These and other innovative approaches offer great promise for renewable energy program delivery especially if they also integrate applied learning experiences and can be delivered regionally.

Career pathways showing the connections between foundational programs, specialty renewable courses, certificates and degrees should be created to clarify for students and employers how these programs and courses fit together. Renewable pathways would clarify these connections for new and incumbent workers, and can be used to guide program and curriculum alignment, and to establish articulation agreements among K-12, two-year degrees and certificates, apprenticeship programs, and university-level degrees and continuing education. Expanding the renewable energy workforce pipeline and equipping future workers with the skills they need requires that students, employers and incumbent workers have access to a full range of education and training opportunities that can help support and sustain growth in the state's renewable energy industry.

The ability of Washington's education and training system to respond to the needs of renewable energy employers will depend not only on expanding program capacity, but on having in place a strategic approach that includes strong statewide coordination for the development and delivery of renewable energy programs that anticipate and meet the growing demand for a renewable energy workforce. State leadership and financial support for the development of these programs is critical, but effective coordination between existing state education and training delivery systems is also essential to ensuring a focused and efficient approach.

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Introduction

This report identifies current trends in major renewable energy sectors in Washington and the implications for workforce development. Chapter One of the report provides an overview of the renewable energy sectors of Washington, the U.S. and the world, including the forecasted growth for these sectors and the policy drivers behind the shift to a clean energy economy. Chapter Two incorporates data collected from employers representing wind, solar and biomass. Hydroelectric energy efficiency upgrades and small-scale hydro are also included, as they are identified under the state's renewable portfolio standard (I-937).

Chapter One begins with an overview of the current global change underway in the energy sector, the political environment driving this change, and recent and forecasted growth in the renewable energy and efficiency sectors in the world, the U.S. and in Washington State. Appendix A provides a detailed look at Washington's renewable energy industry, including the industry participants by major fuel type, historic production and growth projections, consumers of renewable industry output, and national and global perspectives. Appendix A also looks at industry trends including the major drivers, challenges and opportunities for each major renewable fuel type and projections for renewable energy output.

Chapter Two looks more deeply at the renewable energy workforce, and identifies the key workforce issues raised by employers that affect the degree to which the current and future workforce is prepared to support this renewable energy growth. The chapter is based upon interviews and supplementary data from 27 renewable sector employers. Chapter Two identifies employers' perspectives on growth in renewable sectors, future labor and skill needs, the existing education and training infrastructure and programs for renewable energy sectors. The chapter also identifies potential gaps and action steps. The primary focus of the research is on craft/technician-level jobs that require sub-baccalaureate education or training (apprenticeship, two-year associate degrees or short-term certificates). A secondary focus was on other key renewable occupations that emerged during the interviews with sector employers, including those requiring baccalaureate-level degrees or other higher-level skills.

Chapter One: Energy in Context

This section contains global, national and state-level overviews of the energy sector, including consumption and production levels, growth forecasts and political influences. Appendix A provides a detailed look at Washington's renewable energy industry.

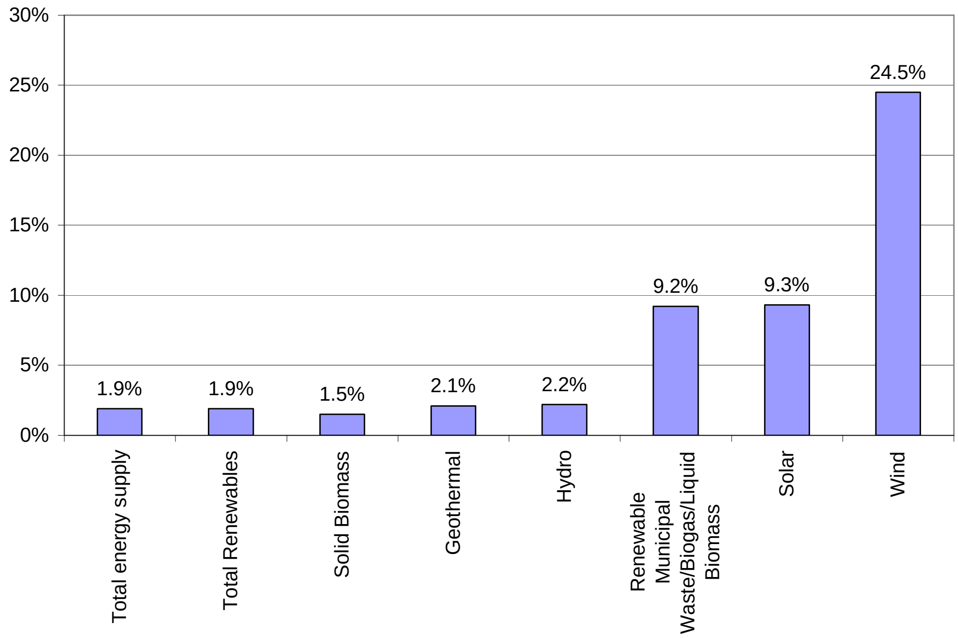
Global Energy Overview

The global energy industry is entering a period of unprecedented change. The critical relationships between energy, the economy and the environment are becoming well known, and there is a growing sense of urgency to address climate change. This call for action is clearly expressed in the *World Energy Outlook 2008* by the Organization for Economic Cooperation and Development, International Energy Agency (OECD IEA):

> It is not an exaggeration to say that the future of human prosperity hinges on finding a way of supplying the world's growing energy needs in a way that does not irreparably harm the environment. Until recently, it looked as if we had plenty of time to meet that challenge. No longer. Surging oil and gas prices have drawn attention to the physical and political constraints on raising production — and the vital importance of affordable supplies to the world economy. And the latest scientific evidence suggests that the pace of climate change resulting from man-made emissions of greenhouse gases — the bulk of which come from burning fossil fuels — is faster than predicted. The urgent need for a veritable energy revolution, involving a wholesale global shift to low-carbon technologies, is now widely recognised.[1]

Coinciding with this urgent message is an unprecedented rate of growth in the recent development of renewable energy resources worldwide, as shown in Figure 1.

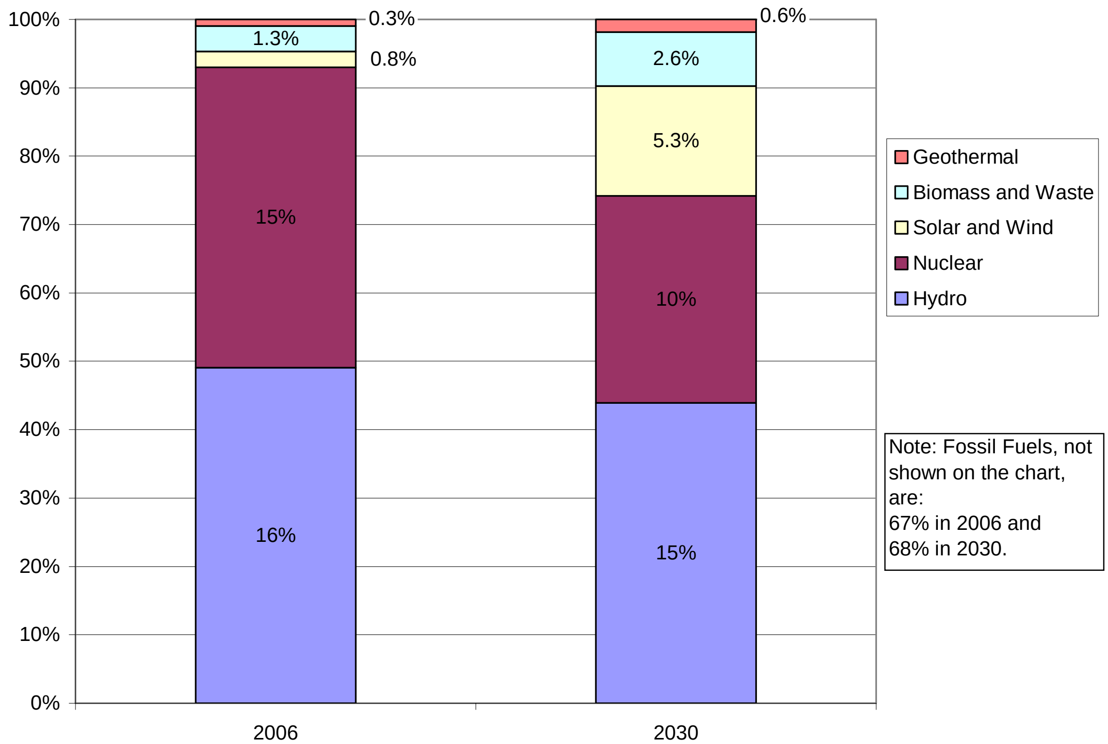
Figure 1. Annual Growth Rates of World Renewable Energy Supply, 1990-2006[2]



The global forecast for renewables shows that more change is coming—and at an even faster pace. As shown in Figure 2, world renewables-based electricity generation — mostly hydro and wind power — is projected to rise from 18 percent of total electricity generation in 2006 to 23 percent in 2030. At the same time, however, fossil fuel (not shown in the chart) is projected to maintain its lead as the largest electricity generation resource; in 2006 all fossil fuels combined equaled 67 percent of generation, and in 2030 it is forecasted to be 68 percent.

By 2015, renewables will overtake natural gas to become the second-largest source of electricity behind coal. Global output of wind power is projected to increase eleven-fold, becoming the second-largest source of renewable electricity after hydro by 2010. The transportation sector will also be affected by growth in the use of renewable fuels: the total supply of renewable road transport fuels worldwide is projected to rise from 1.5 percent in 2006 to 5 percent in 2030, spurred by subsidies and high oil prices.[3]

Figure 2. 2006 Global Electricity Production by Fuel, and Forecast for 2030[4] (<u>excludes fossil fuel</u>)



Between 2006 and 2007, global revenue from renewable energy and energy efficiency industries increased forty percent, totaling $77 billion worldwide.[5] Global investment in clean energy technologies expanded sixty percent to $148.4 billion during this same period. Venture capital investments in the U.S. alone quadrupled from $599 million in 2000 to $2.7 billion in 2007.

Investments in renewable energy supply in the period 2007-2030 are forecast to reach $5.5 trillion (in year 2007 dollars). New renewables-based electricity generation accounts for 48 percent of these total projected investments during the forecast period.

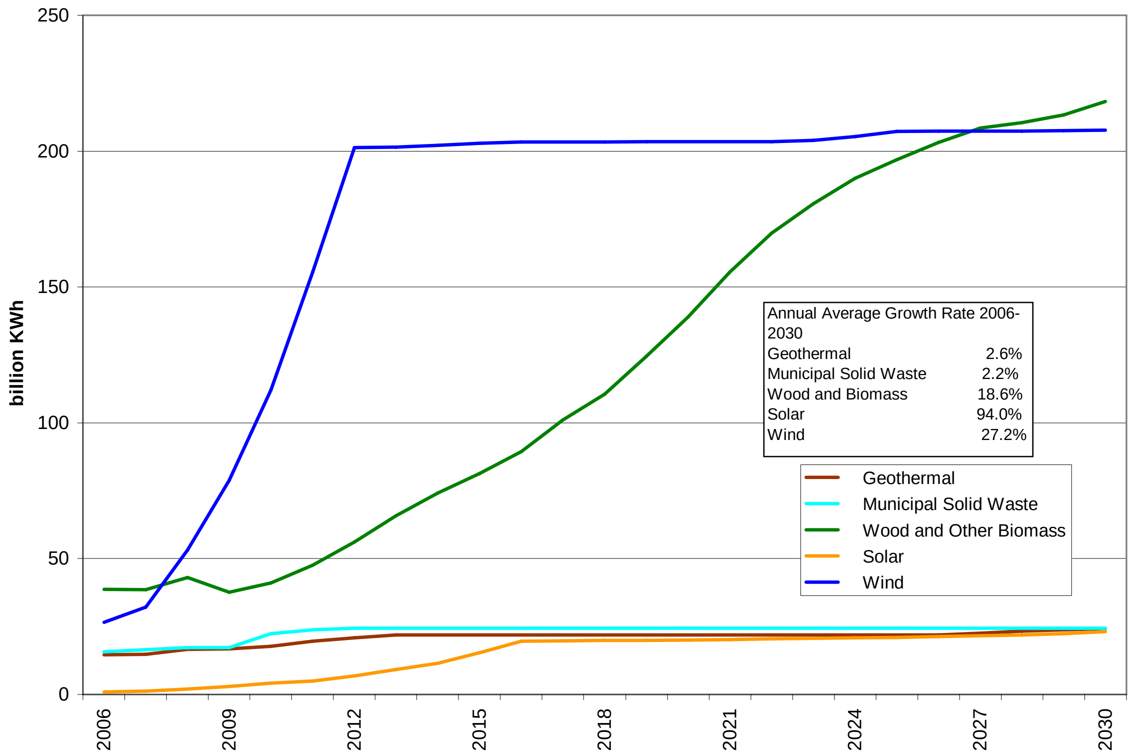
U.S. Energy Overview

Similar to worldwide trends, the U.S. has also seen significant growth in the development of renewable resources for electricity production. The rate of growth is expected to increase steadily in the future, with electricity generated by non-hydro renewables estimated to grow at an annual rate of 4.3 percent through 2030.[6] In the U.S., large conventional hydroelectric generation has reached capacity and no new facilities are expected to be built in the future, although there is significant potential for increasing the output of existing hydropower facilities and adding small generators to existing waterways.[7] Across the U.S., as in Washington State, laws promoting renewable energy reflect the limited ability to develop new large conventional hydropower sites and generally do not target it in policies designed to promote resource options available to meet future growth demand. Figure 3 shows the U.S. Energy Information

Administration's (EIA) figures for non-hydro renewable electricity production in the U.S. and the forecasted production through 2030.

The share of electricity generated from non-hydro renewables is projected to meet 33 percent of the total growth in generation between 2007 and 2030. According to EIA, the share of non-hydro renewable electricity in meeting demand growth probably would be higher if additional states implemented renewable portfolio standards or policies were implemented to limit greenhouse gas emissions. The share of total electricity generation by non-hydro renewables is expected to grow from 8.5 percent in 2007 to 14.1 percent in 2030. Growth of up to 18 percent has been predicted in models where greenhouse gas regulations are taken into account.[8]

Figure 3. U.S. Non-Hydro Renewable Electricity Generation, Current and Future[9]
(includes effects of post-stimulus investments)



The primary drivers of this growth are state renewable portfolio standards and federal production tax credits. To a lesser degree, net-metering laws have also promoted renewables by assisting in the development of small-scale projects. The development of renewable energy certificates (RECs) has created additional incentives for renewables.[10]

National greenhouse gas legislation has not yet passed, but the U.S. House of Representatives have passed initial supporting legislation and is at this time being considered by the Senate. Federal laws limiting emissions is expected within the next few years.[11] States and the financial community are responding as if they anticipate regulations; energy companies are being encouraged to shift investments towards low-carbon technologies.

Historically, when oil prices have dropped, renewable energy projects have become less attractive to investors. However there are signs that this dynamic has changed. While venture capital investments economy-wide declined 8 percent in 2008, dollars invested in clean technology grew more than 50 percent.[12] U.S venture capitalists are still investing heavily in renewables, which represented seven of the ten largest deals in 2008. U.S. Energy Information Administration forecasts dated March, 2009, shown in Figure 3, continue to project a rapid growth rate of over sixteen percent annually for non-hydro renewables through 2030.[13]

Recent fossil fuel price fluctuations have exposed the risk of relying too heavily on this established resource. The federal financial rescue bill from October 2008 recognizes the benefits of diversifying our energy sources by including $18 billion in incentives for clean energy and extension of renewable energy tax credits. The American Reinvestment and Recovery Act of 2009 provides an additional $43 billion towards the goal of "Reviving the renewable energy industry and providing the capital over the next three years to eventually double domestic renewable energy capacity"[14]

The U.S. political landscape has added further support for the development and use of renewable resources under the Obama administration, and policies that are favorable to renewables are moving forward. In addition to nationwide regulation of greenhouse gas emissions, a national renewable portfolio standard, more stringent vehicle emission standards, and other efficiency measures are being proposed.

To date, policies supporting increases in renewables in the U.S. have come primarily from the twenty-four states that have legislatively enacted renewable portfolio standards (RPS). Thirty-eight states, including Washington, have in place (or are now creating) greenhouse gas emission reduction plans, and most of these states are also participating in regional climate action initiatives including emission cap and trade programs.[15] The development and use of renewable energy and energy efficiency are viewed as key strategies for achieving these initiatives.

Municipalities are also engaging in large renewable energy projects. One example is an announcement by the City of Los Angeles that it will add 1,280 MW of solar capacity – more than doubling the existing solar power generated today in the U.S.[16]

Washington's Place in the Energy Industry

Washington's electricity production and energy supply is significantly different from the U.S. and the world. Figure 4 shows electricity production by fuel type for the world, the U.S. and Washington. Compared to the U.S., the world as a whole generates a higher proportion of its electricity from hydropower and somewhat less electricity from fossil fuels. The U.S. has very large coal resources, which are used to generate about half of all electricity.

Washington has the most renewable electricity generation and capacity in the U.S. because it is the leading producer of hydro-electricity. The 7,079 MW Grand Coulee hydroelectric power plant on the Columbia River is the largest capacity electric plant in the United States and is nearly twice the size of the next largest power plant of any kind in the U.S.[17] Washington, like most of the world, has fully developed it's large, conventional hydro capacity and is unlikely to add new large projects in the future. Significant potential remains for increasing the efficiency (and thus, the output) of existing hydropower facilities and adding small, low-impact hydro facilities.[18]

Washington is also fifth in the nation for installed wind capacity. The state has only one large coal plant, located in Centralia, Washington, and is among the top ten states in consumption of bioenergy. Washington's use of biomass for electric power production and total biomass energy generation overall is somewhat unique due to the reliance by many companies on biomass for cogeneration, which is the combined use of power generation and useful thermal output for industrial processes and heating.

The state is a net exporter of electricity, however the seasonal nature of hydro means the state also relies heavily on imported power produced in other states (discussed in further detail at the top of page 9).

It is worth noting that in addition to electric power production, Washington has a key role in providing other energy resources. Although there are very few indigenous fossil fuel resources in Washington, the state's five petroleum refineries comprise the principal refining center for the Pacific Northwest. Additionally, forest resources have led to the state's leadership role in energy-producing forest products.

The U.S. and Washington are highly dependent on energy imports and exports. Figure 5 shows total energy consumption by resource type for the world, the U.S. and Washington. Electricity generation represents just under half of the state's total energy use. Most of the state's energy consumption is petroleum used for transportation. The state's jet fuel consumption is among the highest in the nation, due partly to several large Air Force and Navy installations and partly to the high volume of international flights. The U.S. also consumes about half of its total energy for use in transportation.

Figure 4. 2006 Resource Mix, Electric Power Production[19]

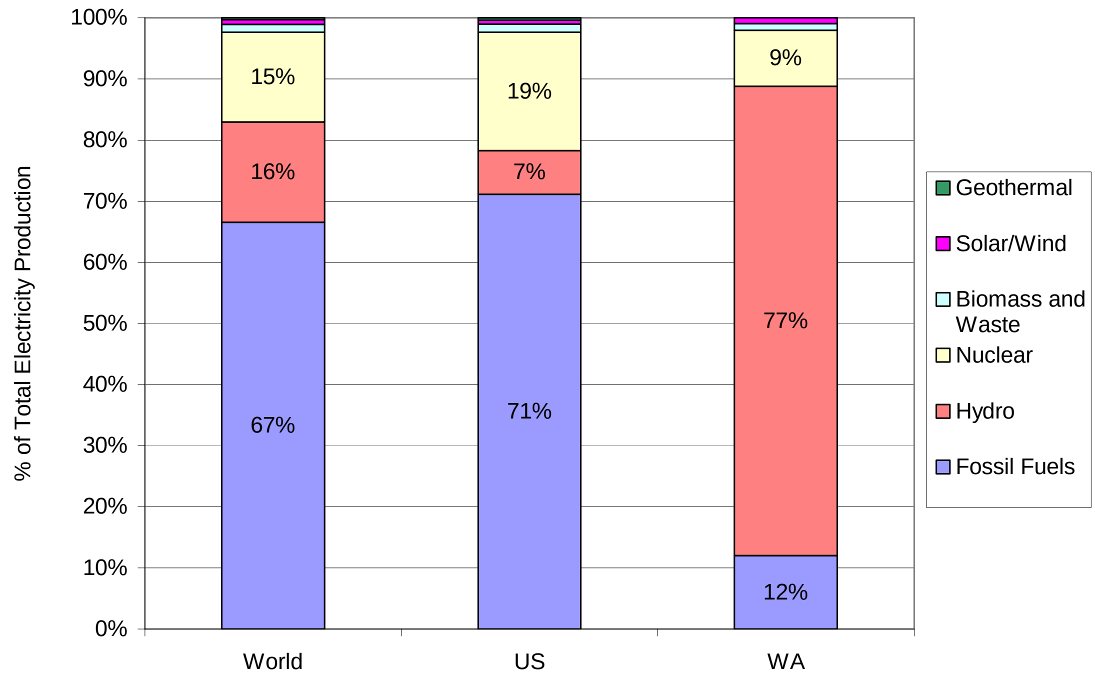
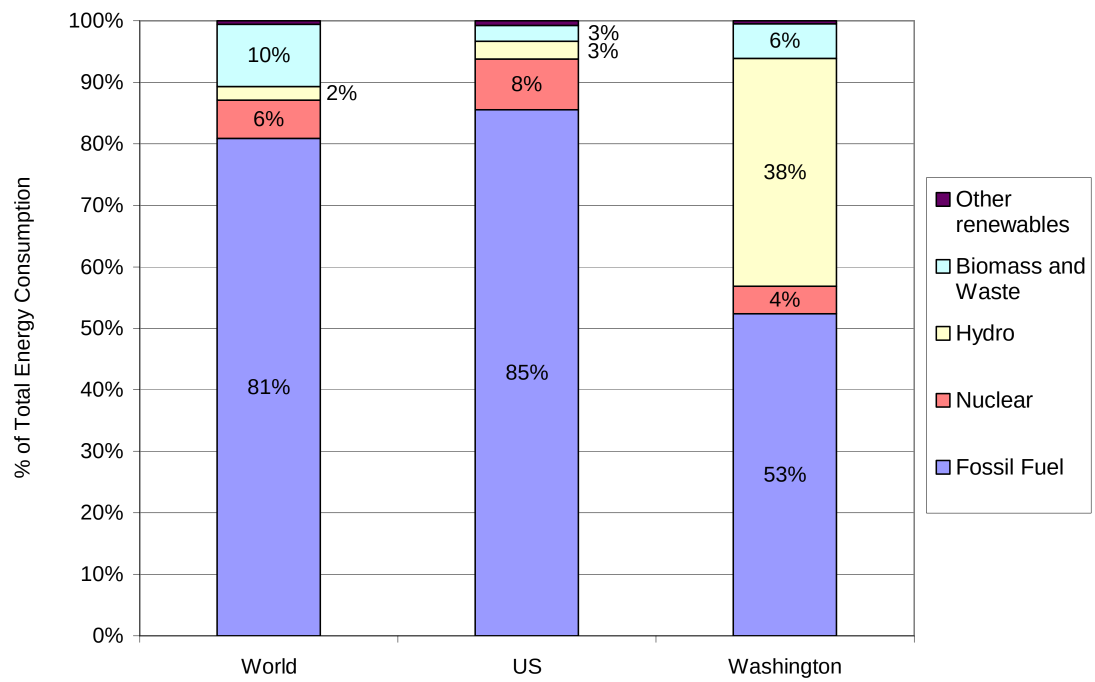


Figure 5. 2006 Resource Mix, Total Energy Consumption (All Fuels)[20]



Awareness of how the region's energy infrastructure has developed is critical to understanding the political and economic forces at work in the region, and how the forces can change the future of the system.

Hydropower is a variable resource which fluctuates depending on numerous factors including rainfall, instream flow and reservoir requirements. Many reservoirs are generally kept quite low during the winter to help manage flooding. In the past, the demand for electricity to meet winter heating needs have far outpaced the summer demand, resulting in a large power surplus in the Northwest – conveniently timed to meet summer cooling demand in California and the desert Southwest. The southern states returned the power to the Northwest in the winter to meet our peak demands, and the Western grid was fairly well synchronized. The power returned to the Northwest is generated primarily from coal, natural gas and nuclear sources.[21]

This arrangement helped keep power prices low for Northwest utility customers and has been a great financial benefit to the Northwest economy. Low power prices have been used for decades to attract electricity-intensive businesses to the region.

Most people in the region believe the electricity they consume is hydropower, because on an annual basis we produce more hydro than we consume annually and we are a net exporter. In reality, electricity consumption in the Northwest had surpassed the hydro system's capabilities back in the mid 1950s and the region has been building primarily fossil-fueled generation since that time.[22]

In the 1970s major transmission connections to the southern states were constructed and the hydro system has since become increasingly integrated with other fuel sources, enabling operations to be optimized across the entire Western half of the United States. Many generating facilities, transmission lines and gas pipelines have been constructed across the western grid system to support this operational pattern. While the financial benefits of the Northwest hydro system are dedicated to the Northwest public utilities, the physical system is blended with many other resources in the West in a large, delicately synchronized, highly weather-dependent balancing act.

Over time, the rapid population growth all across the West put stress on the system, creating multiple challenges. Most new homes in the Pacific Northwest, especially east of the Cascades, now have cooling systems that are creating peaks in summer electricity use comparable to the winter peaks, limiting the power available to export.[23] Citizens in population centers often rejected proposed sites of new power plants near urban centers or residential areas. At the same time, the costs associated with adding transmission capacity made it extremely difficult to connect and deliver power generated in remote areas to the power grid.

The drought of 2000 foreshadowed an acute energy crisis in 2001. In the winter of 2000, an extremely low winter snow-pack occurred in the Northwest. Power marketers quickly realized the situation would limit surplus power available the following summer to meet California's summer demand. The system's vulnerability triggered an unprecedented demand for other generation sources, primarily natural gas, causing prices to skyrocket for all generating fuels.

This dynamic, combined with insufficient power market regulations and oversight, created an opening for market manipulation which in turn triggered summer power shortages in California, and power prices surged all across the west.[24]

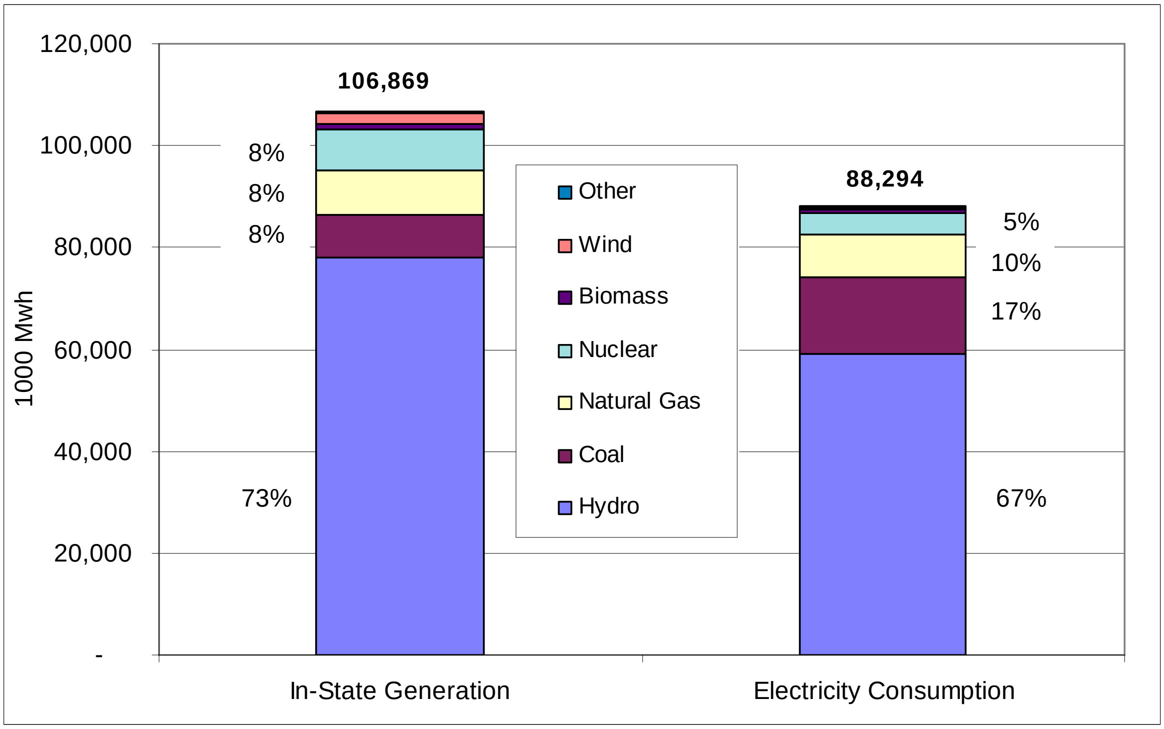
Prior to the power price spikes in 2001, electricity was extremely cheap in the Northwest. Power prices, which had rarely risen over $50 per megawatt-hour, spiked at over $3,000 per megawatt-hour. Since that event, the region has become more aware of the limitations and vulnerability of the hydro system. This has coincided with increased concerns about energy security, environmental protection, climate change and economics, resulting in increasing public support for renewable energy and efficiency programs.

In 1999, the state began collecting data from utilities on the generating resources used to serve customers in Washington, and for the first time was able to compare the sources of power *generated* in the state to the sources of power *consumed* in the state. The differences enlighten our understanding of the connectedness of the power system.

Figure 6 compares generation and consumption data for 2007 (2007 is a fairly representative sample of the trends for recent years.) As shown in the figure, Washington generates more electric power than it consumes, but the power consumed has a larger proportion of coal, at 17 percent of consumption compared to 8 percent of generation. Similarly, natural gas represents 10 percent of consumption compared to 8 percent of generation.

Power plant developers, responding to Washington, Oregon and California's more stringent land-use and environmental regulations, began pushing development of coal plants to the interior western states. Many of these plants were built primarily to export power to the coastal states. When imports are accounted for, these coastal states are clearly not as "clean" as their in-state generation would show. The coastal states have also pressed hard to limit greenhouse gas emissions, even from these imported sources, but have run into difficulty regulating generators located outside their jurisdiction.

Figure 6. 2007 Washington In-State Electricity Generation and Consumption by Fuel Type[25]



In response to growing political will to achieve environmental goals around power generation generally—and to address the growing coal imports specifically—two significant state policies were established. The first was Initiative 937 (I-937), a renewable portfolio standard enacted in 2006 which requires that 15 percent of the power sold to Washington consumers must come from renewable resources by 2020.[26] Washington was the first in the nation to include efficiency targets as well as renewable electricity targets: Washington utilities, under I-937, are required to achieve all cost-effective energy savings. (Cost-effectiveness is determined based on Northwest Power Planning Council methodology. See previous endnote for further information.)

The second policy, which will have more of a long-term impact, is Senate Bill 6001, an emissions performance standard (EPS) that restricts Washington utilities from purchasing electricity from new generating facilities with greenhouse gas emissions exceeding that of a high-efficiency natural gas plant. The intent of this policy, which was passed in 2008, is to prevent further out-of-state coal developers from selling into Washington.

The next significant action to further promote the development of renewable power generation would be to implement a carbon emissions regulation, such as the "cap and trade" program being considered by the Western Climate Initiative.[27] This would require fossil-fueled generators to internalize the cost of emitting greenhouse gases. Renewable generators have long been disadvantaged because they have high initial development costs. They may have very low operating costs and no fuel costs but, relative to the well-established natural gas and coal industries, their higher up-front costs have made renewable projects a hard sell to investors seeking short-term returns. A cap and trade program would set a "cap" – an absolute limit – on emissions, which would ratchet down over time while simultaneously imposing a cost on all emissions, creating an incentive to further reduce or eliminate emissions. Washington is a founding partner of the Western Climate Initiative, the most aggressive cap and trade program being considered in the world.

There is growing evidence that all of these policies and potential actions are accelerating the development and use of renewables. One source of information, the Northwest Power and Conservation Council (NWPCC), shows that between 2003 and 2011, forty-eight percent of planned additions located in Washington will be from renewable resources – wind, biomass, tide and wave energy, solar and efficiency upgrades at hydro facilities. An additional 72 percent of proposed generating projects are from non-hydro renewable resources.[28]

Utility Integrated Resource Plans (IRPs) are another source of information documenting the growing shift toward renewable sources. IRPs are public documents projecting future load growth and laying out the utilities' plans for meeting the growth.
Utilities that are short of supplies to meet their expected energy needs tend to be adding more renewable generation to their portfolios (subsequently meeting I-937 requirements.) Utilities with extensive surplus resources tend to plan on buying renewable energy credits to meet I-937 requirements rather than build new generation capacity. Over the next ten years, Washington utilities plan to decrease both their own coal-powered generation and their purchases of coal-powered generation from others. They also plan to increase their generation and purchases of power from natural gas.[29]

At the same time, the larger utilities with I-937 compliance obligations are ramping up their efficiency programs to historic levels. These utilities plan to meet 6.9 percent of their total load in 2018 with efficiency. This is both in response to I-937 but also to offset the cost of adding new generation.[30] The utilities that are not impacted by I-937 plan to meet less than one percent of their load with efficiency in 2013 and 2018. However, these utilities will likely be influenced by a new rate structure under development at the Bonneville Power Administration (BPA) which will provide an incentive for efficiency.

Statewide, the aggregated total of efficiency resources will equal more than six percent of load by 2018. This is a conservative estimate; it is in addition to existing conservation and efficiency efforts, may not fully include existing efficiency programs funded by BPA, and was estimated prior to knowledge of the federal economic stimulus funds intended to rapidly increase efficiency activities.

The following figures show the integrated renewable and energy efficiency growth plans for Puget Sound Energy and Seattle City Light. Figure 7 shows Puget Sound Energy's expected load growth. The wedge at the top of the figure represents the part of the utility's plan to be met with new efficiency programs. Wind, biomass and new high-efficiency natural gas plants make increasing contributions to meet demand, while the utility ramps down its reliance on spot market purchases and existing resources.

Figure 7. Puget Sound Energy's Plan to Meet Expected Load Growth

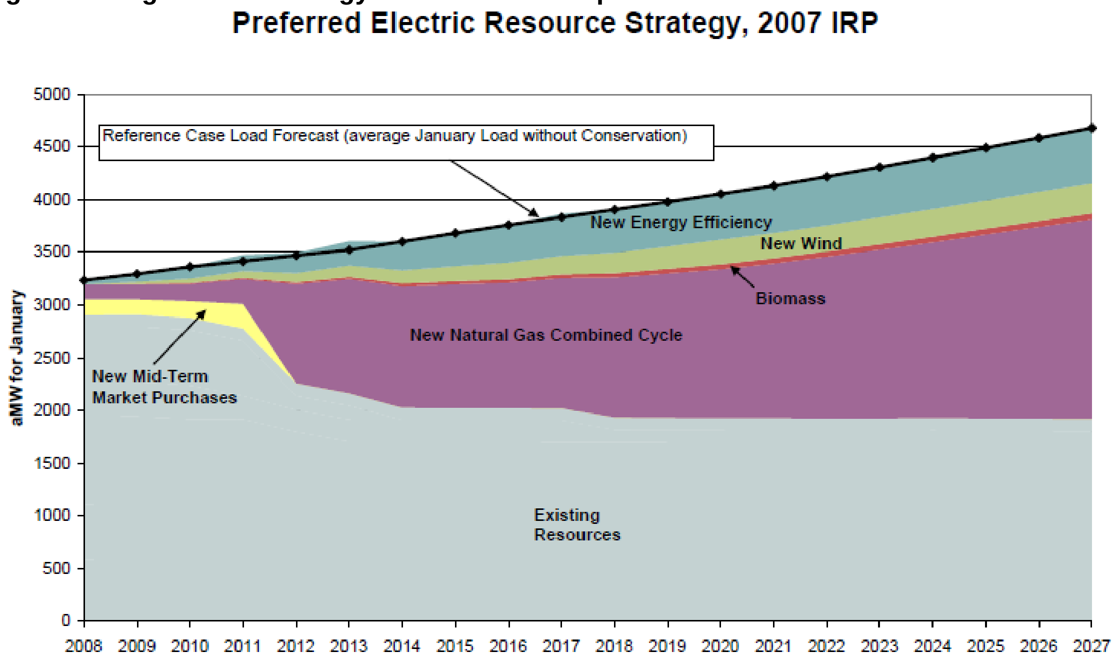


Figure 8 shows that Seattle City Light plans to meet its forecasted load growth by 2020 primarily through an accelerated conservation program. The utility is also rapidly expanding its geothermal, wind and biomass resources. It plans to increase optimization of its hydro system through seasonal power exchanges. While the source of its power exchanges is unidentified, all of the remaining resources in the utility's planning horizon are renewable.

Figure 9 shows the targets outlined for Seattle City Light under I-937. The utility currently owns a portion of the output from the Stateline Wind Facility, but will need to add the renewable resources detailed in Figure 8 to meet its target.

Figure 8. Seattle City Light's Plan for Meeting I-937 and Energy Requirements

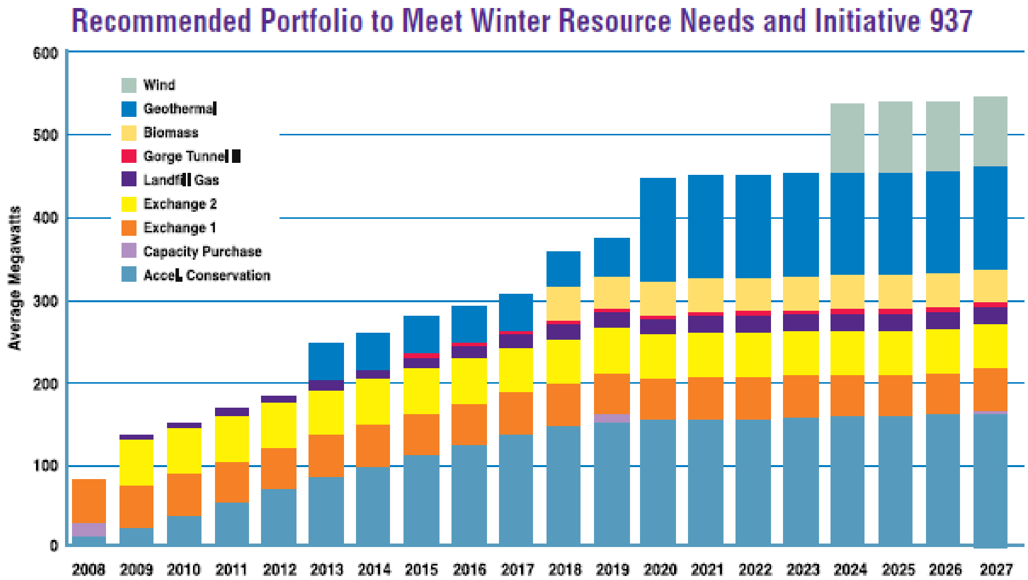
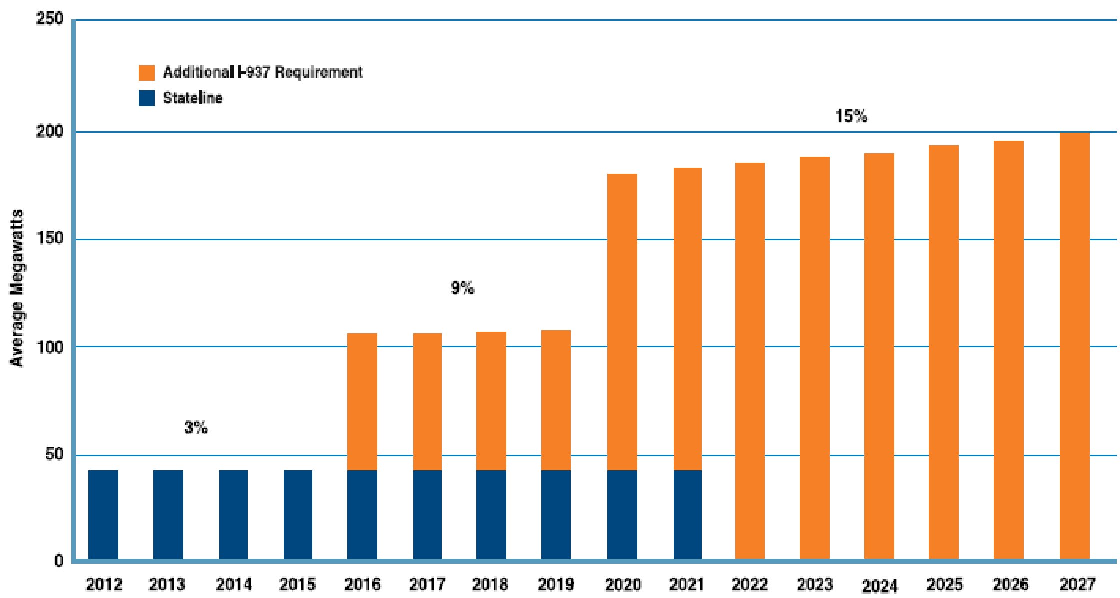


Figure 9. Seattle City Light's Resource Requirements to Meet I-937 Targets



Energy efficiency clearly plays a key role in enabling utilities to meet I-937 requirements. Fortunately, Washington is a recognized leader in energy efficiency. On a per capita basis, Washington has the most buildings of any state that meet the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) standard,[31] and the state is a national leader in conservation as evidenced by national rankings such as *Forbes Magazine* and the American Council for an Energy Efficient Economy.[32] Governor Christine Gregiore's 2009-2011 proposed state budget for Washington reflected continuing value placed on "reducing emissions, creating jobs and thriving in a low-carbon economy."[33] However, it will have to work hard to hold onto its high rank;

almost every state – indeed many countries – are competing to recruit green industries, bring in new green jobs, and raise the bar for environmental stewardship.

In summary, growth in clean energy policies is occurring in response to significant price volatility for fossil-based energy resources, growing environmental concerns (particularly climate change and land-use), and a desire for energy independence. The rapid rate of technological improvements in the energy industry, the desire for more localized energy production, and energy security are also important factors. There is a growing consensus that an effective way to address these issues is by developing an economy based on increased energy efficiency and the use of renewable resources.

Appendix A provides further detail on the existing consumption and production status for hydro, bioenergy, wind, solar, geothermal, and ocean/tidal renewable energy industries in Washington.

As we discuss in detail in Chapter Two, anticipated growth in renewable sector business activity will also boost employment demand for qualified workers. Industry trends, available labor markets, and the knowledge and skill requirements of key renewable sectors can vary somewhat depending on work conditions, technologies and expectations of employers. The state's capacity to provide relevant training and industry perception about the demand for workforce education and training is also central to Washington's ability to support continued growth in renewable sectors.

Chapter Two: Workforce Development

This chapter provides a brief overview of the existing research on renewable energy employment and workforce development issues, followed by a description of the methodology used to conduct a survey of renewable employers in the biomass, hydropower (limited to hydro efficiency upgrades and small hydro, due to the growth potential for these resources), solar, and wind energy sectors. The chapter also provides detailed survey analysis and results for each sector. Available state education and training opportunities in renewable energy are also identified and discussed. A special appendix (Appendix C) discusses the results of a recent state survey that included estimates of employment in renewable energy among different regions of the state, including the Pacific Mountain Workforce Development Area, which encompasses five contiguous counties in the western region.

Research Context

Research on employment and workforce development for renewable energy sectors is marked by diverging conclusions about the number of jobs that will be created as renewable sectors grow, including the kinds of employment that will be created, and the skill requirements that employers will deem necessary for workers in renewable energy jobs. Indeed, existing research on job creation and economic outcomes tied to renewable energy varies widely and depends in large part on the focus of the research, operational definitions, and the economic models employed.

According to a recent report by the American Solar Energy Society, in 2007 the U.S. supported over 500,000 renewable energy jobs.[34] By 2030, under an aggressive forecast scenario, the report estimated there could be more than 7.3 million Americans employed in renewable energy jobs. Most studies of clean and renewable energy employment and job creation have estimated more modest outcomes.[35] Overall, however, most studies seem to agree that a likely outcome of an expanding clean energy economy will be a net gain in total employment.[36]

The Washington State Employment Security Department's recently completed study of green economy jobs was a leading attempt to define and measure employment in several green economy industry areas that included renewable energy.[37] The study expanded on a prior report commissioned by the Washington Department of Community, Trade and Economic Development that identified "clean energy" industries and 8,400 jobs that existed in 2004. [38] The earlier report was the basis for a study described in Governor Gregoire's Executive Order 02-07 and required by the Legislature in House Bill 2815 (E2SHB 2815), which passed in 2008 and called for the creation of 25,000 green jobs.

The recent Washington green economy jobs survey, which received data from 9,500 employers, estimated that 47,194 private-sector green jobs existed in the state in 2008. But the report also noted that just over four percent (2,027) of those jobs were in renewable energy. Construction-related industries and professional and technical services accounted for nearly half of renewable energy employment. Since the study did not include public-sector employers, many of whom sponsor renewable energy projects, the estimates are probably conservative. However, the findings are reasonably consistent with other data showing that a relatively small percentage of non-hydro electric power in the state comes from renewable energy.[39]

The survey findings regarding industry and occupational mix seem logical, since the bulk of employment associated with most renewable projects relates to the manufacturing of component parts (for wind turbines and solar panels, for instance) and for the design and construction of renewable facilities. Once erected, most renewable energy facilities operate with a relatively small number of operations and maintenance employees, and maintenance services are often provided by outside contractors.[40]

Another important survey finding was that most employers do not appear to have created "new" job or occupational titles in any of the green economy sectors, including renewable energy. While the study found a few job titles that could be associated specifically with renewables (such as solar panel installer or biomass worker), employers are not currently creating new job titles for most renewable occupations. It may be that many renewable-sector jobs are embedded within job classes that simply render them indistinguishable from traditional jobs. This finding also raises an important question about the work of renewable-sector employees: To what extent is the work of employees in renewable energy companies different from that of traditional jobs in the energy industry or other industries that require similar skill sets? There is some evidence that renewable technologies often require some specialized skills, and that the work conditions associated with renewable jobs make some jobs unique. But it is unclear whether the foundational work of renewable employees requires skill sets that are considerably different from those required in "traditional" energy sectors.[41]

It is worth noting that in the future the renewable energy industry will also face many of the same workforce challenges as traditional energy employers. One recent study noted national projections that fifty percent of utility workers will be eligible for retirement in ten years.[42] The study noted that fifty-seven percent of utility workers in Washington and Oregon are now age 45 or older. Additionally, the pool of available workers is shrinking due to demographic trends.

Education and training programs in energy-related technical areas have seen declining or flat enrollment. And long-term state population trends suggest that through 2030 the future labor pool will be smaller, and that utilities will be forced to compete with other industry sectors for new workers.

Finally, the composition of Washington's future workforce will consist of larger numbers of ethnic minorities, which have traditionally been underserved in education and training, thus the future pool of workers may be less well prepared than industry requires. As competition for smaller numbers of skilled workers intensifies, renewable energy employers will also face serious workforce challenges in the future, constraining growth in these sectors.

For the state to achieve its clean economy goals, and for industry to meet its growth projections, the state's workforce and training system will need to pursue new strategies that will support continued development of the state's renewable energy infrastructure and ensure the availability of a skilled workforce. Employers, unions, government and education partners will need to identify current and future skill requirements for craft workers, and work collaboratively to support the development of education and training initiatives that are responsive to industry needs and provide future and incumbent employees with the skill sets needed to pursue renewable energy careers.

Methodology

The overall strategy employed by this project was to understand the industry and workforce development issues associated with renewable energy sectors by collecting information directly from regional employers who are developing, operating and staffing renewable energy facilities in Washington. Information from other expert sources was also collected.

The authors met with project sponsors and stakeholders to determine the most effective research design for this section of the project. A review of project goals and analyses of existing research led to the selection of solar, wind, biopower and hydroelectric power (specifically efficiency upgrades and small hydro) as the primary renewable energy sectors for employer interviews. The selection of individual companies was based upon the following factors:

- Employer located in or provides services to customers in Washington State
- Include employers from each renewable sector and a range of size, geography and markets
- Focus on power generation
- Primary emphasis on technician-level employment, skill requirements, and related education and training

Telephone interviews were deemed preferable to a mailed questionnaire because of the qualitative nature of the questions. The one-on-one nature of the telephone interviews helped to ensure good response rates from industry representatives, enabled clarification about the meaning of some responses, and allowed for further questions on some topics.

A total of 27 organizations agreed to participate in the study. These organizations included renewable energy companies and other experts in renewable energy sectors. The organizations and sectors for which the interviews were conducted are listed in Table 1 below. Contact information was collected for each organization, and the study sponsors sent invitation letters via email to each targeted organization. [43]

Table 1. Company Participants

Renewable Sectors and Companies				
Organization	Biomass	Hydro (upgrades/small)	Solar	Wind
Avista		√		
Chelan County PUD			√	
Cole Industrial	√			
Dept. of Natural Resources				√
Energy Northwest	√			√
Grant County PUD		√		
Grays Harbor County PUD		√		
Grays Harbor Paper	√			
IBEW, Joint Apprenticeship and Training Council, Mt. Vernon			√	
Lewis County PUD		√		
Puget Sound Energy				√
Puget Sound Solar			√	
Sierra Pacific - Grays Harbor	√			
Silicon Energy			√	
Simpson Tacoma Kraft	√			
Seattle City Light		√		
Snohomish County PUD			√	
Seattle Steam	√			
Soar Technology		√		
Sunwize Technologies			√	
Tacoma Power		√		
United States Bureau of Reclamation, Grand Coulee Dam		√		
Washington State Dept of Ecology		√		
Washington State University Extension Energy Program		√	√	
White Creek Wind Project				√
Vestas				√

Employer Interviews

The detailed interview protocol included questions on the following topics:[44]

A. **Industry Growth Trends**: Challenges/opportunities for growth in the sector
B. **Workforce**: Employment, skills and gaps in key technician-level occupations
C. **Education and Training**: Critical training topics and delivery methods
D. **Other:** Workforce training, occupations and related issues of importance

Interviews were conducted in March and April 2009, with follow-up contacts in May 2009. Respondents included site operations and maintenance managers, training managers, and company executives. All respondents were told that the interview data would be treated confidentially and that individual companies or respondents would not be associated with specific responses.

In several cases, follow-up interviews were conducted to clarify incomplete data, or to answer further questions about specific responses; in a few cases email responses were received from respondents with additional information.

Study Limitations

The study results are limited to data collected from representatives of the companies who participated. Information collected from respondents was largely qualitative and organization-specific, and no comparative analyses were conducted. Some interview topics and questions did not result in usable data, either because of non-responsiveness, or because certain questions proved to be redundant or not relevant. These data were examined but not incorporated in the report.

The primary focus of this report is on the identification and explanation of predominant themes across the topical areas addressed in the survey. Given the limited number of interviews included in this study, generalizing the findings to the larger population of renewable employers should be treated with caution; further validation of the findings through additional data collection and confirmation by other employers is recommended.

Results

Results are presented below as narrative analytical summaries for each sector that integrate the research findings and include limited examples of data from employers. The goal was to identify common themes that reflected the perspectives of the majority of employers in that sector. Divergent findings among respondents are also noted. The results are organized to follow the general categories and topics outlined in the interview protocol. The results are presented in the following order:

- Wind
- Solar
- Biopower
- Hydropower efficiency upgrades and small hydro

Wind Energy Sector Analysis

Growth in Washington's wind energy sector has been rapid and substantial. Nationally, Washington has the fifth largest installed wind capacity. Additional growth is planned east of the Cascades, with some smaller projects slated for the Western region of the state. The technology varies primarily by manufacturer, and new model types are being produced, including larger and more efficient high-capacity wind turbines. Global demand for new wind turbines and component parts is outstripping supply. While the vast majority of wind turbine systems and parts are produced overseas, an increasing number of U.S. companies are emerging to manufacture components and subassemblies.

Growth Trends

A number of Washington-based utilities have invested in wind, and there are numerous companies that provide site development and/or operations and maintenance support to wind farm owners. These employers report that growth in the state's wind energy sector over the past several years has accelerated. Most employers cited the state's Renewable Portfolio Standards (RPS) requirement under Initiative 937 (I-937) as a key driver for the growth in wind energy. Some utility employers pointed out that their Integrated Resource Plans called for a diverse mix of renewable energy resources and energy efficiency prior to the RPS requirements. These pre-RPS plans were based upon company forecasts about future demand for new load growth and concerns about the state's heavy reliance on large hydroelectric facilities (most of which they believe are already operating at capacity, and that there is little public support for new dams).

Wind turbines are a mature renewable technology with a growing manufacturing supply base, and there are many suitable locations for wind generation in the state. Several employers noted that the national focus on wind energy has driven up demand for new generation, whereas other renewable options such as ocean/tidal, solar and geothermal have not developed as quickly.

The overall effect has been a steady surge in new construction of wind farms by public and private utilities and developers, with a number of expansions or new projects planned or underway.[45] One employer reported experiencing "exponential growth, there's lots of catching-up to do." As more wind farms emerge or expand operations, integration of wind energy into the transmission grid is also gaining more attention across the region. As one employer observed:

> The number of physical assets has increased, they're popping up into view, and they're being placed in areas where there are good wind resources. The policies of local and state governments, they've driven large utilities to take a closer look at renewables, especially wind, to meet generation needs and forecasts. The technology also has matured; wind is now about on par with other generation options for reliability, performance, and cost per megawatt hour. Now there is a big focus on integration, especially with BPA, they're working hand in hand with local utilities, IPPs (independent power producers), merchants, to figure out how to integrate wind resources into the grid, balance it and make it work efficiently within the grid. Big power producers are really getting into making these systems work.

Most employers agree that investments in wind energy are likely to continue for several years, but there were differing perspectives about the growth potential and the costs involved in new or expanded facilities. One employer stressed that the costs associated with additional investments in renewable energy by utilities cannot be sustained without increased costs to consumers in the form of electric rate increases: "Once the public figures out the economics of renewables it will generate a lot of concern, because it's going to raise costs for customers." He added: "These projects are very expensive, these are new facilities that we've built; it's not that we're just upgrading existing facilities." Yet most employers emphasized that wind energy is critical to providing additional capacity and options for meeting future demand for electricity. Some employers believe that strong public support for renewable energy may help offset consumer backlash due to rate increases.

<u>Recession Effects</u>: While the impact of the economic recession has slowed the rate of growth in the wind sector somewhat, employers downplayed the effects on their plans for new site development or expansion. One employer stressed that they remain tightly coupled to their Integrated Resource Plan to drive new development in wind and other renewables for the long term:

> We have an IRP that goes out 20 years. The planned growth is pretty steep. At some point we may spread out growth in our plan, but the population is growing, and at some point we'll have lower unemployment, people will keep coming here for the high quality of life.

Another employer noted that the emphasis on renewable energy development as part of the federal stimulus plan will help the wind sector maintain its momentum in the short term. One wind farm manager viewed the recession as a temporary constraint on new growth; he felt that there is plenty of additional capacity which has yet to be fully developed. As he put it:

> There is so much wind resource, and land that is prime for wind where there are optimal conditions. There's private land, environmentally friendly locations, and lots of transmission options to get the power back to customers. Land isn't a limiting factor; it's going to be equipment availability, capital and investment to make new projects viable. Governments and private business will build new transmission to bring the power from wind farms to the markets.

For the long term, however, employers anticipate that new growth in wind will slow, mainly because they believe that most of the prime sites in Washington will be fully developed within the next several years. Energy Northwest is planning a moderate-sized (70 MW) project in Pacific County that takes advantage of an available wind resource in the Western part of the state, but the site also has a more modest and less-consistent wind source than many locations east of the Cascades. Employers generally agreed that projects are likely to decline in size and number over the next five years. One employer noted: "We'll see some regional growth, maybe. These are large projects and there will be a point when people will say 'this is great but there are enough.' The projects will move more inland – Denver, Kansas. New installations will taper off in four to five years."

Several employers noted that rapid growth in new and expanded wind facilities will also increase the demand for replacing component parts and related maintenance for a larger number of wind turbines: "Everything is going along well in construction. We'll see more growth as we begin to deal with maintenance. All these turbines are going in at the same time, they are all new. In the future, we will need to expand our maintenance abilities." Another employer noted the fact that the majority of components are produced overseas, which adds time and the costs associated with parts replacement and repair:

> These wind turbines are getting older, and we'll need to rebuild the components: circuit boards, motors, pumps. That would be a higher level of technical skills; it could be located in more densely populated areas, but ideally in the region. Now we get the components from Germany and Demark which means lost time, shipping costs. It doesn't need to be like that.

The demand for technician and maintenance personnel may also shift somewhat as manufacturers re-consider the added cost of providing multi-year warranties for the wind turbines they sell. One long-time power generation manager who was transferred to oversee wind operations said he was "shocked" to learn that turbine manufacturers provide warranties for their products: "That's unlike any other power generation technology, maybe because it's so new, but in any other form the manufacturers are not going to offer warranties. You buy it, they install it; then it's your problem." Some employers reported that the warranty periods provided by some manufacturers are being reduced because they say they are too costly to support.

Workforce Issues

Employers reported a number of challenges to attracting, training and retaining a skilled wind workforce. Topics ranged from the availability of a skilled workforce to current skill gaps and future training needs. Respondents were asked to identify key occupations and provide input about the current demand and future preparation of key technical occupations. Technical occupations were a focus of the research, and employers spoke most often of these issues as they related to wind technicians rather than other jobs.

<u>Limited Labor Pool</u>: All employers indicated that they had concerns about the availability of qualified wind technicians, and most have current openings. But most respondents said that they have thus far managed to find individuals with experience, or train workers from other energy sectors to fill vacancies. In the short term, most employers stressed that they "just don't have a huge pool to draw from." Employers reported being more concerned about filling future openings as they and other wind farms come online or expand operations. One employer put it this way: "There are not a lot of shortages now, but we anticipate there will be as we expand our facilities, and competition for skilled techs will probably heat up as the industry grows. We really need to grow our own tech workforce."

<u>Unique Working Conditions</u>: Among the workforce challenges cited by employers, the working conditions of wind sector employees emerged as a top issue. One core issue is the remote location of the work. Most wind facilities are located in remote areas, which usually have limited housing and amenities that are more plentiful in urban areas. As with some other energy-sector occupations, such as line or substation workers assigned to rural areas, recruiting and retaining workers for these sites can be difficult. One site manager described how working on a rural wind farm affects employees: "People have to commute or be willing to re-locate in a remote area. I drive an hour each way. I work from home frequently. There are no places to live. We take up 9,500 acres and it's all rural because that's the most economic property."

Aside from the lack of amenities, housing and isolation, the work of wind technicians and other technical specialists is physically demanding. Maintenance and repairs must often be performed in inclement weather, and while winter conditions can be especially difficult, the summer heat can produce extreme temperatures inside the turbine tower, where technicians must scale a ladder to the nacelle platform to service the turbine. Some employers also described how the unique nature of the technology poses a number of challenges and potential safety hazards. One manager described the technology and maintenance conditions at his site this way:

> The difference is you have 87 power plants, generating stations that are 280 feet up in the air. That's profoundly different than having everything on the ground floor. It affects safety, tools you use, how much room you have to stop and stretch, where you eat your lunch. Sometimes it can be freezing cold, other times it's 100 degrees inside."

Nearly all employers described wind technician work as a "young person's job," primarily because of the physical requirements associated with climbing, lifting and the confined spaces in which most maintenance and repair work is performed. Most employers expressed that these physical requirements and work conditions will eventually lead technicians to move on to other jobs as they get older. As one manager reported:

> Most of the guys we have doing turbine work, they're young. It's a young person's job; the work is hard on them. We've heard that there's a 15-year life expectancy in this industry (wind) as an employee. The question is, where will they go after that? It's not a job you can do your whole career, mainly because of the physical demands and conditions.

Another manager cited a specific example that emphasizes this point:

> You work in confined spaces, at great heights, and the components, tools and the work itself is heavy, hard. You can try to use your legs to lift all you want, but at some point you have to rely on your back to get the job done. Imagine laying on your back having to muscle a huge nut or bolt into place. That's not a simple task, you have to contort your body, strain your muscles. It's not just the climbing.

A number of employers have attempted to reduce attrition associated with the physical nature of the work, such as installing "climb assist" systems inside of turbine towers. Although many different models are available, the most common employ weights or a motor-driven cable that technicians attach to with a climbing harness. The cable system partially lifts the technician up and helps to reduce the wear and tear on limbs and knees that come from multiple climbs each day of several hundred feet up a ladder. One site manager noted: "We have the equivalent of an elevator for our techs, we need to reduce the ergonomic impact, we need to reduce the number one killer in wind, and that's the physical conditions."

<u>Retirement Effects</u>: Other employers reported that while their current technician workforce is physically fit and able to handle the physical demands, the lack of a larger pool of qualified workers may make it difficult to replace employees who transition to other jobs or careers. And, although most employers reported that the majority of their technician workforce is still young and they are working to reduce attrition, predictions about widespread retirements in the energy industry are a related concern of wind sector managers, who anticipate greater competition for skilled technicians in the future.

As competition for qualified technicians heats up, employers anticipate that wages and benefits will also rise, increasing operating costs. Currently, the wages of most wind turbine technicians tend to be somewhat lower than for employees in traditional occupations in the energy industry, such as operator or mechanic. This may be due in part to the fact that the majority of companies who operate or service wind farms in Washington are non-union employers, and are not subject to bargaining agreements with organized labor; some wind farm owners contract for maintenance services from non-union manufacturers or equipment vendors.

Technician Work is Fundamental: Some employers stressed that most wind technicians do not command a higher wage because the work itself is very basic. One manager noted: "Once you get beyond being impressed by the technology, the renewable factor, it's not a very complicated machine; the maintenance is pretty routine." Another employer reported that while the technology and working conditions are unique, the level of technical knowledge required of wind technicians is probably not as high as for some traditional energy jobs: "Managers get deeper into systems knowledge. Techs do work that is really pretty basic. What makes it high tech is the technology, but there's also the work context, and the hazards."

Most employers reported that aside from the unique working conditions, safety issues, and some specialized maintenance tasks, the actual work of wind technicians is not much different from that of maintenance jobs in non-renewable sectors of the energy industry. The desire to have employees with both mechanical and electrical skills was often expressed by employers, but most reported that other jobs in the energy industry also demand skill combinations from multiple crafts.

Wind Technician as a Two-Tier Occupation: Most employers described how the basic maintenance and repair work is completed by technicians who have experience, knowledge and training in electrical systems and mechanics, and that knowledge of both of these technical areas is necessary for ordinary maintenance technicians (see Table 2, below). Some employers noted that at the base level, mechanical skills may be more important than electrical: "When you get right down to it, wind techs are really more like millwrights—it's less about the electrician skills, they just need the basics."

But employers also reported that they typically employ a smaller number of very highly trained and experienced technicians who are called upon to tackle the most difficult technical problems and emergencies. These specialist technicians often have advanced training and knowledge of component parts and model types, and may act as field consultants to other sites or companies that lack the expertise to troubleshoot or repair component or system failures.

Table 2. Two-Tier Wind Technician Occupations

Occupation	Summary Description
Maintenance Technician	Routine maintenance and repair of electrical and mechanical systems and components
Specialist/Field Technician	Specialized troubleshooting, maintenance and repair, new site development and expansion

These highly-skilled technicians typically have higher levels of education and training than other maintenance technicians, usually including two-year technical degrees, completion of an energy-related apprenticeship program, or specialty training provided by equipment vendors. Although the ratio of regular maintenance techs to specialist/field technicians varies by organization, several employers reported that between 20 and 30 percent of their total technician workforce consists of specialist/field technicians; one large manufacturer reported that 40 percent of their technician workforce consists of field technicians, who develop and commission sites and tackle difficult maintenance problems for their customers. Because of their advanced training, experience, their ability to handle most emergency situations and to help train new technicians, specialist/field technicians reportedly earn a much higher wage than regular maintenance technicians.

Other Key Jobs: While the interviews were focused primarily on wind technicians, they were not the only technical occupations identified as important by employers. Several companies noted that occupations such as instrument technicians, relay/meter technicians, and operations and maintenance (O&M) supervisors are also key to supporting wind farm operations. Information technology/network specialists were also mentioned as important positions, especially as wind farm owners work to provide more of their own O&M support services rather that contracting for those services through equipment manufacturers and vendors.

Mechanical, electrical and software engineers were also named as occupations where future hiring needs will grow as the industry expands. Some employers noted that employees with engineering skills and science backgrounds will also be needed to analyze the potential of new sites for future wind farms, and to determine the environmental effects. One employer noted:

> We're also looking for engineering in specialized areas, wind and site engineers, to scope out specific sites, calculate the location potential, measure the wind speeds, calculate how many turbines, types of models will work best at each location, etc. That up-front work is critical to development and maximizing use of the resource that's available. These are lucrative occupations, and highly-skilled jobs. They add a lot of value.

Some companies have purposely hired and assigned technicians and other staff earlier than required to work at new sites as they were being established so that their own employees could learn about the operation from the ground-up. One manager noted: "We want to get them on board at startup, not after the site is complete. It makes it more costly to hire and train them ahead of when we'll really need them, but we view it as an opportunity, an investment. You need to give the workforce time to become accustomed to the site, the job."

Finally, most employers reported that demand for staff with legal, management and finance skills will increase as new sites are developed. While some employers pointed to a growing need for more staff in these business occupations, other employers pointed out that greater breadth in skill sets is needed among existing technical professional employees such as engineers, who also need legal and financial skills to effectively deal with budgeting, reporting and legal aspects of wind site development.

Core Skills and Gaps

Most employers were quick to comment that current and especially future wind technicians need to arrive at the site with a good attitude about the job, and a good "work ethic," which several employers said they felt was often lacking among many younger employees. These managers noted that the nature of the work requires employees to exercise good judgment and discipline, both because of concerns about safety and because electrical power generation is a continuous process that demands constant vigilance. One manager noted: "Work ethic is an issue. The new generation has a different attitude; some are more interested in video games than eight hours of work, and some seem to feel a sense of entitlement at work. It's pervasive. 'Don't tell me I can't. So long as I get my work done who cares?' But in a 24/7 company it doesn't work."

Employers also reported concerns about the lack of basic academic skills by some existing workers, but especially among recent high school graduates, many of whom are unable to score high enough on company skills assessments to qualify for employment. One training manager noted: "We have a huge part of the upcoming workforce who can't pass basic tests. Algebra, Trig, just the basics, not Calculus." One employer attributed the lack of basics to a failure of the state's education system to require higher levels of student achievement; another pointed to the emphasis by school counselors, teachers and parents on earning degrees at four-year universities over technical degrees at two-year colleges or through an apprenticeship. He added: "We overcorrected in the 1980s, we said 'you gotta go to college,' but people don't always fit in those boxes. We turned kids away from technical careers." One employer noted that most students who do pursue an energy-related apprenticeship are unable to complete their programs because they are underprepared: "We have a 70 percent washout rate in apprenticeships, half due to writing, half to basic Algebra."

Beyond academics, other non-technical skills gaps were identified by most employers. Indeed, most employers reported that general employability skills, including well-developed communications, organizational, teamwork and interpersonal skills are very important, but these skills are often hard to find in new employees. Most employers do provide additional training in one or more of these areas to current employees.

<u>Core Technical Skills</u>: Employers were consistent in their identification of the core technical skills they expect of maintenance technicians, and they described these skills as foundational for advancement into other occupations in the wind industry as well as in traditional energy occupations. It is important to note that workplace safety was identified by all employers as a critical skill area, and both the technical and non-technical aspects of workplace safety were identified as a central skill and as an ongoing training topic.

Table 3 shows that mechanical and electrical skills were commonly identified as essential core skills, and there were several other general and specific skill categories that employers expect of wind technicians.[46]

Table 3. Wind Technician Skills and Description

Skill Category	Summary Description
Mechanical	Basic mechanical knowledge and theory, hydraulics, pneumatics, motors, lubrication, cooling, gears, levers, pulleys.
Electrical	Basic electrical knowledge and theory, AC/DC power, diagrams, measuring equipment, transmission-distribution
Electronics	Basic circuit electronics and analysis, branch circuit panels, feeders, over current devices, power utilization devices, controls and equipment
Math Basics	Algebra, trigonometry, basic computation and measurement, logic
Reading/Writing	Basic reading and report writing
Computers and Software	Use of computers for diagnostics and troubleshooting, basic business applications, site/turbine monitoring systems
Other (including Safety)	Wind flow, impact of weather on turbine functionality. Safety issues related to climbing, working at heights, in inclement weather, and in confined spaces; CPR, emergency medical skills

Training Topics and Skill Gaps

Employers identified a number of areas where technical skill gaps exist among current employees. Not surprisingly, many employers noted gaps in the core skill areas named above. The lack of experience in working with electronics and electronic systems was often mentioned, and electronics was named as an important current and future training topic by several employers. One manager noted:

> Most can figure out mechanical components and electricity but there is not a lot of background in the workforce with logic diagrams, communication circuit boards, etc. Understanding why that circuit board does what it does or even how to fix it. We can't find that.

Other technical skill gaps included a range of general and specific topics, including the following:

Mechanical: Hydraulics and fluid dynamics, internal combustion engines, rigging, pulleys, fasteners, mechanical dynamics: compression, tension, stress, clamp loading.

Electrical/Electronics: Programmable Logic Controllers (PLCs), instrumentation and measuring equipment, fiber optics, digital communications, signal relays, sensors.

Computers/Software: Computer basics, how to use for maintenance functions, such as report writing, databases, tracking, ordering, understanding ladder-logic, programming.

Component Repair: Some employers stressed the need to further develop technicians' ability to repair component parts because of the time and costs associated with sending them off-site for repair or replacement. One manager noted:

> We can get to the point where we can find where the problem is and we know it's in the component but we don't always know what is wrong with the component or how to fix it. It could mean the difference between a $100 repair job and a $1000 component replacement.

Several managers noted that the industry is still relatively young; some employers are still in the process of learning what skill gaps exist, and the best way to fill them. One manager concluded that for most technicians, filling the gaps would come with time and experience applying basic concepts and techniques in the workplace.

Training Delivery Options

Most employers depend on manufacturers and vendors for equipment-specific technical training, which they supplement with internal training of their own. Several employers described having sent technicians to manufacturer-operated training centers in Europe that were fully-equipped with turbines affixed at individual stations. This enabled trainers and technicians to work directly on the very units they would be responsible for maintaining at their own sites. Most employers reported being satisfied with vendor-provided training, and most felt that with few exceptions trainers sent to teach the technicians at their sites were very knowledgeable and well prepared.

Several employers expressed a desire to have additional domestic training options for upgrading the skills of existing workers, and also to help expand the future pool of new technicians. One employer reported that the biggest training gap they have is not internal—they have adapted to the needs of their current workforce—but external, meaning they believe there are not enough programs available to meet the growing demand for trained wind technicians. One employer noted that the wind technician program at Columbia Gorge Community College in Oregon is currently the only fully-developed program in the region that specializes in training wind technicians, and demand for new hires among companies can be intense: "We want someone with a two-year degree since we want quality people. Not all of our competitors will do that, we've seen some of them steal students who were in the wind program at Columbia Gorge before they were even done with the program."

All employers expressed an interest in seeing growth in the number of wind technician training programs offered by community and technical colleges and other training providers. While some employers said they would be interested in specific courses and short-term certificates for existing workers, building the pipeline of new workers for the future was their highest priority. Some employers expressed a concern whether public colleges would be able to keep up with changes in the industry, including having adequate lab space and current technology, equipment and tools available for trainees to learn with. Other employers were concerned that the industry lacks standards for training wind sector employees, which they say are needed to ensure program quality, and to address employee safety: “As the industry grows, one question is whether we’re effectively training to standards? Safety will continue to be a key issue. We need a mature industry and workforce to get the lessons learned.”

For some employers, relying on the public sector to expand the pipeline of new wind technicians for future growth depends on whether public institutions can respond quickly and effectively to their needs, especially with new federal investments in clean and renewable energy, which will accelerate development but also raise expectations: “The big issues for the public sector institutions are speed, quality and funding. Companies need these people right now, they can’t wait, but public training institutions don’t always respond as fast as we’d like.”

<u>Expanding Online Options</u>: Employers also expressed an interest in expanding their use of online training to upgrade the skills of existing wind industry workers. All but one employer uses computer-based training in some form, whether delivered online or using installed software. For many employers the convenience of computer-delivered training is extremely appealing; the time and cost savings due to lost productivity and travel to attend off-site training is especially attractive to employers with remote locations. One manager noted:

> We need to get training that’s online or available for distance learning. I have to hire today and find the most qualified people – how do we get the training on top of a full time job? It’s a realistic way to train them without losing productivity or driving for hours. We’re remote and we need more online options. I’ve been looking for night classes and online classes because these guys have full time work. We’ve found classes for basic electricity online. It’s not accredited or degreed, but it’s helping us now.”

One site manager described how he has incorporated more computer-based learning using a “canned” training package for his technicians that covers basic electricity, hydraulics, turbine physics, and other technical basics. The testing is all done on the computer. Some key advantages are that employees can work at their own pace, they can do it during down periods or between preventive maintenance and repair jobs, and they do it all without leaving the worksite. But some employers also commented that most of the computerized training packages or online options they’ve used are not very interactive, limiting its appeal and its effectiveness. As one manager put it: “Some of the online stuff we’ve seen isn’t very interactive yet. You need to be able to interact with your peers, with a teacher.”

Employers were also unanimous in their opinion that training for technician-level employees could not consist of online or conceptual training alone: integrating theoretical concepts with opportunities to apply them in the workplace—or at least in an applied setting—was paramount to developing the skills needed to do the work. Indeed, this theme of learning and applying theoretical and technical concepts in the workplace was pervasive whether employers provided training in-house, through outside vendors, or whether the conceptual aspects of training were delivered online or in a classroom setting. The following comment was fairly typical: “We have some computer-based tools and applications for theory learning so our site techs can learn turbine theory, but we rely mainly on applied learning and teaching.” Another employer noted: “You can only do so much with basic training and learning, it’s a good foundation, but then you need to go out and do the work and apply it.”

The model of pairing an experienced, journey-level worker with a less-skilled employee was the most common training strategy used by employers, whether it was part of a formal apprenticeship program, or provided by vendors or other training providers such as community or technical colleges. These on-the-job strategies were implemented in a variety of ways, depending on the needs of trainees, training topic and content, the source of instruction, and work schedules. In some cases intense classroom or computer-based training was followed by periods of hands-on learning; in other cases the training is integrated so that concepts and technical aspects of the work are taught and applied simultaneously, so that the conceptual learning is immediately linked to the work.

Future Training and Delivery

Employers provided several insights about future education and training needs for wind sector employees. The most pervasive themes had to do with having access to high-quality instruction and facilities, and the need to expand their training focus on developing technician skills related to component repair. As noted earlier, employers expect that the growing number of new wind turbines installed in the state over the next several years will increase the overall volume of technician-related work, but with more turbines there will also be an increase in the amount of work related to component repair and replacement. Equipping technicians with the skills to do additional repair work will reduce the need to send parts off-site for repair (or replacement), trimming down time and shipping costs. Future training may be needed to enhance the ability of technicians to initiate repairs of some specialized components that they currently rely on distant vendors or other technicians to complete.

Several employers expressed a concern that the number and availability of technician training programs in the state are inadequate to prepare the future labor pool of wind sector employees, especially technicians. Although some college programs and apprenticeships provide workers with many of the foundation technical skills needed by technicians, most employers said they liked the idea of a program designed specifically for the wind industry. One manager felt that a customized approach would also provide an opportunity for industry to define the training standards and the competencies that should be required of technicians. Similarly, another employer saw it as an opportunity to formalize worker knowledge: “This is a relatively new industry, and we’re learning as we go, but you can't just rely on tribal knowledge to operate and maintain these wind turbines."

Finally, several employers noted the value they attached to training that allowed employees to work directly on the same turbine and component parts that were used at their own site. State-of-the-art equipment, along with support from training staffs and effective curriculum tools, was highly-valued by employers. One employer said he felt that the lack of relevant training materials and equipment in the region put him and other employers at a competitive disadvantage: "We need more options…I don't see us putting in a wind turbine somewhere for training purposes; we have no study materials, no training center, no specific equipment to train on, and no documentation."

<u>An Expanded Role for Regional Colleges?</u> Several employers saw an expanded role for regional community and technical colleges to enhance their options for upgrade training, and to help build the state's capacity to increase the number of qualified workers for the future of the wind industry. One employer noted: "It's a challenge to find those individuals when you have only a handful of two-year training programs in the area." But there were also questions about the ability of public institutions to offer effective solutions: some employers wondered whether public institutions would be able to provide up-to-date equipment, flexible scheduling, and programs that were able to stay current with changes in the industry.

Solar Energy Sector Analysis

Solar energy is the use of energy from the sun to generate either electricity or heat. A wide variety of technologies, designs, strategies, and building approaches exist that employ solar energy including advanced conservation and efficiency strategies. These range from low-tech architectural features of ancient structures to high-tech power supply systems for satellite telecommunications.

This section includes four general categories of solar technologies described by employers during the interviews: solar photovoltaic (PV), solar hot water (SHW), passive solar and concentrated solar collectors.

- Solar PV systems convert sunlight directly into electricity. Most often PV systems are panels placed on rooftops or on a free-standing frame. Sometimes PV systems are "off-grid," (meaning not connected to the power grid system) or they may be "grid-connected" and local power companies typically buy back surplus power in an arrangement called "net-metering."

- Solar hot-water systems use sunlight to heat water. These systems generally have a collector placed on a roof or free-standing structure, and a "working fluid" which typically transfers the solar heat through coils to warm the cold water in a storage tank.

- Passive solar can be any solar energy system that doesn't require electricity to operate mechanical systems, but it is most frequently used to describe building design features that convert sunlight into useable heat which then causes air-movement for ventilation. The same design principles can be used for summer cooling or winter heating. A properly designed passive solar building uses significantly less energy than a traditional building.

- Concentrating solar collectors (CSC) use lenses or mirrors and tracking systems to focus a large area of sunlight into a small beam. The concentrated light is then used as a heat source to generate electricity.

The interviews did not include builders, architects, designers or others in the building industry, which are closely tied to solar. One respondent emphasized that significantly more solar sector work and energy savings could come from looking broadly at the building industry, and specifically how buildings are designed to incorporate solar.

Solar hot water technologies have been relatively stable in both price and technology since the early 1980's. Grid-connected solar electric technologies have only moved from the demonstration stage to implementation in the last eight years, and are showing rapid technological change and price decreases.

Traditionally, power companies have constructed large, centralized power sources and delivered the power long distances via transmission grid systems. Solar PV differs from traditional sources of electricity in that it is most frequently used as a "distributed" or "decentralized" resource, generating power at or near the point of consumption. This proximity creates unique opportunities for solar PV. A consumer's decision to generate their own power should open the door to a review of a consumer's total energy use. A home or business owner contemplating a large investment in solar might discover that they could get the equivalent of more power out of their system – or maybe even downsize their power system needs - by first investing in energy efficiency upgrades. Additionally, many of the problematic design issues that emerge during a solar installation are building design and construction issues. Currently, the typical educational path for solar installers or building industry participants may not adequately prepare these workers for this type of assessment.

Several of the solar industry experts we interviewed promoted the benefits of doing a holistic energy analysis, and pairing efficiency alongside solar. Those that spoke on this subject were knowledgeable about efficiency improvements, valued the work as a contribution towards environmental sustainability, and took seriously their role in educating customers on a full range of energy and efficiency options: "Some of the community colleges are doing energy efficiency training – that's good stuff. Do your efficiency first, the audits and assessments, before your solar installation. Every house is going to need one of these to get off of oil and reach our climate targets."[47]

Given the significant overlap between solar systems and building design, it may be useful to view the solar design and installation industry as a series of building practices that require training and education across the entire building sector of the economy. To infuse these technologies and concepts into the built environment will require education of designers, developers, architects, general contractors, plumbers, electricians and consumers, representing a much broader labor pool than just installers.

Growth Trends

All of the solar industry employers reported significant and rapid growth in their businesses, estimating at least 30 percent sales growth over the last three years across solar photovoltaic (PV) and solar hot water (SHW) installations, manufacturing and distribution. While they have seen some recent slowing of large projects due to the recession, they expect that this condition is temporary, and they all anticipate significant and steady growth into the future. As one employer described it, "Fast track technology development may have slowed, but it's a temporary setback. We will see steady growth for a long, long time." Other employers emphasized that growth in the industry has already expanded the opportunities for solar contractors and employees:

> There are a lot more big projects being developed: City halls, fire departments, state projects. There is often a separate bid for the electrical portion of these projects. Then the electrical people will ask for a bid from the solar people. In

the future, every architecture firm will have on staff someone to do the energy calculations and solar design.

Employers unanimously reported that the primary driver for growth in the solar industry has been federal, state—and to a lesser extent utility company—incentives. The up-front cost of solar is frequently higher than other generation sources. However the investor in these cases is often unique to energy development: the building and home owner are frequently the developer, rather than the utility. Incentives have been created to offset the initial cost and create a potential revenue stream from surplus solar power. According to one respondent, these incentives do not apply to large utility-scale solar projects, which is the reason he believes no large utility-scale projects have been built in Washington.[48]

Washington's renewable portfolio standard (Initiative 937) is not viewed as having much impact on the solar industry. The high initial investment required, as well as the decentralized nature of residential and commercial solar, has prevented significant interest from utilities to include solar in their Integrated Resource Plans.

Employers reported that public perception about the viability of solar here in the Northwest has improved in recent years. The educational efforts put forth by the industry appear to be overcoming dated notions that solar is ineffective in our climate. Employers noted there are increasing situations where solar just makes good financial sense for customers seeking a stable power source with no long-term fuel costs and low maintenance requirements.

Increased media attention about energy and costs is good for the solar industry. One employer summarized the situation this way: "When solar is in the news, it causes growth. Phones start ringing off the hook from Al Gore's movie, because of the war, because of electric cars, high gas prices. Every time there is something big in the news about climate or if energy prices go up, we get busy." Growth also has come as a result of increased concerns for energy independence and national security. One employer noted: "Customers are installing solar out of fear of being left cold and in the dark." However, another respondent reported that most consumer are unaware that the majority of modern solar PV systems are grid-connected and do not provide power back-up in the event of a power failure.

Keys to Growth: Employers believe that continued growth in the solar industry will depend in part upon on-going public education, awareness of climate change impacts and climate solutions and either sustained policy support or sustained high fuel prices. "Solar is not a new industry – but it's an *emerging* industry in that it is now becoming commercialized" one employer explained, adding, "We need consistent policy support for the next five years." [1]

High fluctuations in both incentives and fuel prices create boom-and-bust cycles that are difficult for companies to withstand. Several of the respondents felt that consistent policy

[1] During the data collection phase of this study, the Washington State Legislature enacted Senate Bill 5101 which provides significant tax incentives for solar.

support that focuses on targeted incentives, including manufacturing and components, would be very helpful to establishing the industry in Washington. Currently, most of the manufacturing and almost all of the components come from overseas. One employer added, “We need continued adoption and support by utilities for renewables—policies that keep them thinking longer-term rather than only 3-5 years out.” This instability has also made employers reluctant to add new employees, and has also limited potential applicants from seeking employment in the industry: “There are roller coaster effects from the federal tax incentives coming and going,” noted one employer.

Several respondents felt that the industry could benefit from a simplified electrical code. They felt that the way the code is interpreted—and how the state’s Department of Labor and Industries is applying it—is overly complicated and inconsistent. Ideally, a contractor should be able to cross jurisdictions without problems. They pointed to Germany’s very simplified code as having contributed to lowering the cost of solar. There is a sense that much of the difficulty in expanding solar in the state is due to fear or a lack of knowledge: some utilities, building inspectors and code officials reject solar because they don’t understand it. Several respondents say the industry needs more well-trained solar contractors, building inspectors and code officials, which they hope would lead to fewer difficulties and greater acceptance.

<u>Recession Effects:</u> There were mixed responses about the short-term impact of the current recession. Some respondents said they have not felt any impact, while others have seen delays in larger projects that are dependant on outside funding. The cancellation of a few very large projects nationally, combined with large new manufacturing plants coming online in China, have resulted in a large surplus of panels flooding the market and lowering their cost. Wholesalers are offering deep discounts to retailers. No downturn in the economy is evident in the number of applications to the state for tax rebates from solar installations, which have been growing at a steady pace since the program’s inception.

Some respondents reported being booked out three weeks in advance rather than three months, but the reasons they cited may or may not be related to the economy. Some projects were rushed to be completed before the federal tax credit expired at the end of the year. Then the Obama administration extended the federal tax credit and lifted the $2,000 cap on rebates which extended the burst of activity. The recent slow-down seen by some employers could be a combination of the “post-bubble” activity around tax credits and the recession. Employers believe that consumers may be waiting to see what further incentives the federal government might offer.

One respondent said that people investing in solar systems are a unique group; they have strong environmental reasons and they tend to have healthy bank accounts. He felt that these consumers are going to invest in solar systems regardless of the cost, although the federal tax credit has helped. The media, however, has been reporting that the price of solar will go down, which causes people to wait to act because they think they will get a better deal in the future.

Workforce Issues

Qualified Labor Pool Lacking: All respondents reported a lack of experienced workers. As one employer put it, "If I put an ad out, I'd say half a percent of applicants will have anything close to solar experience. Any position, if I ask for solar experience, I'll find nothing. If I do the training, it's hard for me. If you don't hire trained people, you require people to be self-starters and that's a hard position to put someone in."

While some employers would like to see more people specialized in their fields, there were also some thoughtful observations about the need for generalists. One respondent worried that "when colleges create degrees that are really specific and the industry doesn't grow, the students are out of luck. I'd like to see students coming out with general backgrounds in solar, business, and general understanding of policy." Another agreed with not becoming too specialized: "In apprenticeship programs, we focus on the theory side, that doesn't change. If you only focus on the application, then you specialize and don't have the general principles. That limits their portability across jobs."

Another employer compared solar to the construction industry: "We're going to ramp up solar PV slowly, so how can we best ramp-up the talent to support this future work? We're not going to have the demand for thousands of PV installers anytime soon. One of the reasons construction work pays so high is you don't work all the time every year, it's a cyclical industry, boom-bust."

One area where respondents did not see significant job growth in the near future was in solar system maintenance: "We have nearly zero maintenance on our PV system, once in awhile we go out and wash them off because they get dirty but there's very little maintenance. It's easy to forget they're out there. We've had almost no panels fail. And, they have a 10 year warranty, so we don't have to do repair. Once it's installed, there's not much to maintaining solar PV, especially not compared to wind or other forms." Then he added there are "more jobs in manufacturing than in operations and maintenance for solar." Another respondent noted that demand for maintenance might increase in the future when the warrantees on inverters begin to expire.

One employer observed that there's a lot of interest among young people about renewable energy, and that the industry needs to take advantage of that interest to build a labor pool for the future:

> I get a resume a day from young energetic people. They could be doing these jobs. They could be working with schools to do the audits – and be in an energy educator position. They could do blower door tests. The interest is there. Making the training available will be important. These kids are interested – giving them the training and the jobs will be very important.

Retirements: Most respondents did not view retirements as a major concern in the solar industry, though it will have some impact. One respondent observed that "Existing installers are getting older, new people getting into the industry probably won't retire soon. People moving over from the trades will likely retire soon. There are a lot of baby boomers getting training right now."

But one employer expressed concern that the current shortage of plumbers skilled in SHW would only get worse as the workforce continues to age:

> We were having a hard time finding a plumber. Plumbers are a big gap. I've been wanting to find a female plumber. I've been going to the Women in Trades events. I'm not even looking for a full-blown plumber but someone working on their credits. We wanted someone full time. Most plumbers are going to retire too. The average age is about 50. Young kids are going into tech fields. They think it's pretty grungy work, but there are no sewers in solar hot water. We looked at the military but they have private contractors doing most of that work now. They charge too much and don't know what they are doing. We are going to have a huge shortage of plumbers.

There were some opposing views as to whether retirements would be good or bad for the industry. One group of respondents thought it would be good for the industry to get some fresh perspectives. As one employer put it: "The old timers have a hard time understanding that power can be generated on a rooftop. It completely blows their minds sometimes. According to them, houses are supposed to *use* energy and they wouldn't *generate* it."

One respondent said he didn't worry too much about retirements, "As long as these industries provide attractive wages, benefits, opportunities, it will be attractive to new people. So long as the industry has the training capacity to do it we'll be OK."

<u>Work Conditions</u>: Solar installers face unique working conditions. The work is physically challenging, as much of the work requires climbing up and down onto rooftops while maneuvering large, heavy and fragile pieces of equipment. The work is sometimes done off-grid in remote locations inaccessible to power lines. However, most solar is connected to the grid, and there are critical safety risks associated with tying systems into live power lines.

Another employer noted that the aging of the workforce also makes the physical demands of solar installation work more difficult, and potentially more dangerous: "We had one guy who was older and getting up on roofs was harder. It's a very physical job. There are a lot of older electricians out there. Sometimes they bring their kids out to go up on the roof."

<u>Solar Sector Skills</u>: Most respondents listed similar skills which are unique to solar electrical work. One respondent summarized the unique aspects of PV installers by saying, "The biggest difference is installation of the modules, getting on the roof and installing. The wiring is all the same as code, nothing new. The installation is new. For roofers, they have to install the rack but otherwise it's the same. From the business side, there is a lot of lingo for someone to learn."

There was one respondent who didn't think that much was unique about solar installations: "Electrical work is very broad. I don't see there's a lot of other skill sets needed, there is some upgrade, product-specific training needed, you have to pay attention to spec sheets, but I can't say that it is much different from other electrical work." On the other hand, looking beyond the specific electrical work requirements and more globally as it related to the building industry, one respondent identified unique solar sector skills to include astronomy, shading analysis, roofing techniques, glazing skills and structural analysis.

Solar Occupations and Skills: Due to the emerging nature of the solar industry, solar occupations are not typically described as separate occupations in most state labor market information systems. Sometimes they are listed as "HVAC Installers" and sometimes "Other Engineering Technicians." The job titles and descriptions listed in Table 4 were identified by employers as being central to the solar industry.

Table 4. Key Solar Occupations, Functions and Skills

Occupation	Functions and Skills
Solar System Designers/Design Engineers	• Conducts site survey, calculates energy requirements of building, local climate conditions, celestial mechanics, solar technology and thermodynamics • Determines optimum system size and type, arranges location of components, draws diagram using drafting tools • Models sun path and impacts of adjacent structures • Knowledgeable about CAD, Solidworks, or Sketch-up
Solar PV Installer/Roofer Glazier/Framer/Electricians[49]	• Responsible for installation, commissioning and servicing of PV systems • Understanding whole system function • Connect systems to the grid • Installing inverters • Need wiring and conduit skills, basic trades skills, site survey skills
Solar Hot Water Installers/Plumbers[50]	• Design and install SHW equipment, including solar collectors, water heater and storage tanks, pipes, mechanical/plumbing equipment, site assessments and troubleshooting. • Understanding hydronic systems[51] • Needs basic trades skills, site survey skills

In addition to the key jobs listed above, employers noted the industry is in need of more salespeople, systems integration specialists and project aggregators, who look at everything needed to do a job, including selecting the materials, delivery to the site, and project setup.

<u>Electrician License Required</u>: In Washington, a solar installer is currently required to either be a licensed electrician or have an electrician's training card and work under the direct supervision of a licensed electrician. Several respondents noted that while the electrician's training card is fairly easy to get, there is a shortage of licensed electricians with solar experience.

There were wide-ranging and strongly felt perspectives on this topic. One respondent felt that the licensing requirement raises installation costs since it results in electricians doing some work elements that may be appropriate for employees who are less-skilled and are not licensed electricians. Some respondents observed that solar installers don't need to know everything that a general electrician needs to know, and yet installers do need additional solar-specific knowledge, which may not come with a general electrician background. Meeting all of the requirements needed to do solar is perceived as a hurdle: "Part of it is not making it too cumbersome for installers to get into the business."

<u>Installation is Basic</u>: Most employers described the core work of solar installers as fairly straightforward and basic. As one employer put it: "Solar doesn't require a 4-year degree. Once you've done it, anyone can do it. All you need is to be able to splice wires, attach things to roofs, some plumbing." Another respondent said, "Installing a PV system is a lot less complicated than other building trades stuff we do, but you need to keep up with the technology and requirements for these systems."

<u>Safety Risks Can Be High</u>: Employers emphasized that the risk of getting seriously injured while on the job is high, and that the consequences of mistakes can be severe. One respondent's comment about safety was echoed by several employers: "Systems operate in voltage ranges that are lethal, safety is a big concern." One respondent noted that the charge generated by just two solar panels can be lethal. In the words of another employer, "Journeyman upgrade training is the right way to go. You need to have qualified people do the work, to get it right and for safety."

<u>Ensuring Quality Work</u>: The need to "get it right" was raised by several employers, who expressed concern about the additional risk to the industry and customers posed by improper solar design and installation. Good installation is critical to maximizing output from the panels. Improper installation means that the customer may not achieve maximum efficiency from their system, or the customer may not receive the maximum tax rebate if the rebate is based on the system's output. Most rebates in Washington State are based on the output of the system rather than installed capacity.

<u>Training Topics and Gaps</u>: Employers all agreed that more solar-specific training is needed for engineers, electricians and technicians. Specifically, they report there is a shortage of training opportunities for both solar design and installation. In the words of one respondent, "We need a two-year program in the Northwest to see more solar designers." Respondents noted that some two-year solar design programs are available

nationally and regionally (Farmington, New Mexico, and Oregon's Lane Community College were mentioned), and the solar/photovoltaic energy designer program at Shoreline Community College was mentioned as a valuable six-week course, but not enough for a fully trained solar designer. For solar PV and SHW installations, there is a shortage of hands-on training available to electricians and plumbers.

The requirement that all solar installations be done under a licensed electrician with solar credentials complicates the training issue. Students can't actually complete an entire installation, even in an educational setting, until they become a licensed electrician. Neither of the state's two community colleges that currently offer a "Solar PV System Specialist" certificate includes completion of the licensure needed to install systems.[52] Some employers were concerned that students may not fully understand that after taking these courses, they still won't be able to do installations unless they are licensed electricians with solar credentials. One respondent noted: "You can learn design but you can't actually do an installation. I think they are now allowed to place a rack on the roof because technically it's not electrical equipment." Respondents were also concerned about a shortage of experienced solar instructors available to teach this subject.

Generalists vs. Specialists: The solar industry draws on skills from multiple professions, and the need to multi-skill the workforce was often mentioned by employers. One respondent noted: "There is a small pool of workers that can understand the marketplace, can work with customers and know the technology for a wide variety of projects. It's not just one set of skills." Specific technical skills are highly-valued, but breadth is also important. One employer observed: "What we need is a sufficient quantity of skilled trades-people who are generalists in their field. Ideally they would have more tools and be better equipped to adapt to change, and better able to earn a living wage. Their skills would be transferrable skills for the future."

One employer expressed concern that the breadth of skill requirements could also present training challenges: "If we get into exotic technologies, such as PV siding for buildings, PV windows or equipment that is part of the structure of a building, then you'll have to train people doing the construction-structure as well as electrical, then everyone will need to know more."

At the same time, many employers noted that most solar occupations do not require the full set of skills that most craft workers have. As one employer put it, "It's more likely that becoming a full plumber or electrician would require more skills than are needed for solar. You could combine with a general contractor. Maybe better with a general contractor who is looking at the whole space." Another employer put it this way: "The best solar installer would be a roofer, an electrician and a plumber. But no one is going to do all of those trainings. And they don't really need all of that training. There are parts of all of those professions that are needed."

Core Skills and Gaps

Employers had much to say about the skills that are lacking in the workforce. One of the most frequently mentioned is basic contracting and hands-on trades skills: "If I get a college graduate with no experience holding a screw driver, I send them to Habitat for Humanity. They've got to know some contracting." Another employer listed "ladder safety, finding studs, wiring, basic tools, sweating copper pipes" as examples of the key skills needed. One employer noted that the fundamental skills needed for roofers to work on solar are to be able to "Attach things to roofs, work on a roof safely, keep away leaks, roof anchoring and roof integrity."

Business skills were listed by almost all employers as being in short supply across the industry. Several employers expressed serious concern about this shortage and its long-term impact on the success of the industry in the state. One employer noted:

> I'm really worried. Up to now it's been "green" guys who are philosophically driven and don't have business skills. They've developed bad habits. They fight with L&I and utilities. They don't have a basic understanding of the concerns of utilities and L&I. It would be nice to have them speaking the same language, really understanding each other's points of view. These guys are going to be killed by these big out-of-state installers who will swoop in and pick up all this work.

Another employer echoed that concern, "It's happened in California–the hippies have lost out to the commercial businesses. The few dealers we have will be easily overloaded. Old school installers don't know financing and business skills to compete with big installers." One employer worried that the lack of business skills would mean "a lot of these guys are just going to go out of business."

One respondent felt that while electrical contractors are in the best position to sell solar, most are not knowledgeable enough to provide solar information to customers: "Contractors don't know enough to promote it. These are electrical appliances and need to be installed by an electrician. Electrical contractors don't know how to make that sell. They lack exposure to solar specifics. Once you show them, it's easy – it's not different from other work they do. It's just a mind-set about learning something new."

Also related to business skills is the ability to look holistically at what is needed to advance the industry. As one employer explained: "What the industry needs is a network of people who want to provide this as a service to people –it's the most important missing piece. This is just another electrical appliance."

Training Topics and Gaps

Demand for training has increased significantly, and many of the training topics identified by respondents are related to the skill gaps described above. Table 5 lists some of the training topics employers would like to see offered (or offered more frequently).

Some respondents noted that the economic recession not only slowed some of the cutting-edge solar research in the U.S., but the recession has also slightly dampened the number of applications for apprenticeship programs, which are tied to job openings. At the same time, however, solar-related courses and programs at regional community colleges are over-enrolled.

Lack of Capacity: Indeed, the overriding concern by respondents is that there is a lack of education and training capacity. Almost all respondents mentioned a severe shortage of hands-on PV and SWH installation training: "Across the board, we just need more classes," said one employer. Employers said there are not enough solar-specific training opportunities, and the classes that are available are full. One training provider said "We could do a training every week but we get overwhelmed. We also need to keep folks up to date with changes, assuming they are in the industry to start with."

Employers would like to see more training covering "general solar – what it is, how to apply it in different scenarios and the business side." The IBEW Joint Apprenticeship and Training Commission offers PV installer training but it is only 16 hours, which one employer described as "Not nearly enough. Not enough to get the NABCEP [North American Board of Certified Energy Practitioners] training certificate."

Table 5. Solar-Related Training Topics Identified by Employers

Topic	Description
Solar Site Survey	Topics include determining the solar path, shading and integration of the solar system into buildings
Basic Communication/Public Interaction	Client management, customer service, presentation, oral and written communication
Business Skills/Sales	Cost analysis, interest rates, incentives, sales
Project Management	Organizing and managing projects including budgeting, materials, managing employees
Electrical Codes	Knowledge of all applicable codes and requirements
Basic Design	Ability to read plans, draw up plans, use CAD programs
Passive Solar Design	Integrating passive solar designs into structures and systems

The need for more training in solar site surveys, basic communication, business and electrical code was repeated many times by employers. Site surveying evaluates the potential benefits of a solar installation. This means understanding how the path of the sun and sources of shade affect the output of PV panels. As one employer explains, "It's very site-specific. You need to do a good, accurate site assessment. Plenty of people just don't have a good site for solar."

The need for communication skills comes from the need to interact with clients, employees and other contractors. As one employer stated, "Clients can be fussy. They are putting a lot into these systems. Customer management and basic human relations are important. But we don't like pushy sales people." Effective communication skills are also important when working with other contractors on projects to ensure that installations are properly integrated: "Sometimes our guys show up as subcontractors on a site with a head electrician. I want our guys to stand up to these guys. The head electrician doesn't know solar and has caused problems for our guys."

Employers would like to see more training on basic business skills, business ethics, and marketing. As one employer stated "They need to understand the incentives, ethics, business skills and accounting." Another is looking for hands-on solar experience in sales people: "I'm not going to just hire a marketing guy. I'm going to look for someone who has installed solar and has a good understanding of electrical and PV systems." Sales in solar is different from other sales because "People buying solar systems are not your average customer. The utility knows how to market to their general customers but I know who buys solar. They are different. People generally don't do this to save money."

<u>Training for Transition:</u> Employers felt that their businesses are often used to train employees who end up taking jobs at utilities. Although they recognize the need to offer training opportunities, they also felt that utilities need to do more training of their own employees. One employer noted: "Utilities a while back wanted to put in extra meters to verify the electricity coming onto the grid. All the meter readers needed to be trained. We had to train the meter readers to know what they were looking at." Employers also recognized the benefit for highly-skilled older workers to have the opportunity to go to work for utilities when they no longer want to be climbing up on roofs. In their words these skilled workers are also valuable to utilities and to the future of the industry because "they know what they are looking at."

In the same vein, contractors who want to make a transition into solar also have training needs. Training content may vary based on a contractor's area of expertise: "Are you moving from general contractor to solar, or from electrical engineering to solar? That would make a difference as to what you need to know." Existing electricians need to learn about installing modules on the roof and required codes. For roofers to expand into solar, a significant new skill set may be needed, for instance to safely attach solar mounting racks to roofs in a way that will prevent structural and water-related roof damage.

One employer summarized an approach and a potential solution: "We were talking about the need for a class for people who are already electricians and plumbers to teach them the specifics of solar. People who are already doing this work need advanced training. Might be that you let contractors know that you have this education available. For six weeks they attend this class and get a certification. This would be great for the community colleges. Then if they want to, they can go further and do a two-year program."

Training Delivery

Employers use a wide-variety of training delivery mechanisms to get what they need; however the most common method is on-the-job training where an expert teaches a less-experienced employee in the field on various projects. Professional associations and union apprenticeship programs are also common sources of basic and advanced training in solar topics, and some include training needed to achieve national certification. Some of the training and certification opportunities identified by employers include:

- The North American Board of Certified Energy Practitioners (NABSEP) offers national PV and SHW training and certification. In the words of one employer, "If they go through this program, they are excellent employees. It's a real stamp of approval."

- The American Solar Energy Society (ASES) hosts an annual conference. They often have NABSEP-certified training available at the conference.

- Solar Energy International teaches online and in-person classes on how to design, install and maintain renewable energy systems, and how to design and build efficient, sustainable homes.

- Employers also rely on union apprenticeship programs. The local and national Joint Apprenticeship and Training Committee (JTAC/NJTAC) continually collect input from employers for integration into training for journeymen and apprentices. The NJTAC maintains a comprehensive solar PV curriculum guide.

- Vendors offer training and certification that is sometimes required in order to be a distributor for their product. Wholesalers conduct training for retailers, as required.

On-line options and computer-based training is growing in popularity, and employers said that much of the basic course-work is conducive to on-line training and could be helpful. But many employers noted that online training may not be the best approach for filling the most critical skills gap in the solar industry; they reported that interactive, hands-on training will probably continue to be the preferred approach. As one employer explained, "The quality of training is higher with hands-on work. For some of the basic principles on-line may make sense, but for specifics it needs to be face-to-face."

Biopower Sector Analysis

"Biomass" is a broad term for any plant-derived organic material. "Bioenergy" is a slightly narrower term for plant-derived organic material used for energy production. The organic matter can be used directly as a fuel, such as for firing a boiler, or converted to a liquid, such as biodiesel, and used for many forms of transportation. "Biopower" is the direct use of organic materials specifically to generate electricity. Renewable biopower is generated by sustainably grown organic material or material removed from the waste stream.

Biopower can be made from forest products, municipal solid waste in landfills and agricultural field residue. It can also be made using anaerobic digester technology from municipal wastewater and animal manure. This section of the report focuses on biopower from forest product waste, primarily by-products of the lumber, pulp and paper, and construction industries as well as some municipal yard waste.

"Combined heat and power" (CHP), sometimes known as "clean heat and power," and "cogeneration" (co-gen) are similar terms for a highly efficient process which simultaneously produces electricity and useful thermal heat. The heat can be used in an industrial process or for space or water heating. The heat can also be shared with nearby facilities in a district heating system or be sold to a nearby industry. A "stand-alone" biopower facility only generates power and does not make use of the waste heat.

Biopower is most economical when there is a secure feedstock supply and when it is combined with other products.[53] The inclusion of co-products, including making use of the heat or becoming a power supplier, enhances the efficiency and environmental sustainability of the process, but may be outside the facility's core line of business.

Growth Trends

The biopower industry is currently experiencing some significant challenges that are limiting growth. While the future potential for growth in biopower is large, the current success of the industry is quite varied. A critical factor that appears to be determining the ability of individual companies to prosper is tied to how dependent companies are on the wholesale biomass feedstock market. Currently there is intense competition for biomass feedstock, largely as a result of the economic recession: the recession exacerbated the downturn of the construction industry, which has come to a near standstill. The lack of new construction has severely reduced the demand for lumber, and as a result regional lumber mills are processing less lumber and hence the volume of wood waste available as biomass feedstock has declined significantly. Stand-alone biopower producers are forced to compete for this feedstock with pulp and paper mills, which use it in the paper making process. Since both pulp and paper and lumber mills that operate cogeneration facilities have slowed production output, they are holding onto their wood waste for internal use rather than selling it on the open market. This chain of events has created a shortage in feedstock in the region and has been accompanied by steep price increases.

One respondent expressed concern that the intense competition for biopower feedstock may ultimately result in trading one "green" job for another: "One large biopower facility can buy up all the feedstock – even shutting down a paper mill by competing for feedstock."

Perhaps more importantly, the size of the workforce needed to operate a stand-alone biopower facility is small compared to most paper and lumber mills. Employers reported that biopower facilities typically employ 15 to 25 people. By comparison, pulp and paper mills and some large lumber mills typically employ several hundred people. This discrepancy has some employers concerned about pushing biopower as a job-creation opportunity – unless there is very careful regional coordination. One employer described the following labor requirements for a modern biopower facility:

> A stand-alone 50 Megawatt biopower generator could employee 400 employees during construction, about 25 people for ongoing operations, and 75 people to transport the 50 truckloads of feedstock per day to keep the plant operating 24/7. The plant would maintain about 5 administrative workers and 20 or so operators and craftspeople. A stand-alone generator would face difficulties finding, securing and transporting sufficient wood waste resources to keep this level of operation going, especially in the current market.

Many of the generation sites that use biomass feedstock are also capable of burning natural gas. These facilities have the opportunity to switch fuels in response to prices. The economy has lowered the demand for natural gas, making it a significantly cheaper option, and companies are taking advantage of these price differences.

Some employers reported that future growth in biopower production is directly linked to the demand for green power. The current recession has reduced overall demand for electricity, causing wholesale power prices to drop and making it more difficult for green power producers to compete with traditional energy sources. These employers felt that consistent demand for the higher cost, higher value green power they generate would make a big difference in ensuring the success of their industry. One employer described the situation this way:

> It is green electricity demand only. Utilities are talking about it but doing nothing. Capping greenhouse gasses would increase demand. Green tags – we sell them – they aren't worth enough. The price difference isn't big enough between green and non-green, at least, here in Washington. If we shut our [manufacturing] plant down and run just a power plant we could sell it all to California. No one in Washington will pay for it.

State policy, I-937 and increasing public support are helping to drive growth in biopower, yet employers report that in the short term the effects of these drivers are also being offset by the very limited feedstock supply and high prices of the current wholesale biomass inventory.

One of the major factors contributing to the cost of bioenergy operations is the transportation of biomass feedstock to the generation site. Feedstock from a remote timber-harvest site may also need to be processed before it can be loaded onto trucks and delivered. While waste from a lumber mill may need minimal processing, both sources may require travelling a considerable distance to deliver to the generator. High fuel prices and associated transportation labor costs can significantly influence the viability of a project, and the scarcity of available feedstock requires that these companies must often search more broadly—and spend more on transportation—to secure new sources of feedstock.

Future Growth

Employers anticipate long-term growth as a result of policies such as I-937 and the federal and state climate policies now under consideration. They were cautious of the legislature pushing to develop new green jobs in the state, which some employers said may come at the expense of other important industrial sectors (including pulp and paper mills) that support large numbers of workers but have declined and are in need of state support. And the difficulty of securing local feedstock and the carbon footprint associated with transportation may render biopower jobs a paler shade of green. As one employer said, "They are in such a hurry to do something for green jobs, but it may not be all that green. There are a limited number of jobs."

Some employers are now seeing most of their economic activity come from projects to increase efficiency at existing facilities rather than expanding operations. Indeed, employers were hesitant to invest in new technology to advance their biopower capabilities, at least for now. As one employer stated, "We understand the connection between the win-win of using our waste to make energy. However it's a huge investment." This same employer noted: "The cost recovers over time, but with the housing [industry] and the economy the way it is, we simply don't have the capital to make any big changes now."

Some changes employers would like to see include further advancements in technology and processes that could help spur growth in the bioenergy sector. Some topics mentioned by respondents include lignin cellulose, which can be burned to fire boilers and turbines, and improvements in gasification technology, which separates wood solids from a clean-burning gas fuel that can be used to generate electric power.

Respondents emphasized that ensuring the future of biopower is critical to providing a diverse portfolio of generation resources in the state and region. Unlike most renewable generation resources, biopower is a baseload resource, meaning it can operate twenty-four hours per day and is not intermittent, like wind and solar. This capability increases the value of biopower to serve utility loads, and to add balance to a portfolio that includes other renewables and large hydro.

Several employers expressed concerns about the "negative attitudes" some utilities have toward biopower projects. These respondents believe that most utilities intend to invest heavily in other renewable sources, even though biopower qualifies under I-937, and that many utilities are not eager to incorporate more biopower into their load growth plans. Respondents said that some utilities view biopower producers as competitors in the regional electricity markets they serve.

One employer felt growth would only come as a result of legislative action that increases consumer demand for green power. He noted that some other states provide much better markets for biopower than Washington: “We could sell to California with a 20-year contract, but Washington and Oregon aren’t showing the demand.”

Recession effects**:** In addition to the effects described above, most employers are seeing other major impacts from the recession. As one employer stated, “Right now we are focused on managing existing infrastructure and keeping our employees employed. We are just trying to stay operational. Last year we went from four shifts to three. We laid off one of our shifts.”

Several employers were hopeful that federal stimulus money and other federal policy actions would either speed up development of biopower technologies, or help raise the demand for biopower.

One positive outcome of the economic recession is that employers are finding that a larger number of qualified quality workers are available in the labor market. One employer noted that the number of applicants has increased and that people are eager to work even if they are overqualified:

> We just hired a boiler operator last week. He has a four year degree and is getting paid what people would get at lesser degrees. He was laid off. We got a skilled worker at a lower rate. He needed work. He grinds up the wood waste and is responsible for boiler operations. He’s an assistant to the managers.

Workforce Issues

Employers reported that despite a larger pool to draw from, there continue to be some challenges associated with finding and training workers in some occupations. Topics ranged from the qualifications of applicants and workforce diversity, to skill gaps and future training needs. Respondents identified key occupations and provided input about future preparation and training delivery for key technical occupations.

Labor Pool: While some employers noted shortages of particular occupations that require specific training, other employers are finding an abundance of workers, many of whom are overqualified. As one employer put it, “Finding qualified people is not an issue. We have an oversupplied workforce by an order of magnitude.”

One respondent noted that with few exceptions the supply of applicants that could be placed into biopower jobs cuts across nearly all occupations: “There is a huge oversupply. They are adequately trained. The loggers and wood products workers are ready to go.” Another employer added: “We are finding enough engineers. If I put out an ad for engineers I’d get 100 applications for one job.”

The only key occupation where employers identified ongoing shortages of qualified applicants was for boiler operators. One employer noted that there is a global shortage of boiler technicians. Some employers noted that although the recession has delayed the retirement plans of most employees, a number of existing boiler operators are nearing retirement at roughly the same time, and they are concerned about their ability to replace them.

Employers also noted the lack of ethnic and gender diversity in most technician and operator positions in their companies. One employer said that their company may have the only female boiler technician in the country. The absence of ethnic minorities and women was noted by others as well. As one employer reported: "We have never had a woman come through. There are no minorities that go into these jobs."

Employers also indicated that few young people are pursuing jobs in biopower-related occupations, especially boiler operators. They emphasized that high schools and community colleges have not done enough to highlight the profession as a career path, and that there is a general lack of courses and programs available to prepare operators.

<u>Work Conditions</u>: Since some biopower operations are connected to existing paper and lumber mills, the general work conditions for employees in those biopower jobs are fairly similar to those found elsewhere in the plant. Although stand-alone biopower plants are structured somewhat differently, the core work is also performed in an industrial setting with a range of physical work tasks and requirements, operational processes and equipment. And, like many energy sector jobs the work can be hazardous, and safety is emphasized.

Some employers noted that while the work conditions are similar to those in other industries, the biggest challenges they face are frequently with the poor work habits of younger employees. Some employers noted that in the paper and lumber mill portion of their operations, the "work ethic" of younger workers is often lacking: Many don't show up on time, while others call in sick frequently. In other cases, employers reported that these younger workers are often not mentally prepared to do their jobs when they arrive.

Interestingly, some employers who run combined operations reported that this problem is much less prominent in the biopower part of the facility, which is considered a higher quality job. One employer described it this way:

> The workers feel it is an honor to be able to be there and they know there are many other people who want their jobs. They know the consequence is great. There is so little turnover, they know not to screw up. Once they are there, they are proud of their work and they want to be there. It's clean, sanitary and less physical than the manufacturing side. Yet it's extremely hands on.

In some companies, union-company agreements about seniority dictate that new hires will start at the lowest levels of a job classification, then move upward in rank and pay over time, with satisfactory performance, moving into new positions as they become available due to turnover or retirements. As a consequence, some respondents reported that they typically hire fairly low-skill laborers, who then join the union and must eventually pass a test to become eligible for operator positions or other jobs in the company. One respondent noted: "If someone came in with skill sets, they still have to start as a laborer and pass the test." One employer described her company's internal hiring system:

> When we have a job open, it goes out to bid within the company first. We check them all and they are ranked by seniority. They take the top 10 and give them the aptitude test. Then they are interviewed based on seniority. Almost none of them have degrees – it's based entirely on job seniority over expertise. We have found that the graduation certificate doesn't equate to knowledge or ability.

<u>Retirements</u>: As noted earlier, employers reported that many long-time employees are delaying retirement. The recession has had a negative impact on the retirement portfolios and accounts of many older workers, who feel they must remain employed until the economy improves. While this has been an advantage to most companies because they are able to continue operations without the disruptions that the loss of skilled workers can cause, several respondents reported that employees who were waiting to be promoted into the job openings that open up due to retirements have been disappointed because their opportunity for advancement has been delayed.

Because the number of qualified applicants has increased recently, filling the positions that do open up due to retirements has not turned out to be as big of a concern as they had anticipated, and most employers have managed to hire replacements with the required skill sets.

<u>Biopower Work is Fundamental</u>: Simply put, a biopower generator is a biomass-fired boiler that creates steam which drives a turbine and generates electricity. Except for the fuel source and some elements of the burner itself, the technology is nearly identical to steam generators which use natural gas, oil or other waste products. Boilers are typically designed to burn particular fuels, although some are able to use multiple fuel types as needed.

Similarly, the work of most employees in a biomass-fired facility is nearly identical to that required of workers who operate or maintain boilers fired by other fuel sources. While the generation technology and operator work may be basically the same, the biomass fuel supply does need some special handling, and this is one unique aspect of the work of employees who are responsible for managing the feedstock. For instance, the chemical properties of biomass materials varies, and each source of biomass needs to be identified, quantified and prepared before it is used as fuel for the boiler. The preparation process may differ depending on the feedstock, but typically includes grinding the feedstock to the proper size, ensuring the proper moisture content of the materials, or meeting other specifications that optimize the thermal output of the fuel source.

Employers emphasized that biopower operators need training in power plant technology and boiler operations. But, they also noted that workers with these skills could come from pulp and paper mills, steam plants or other industrial sites with co-generation facilities. Companies with union-company seniority agreements typically look to internal candidates first, before looking to the open market to recruit employees. Usually new hires are made to fill jobs at the lowest levels of an occupation. This traditional arrangement makes some aspects of the biopower sector unique from other renewable sectors, many of which include new, smaller companies or new divisions of existing organizations, some of which may either have different agreements with unions, or their employees are not currently represented by organized labor.

Occupations/Other Jobs: The key technical occupations mentioned by employers are listed in Table 6. The industry needs workers to collect the wood material, haul it to the generator site, prepare it and burn it. Engineers and boiler operators are needed to design, operate and maintain both the boilers and the turbines. After the power is generated, there may be a need for electricians and engineers to manage the power supply. Skill in optimizing system operations is also needed, as well as business and economic skills to determine the viability of co-products. Other occupations employers mentioned include general equipment maintenance workers, environmental scientists and portable generator (gen-set) operators.

Table 6. Biopower Occupations and Typical Job Functions

Occupation	Typical Job Functions
Boiler operators	Manage boiler operations and turbines
Boiler technicians	Prepare fuel, assist in boiler operations and repair
Control operators	Install and maintain control systems, Programmable Logic Control systems (PLC)
Engineers (Energy, mechanical, electrical)	System design, installation, upgrades and repair
Electricians	Install and maintain power supply systems and components
Business/economics	Marketing, researching and costing feedstock options, co-products

Core Work Skills and Skill Gaps

Most employers described core work skills that were consistent with the occupations and functions listed above. For operators, core skills employers listed as necessary to do this work include a specific knowledge of boiler operations, and more general knowledge of basic electricity and control systems. Employees with training on interconnected systems (not just boilers) are also viewed as valuable.

Employers were more apt to emphasize the importance of basic academic and employability skills when describing critical work skills, including the need for basic math skills, good communication skills, the ability to follow directions, and the ability to train others. Problem-solving skills and basic computer skills were also cited as fundamental. The ability to apply conceptual knowledge on the job was also a high priority. As one employer said, "They are going to have to work on these actual physical systems, and it's much different than on paper." Several employers described how many employees who come into their companies with community or technical college degrees in relevant areas are often "book smart" but lack the practical experience needed to apply that knowledge on the job.

The breadth of skills described by employers was also viewed as important because while most biopower facilities share many similarities, they are not identical, and employees with a broad set of skills are better equipped to adapt to the equipment and work environment. One employer noted: "Every plant is different. They are similar at 30,000 feet high, but at ground level, every plant is different."

Many employers reiterated the importance of employees having a good "work ethic," which they cited as lacking in some employees, especially younger workers. They noted that developing good work habits needs to begin early in life and poor work habits often cannot be turned around in the workplace, and compensating for workers who are not productive is expensive. One employer would like to see schools begin training for the work ethic students will need later:

> I really think the work ethic needs to be drilled in. Kids need to show up for class; that is training for the workplace. There need to be consequences if they don't show up for class. We pass them even if they don't show up. When they get here, they will be fired if they don't show up. They need to understand that. We spend millions of dollars a year on this issue. It's very costly for us as a business.

Some employers emphasized that many new employees also do not get the same degree of "informal" training and work experience that older employees typically got at school and at home. One employer saw this lack of early exposure and guidance as one reason for some of the skill gaps between the older and younger workforce:

> Our older workforce, when they were in high school, they were taught logic, common sense and basic mechanics at home. They learned it from their parents – it was part of life. We need to give the kids more hands on skills. They are focused on whether the answer is right or wrong – they can't figure it out on their own. They can look at a gauge and read if it's in a proper zone but they don't know what's behind that – what makes the gauge go up or down. We need more problem solving skills.

Still other employers said they would like to see educating and training students for the industry happen much earlier, both to raise students' awareness about the careers and skills required by the industry, and to provide hands-on experiences for high school age students. The emphasis on developing hands-on skills was offered by many employers. As one noted, “Most of this stuff you won’t learn from a book. It’s like learning to drive a car by reading a book.”

Employers also urged high schools and community colleges not to minimize the number of classes in technical areas such as mechanics and general engineering, which they say have been eliminated from some programs. As one employer observed, exposure to technical coursework also needs to be available at all levels of education:

> We need to engage these students both in high school and community colleges in the mechanics of engineering. We push kids into engineering and they don’t even know what engineering is. Kids need to play with machines. The kids winning awards in robotic competitions are coming from private schools. Public schools aren’t funding it. It’s where we need to start this -and at a young age. Some of these kids have a brilliant sense of how to work things out. If we don’t allow that skill to develop at a young age, it’s too late. We have missed so much by not giving our kids the opportunity to learn and even play with mechanical systems. It can’t be a scholarship their senior year – that’s too late.

Training Topics

Employers identified a number of areas where technical skill gaps exist among current employees, most of which include gaps in some of the core skill areas named above. Training topics identified as very useful to the industry, and where employers noted the need for even greater technical emphasis by post-secondary training programs, include:

- Boiler operations
- Systems operations
- System design
- Electrical (boiler operators in WA are now required to have an electrical license)
- Computer skills
- Controls
- Basic engineering
- Economics and business (especially around incorporating co-products)
- Electrical interconnections (tying distributed systems into the grid)

Employers mentioned the need for specific training in burners with a “high turn-down ratio,” which refers to the point at which a thermostat turns off the burner and which can vary by fuel type and characteristics. Additional training in burners generally is another potential area for operators and technicians.

Customer service training would be useful to companies who sell and service boilers. One employer explained: “Boiler techs are the frontline people. They are in front of the customers and doing the service work. They need phone skills. They have to interact with a lot of people, especially with a new boiler start up. They work with the customer and sometimes a general contractor for electrical or engineering.”

Training Delivery

Several employers remarked about the lack of training opportunities at all levels, especially post-secondary programs in the region that train specifically in boiler operations. Some employers said they would like to see more post-secondary training opportunities in heating and hot water supply systems as well.

To compensate, some employers look to the HVAC industry for background training in controls, then they train for the rest of the skills themselves. One employer described the training offered by his company:

> When we have a new hire, we send them back to the manufacturer for Boiler Operator 1 and 2 and electrical for about a week each. The classes are for someone with some basic knowledge. They don't have a class where you can go through a one or two-year program. I don't foresee them doing that. If I hired someone off the street with no experience, they would need two to three years of training. You aren't going to get a lot of trade schools stepping up and doing this. It's a problem in finding qualified people. That's why we look for people who have gone through heating-ventilating-air conditioning (HVAC) training.

Employers have high expectations of students who graduate with post-secondary degrees or certificates in relevant fields. But because some of the unique aspects of biopower operations are specialized, and the expertise of boiler operators is gained through time on the job, some employers have moderated their expectations, though they want students to succeed. As one said, "They are going to be expected to know this stuff when they get to a job." Employers also emphasized the value they attach to training that helps students understand how individual systems integrate into the whole system. "That's how they understand enough to fix a problem," one employer noted.

Some employers noted that, while most college programs focus on breadth rather than the level of depth the employers would like, they recognize that some of the skills they need new employees to have are site-specific, and not likely to come from a community college training program. One employer noted:

> Identifying the fuel source and preparing it for the boilers is a specialized skill but it wouldn't come from a junior college. It's highly skilled. Someone needs to really understand the general aspects, but when they get on site they'll learn our fuel sources and our facility. That's why I say they need good communication skills – if they can learn it, they can grow into it.

A few employers mentioned interest in hiring college interns as a way to begin developing a future labor pool for the industry. Employers said they would appreciate the extra help, and also thought it would provide some good hands-on experience to students. They thought it might also provide a good opportunity to observe the workers before making a hiring decision. A major point stressed by many employers was that without the benefit of practical experience, most college students are unable to enter into a job in the industry with the skills and experience needed to do the job well. One employer explained:

> People coming out of college training classes still need another 1-1½ years experience. They still need controls, computer literacy, systems training - not just boilers but the whole system. You need to know how to diagnose the problem to help the customer. Help them focus their solutions – may not even be the boiler.

However, one employer ran into legal difficulties finding a way to offer students learning opportunities at his facility: the students were required to be employees of the company, members of the union and enrolled in an apprenticeship program in order to train at their site. This employer felt one solution would be for the state to build a boiler operation training facility for the industry to use.

Several employers mentioned that in the past they would get highly trained employees from the Navy, but the Navy doesn't operate as many boilers now as they did in the past, and the number of former military personnel with that specialized experience has declined. Employers generally noted their concern about shrinkage in the boiler operator labor pool, and the need to re-build programs to boost future labor supply in this field.

One employer mentioned that his company ties successful completion of a series of on-line training programs to pay increases.

<u>Apprenticeship and On-the-Job Training</u>: Almost all respondents discussed on-the-job training, apprenticeships, or both as an important source of training for new employees. Senior workers, engineers and managers are typically assigned to train the newer workers so that the employee eventually gains specific skills and learns about other jobs as well. Employers also rely heavily on technical training offered through labor unions for new employees and also for upgrading skills of existing employees working on boiler operations and other craft skills.

Other common providers of training are equipment vendors and manufacturers, who typically provide specific technical training to employees on-site, or at regional facilities. Technical programs at community colleges were also mentioned, though some employers found these students to be "book smart, but didn't have the practical experience."

<u>Training Opportunities Essential for the Future</u>: Employers would like to see more trade school training opportunities in general. They also felt that high schools and community colleges need to encourage more students to consider careers in mechanics and engineering. Students need to know these jobs exist, have a better understanding of what these careers are like, and have more hands-on opportunities to learn.

Small Hydropower Facilities and Energy Efficiency Upgrades

For the purposes of this report, small hydro refers to a hydroelectricity installation that typically produces less than 30 average megawatts.[54] Most of the large hydropower sites in the state have been fully developed and there is public opposition to new large hydro. As a result, more focus has shifted to development of smaller sites, such as the upper reaches of streams, irrigation ditches, and existing water supply, irrigation and/or flood-control dams for which small hydro installations may be well-suited. Although a number of privately-owned small hydro installations exist, few utilities currently operate them.

Hydro "efficiency upgrades" refers to upgrading existing hydropower equipment or operations to increase output, reduce environmental impacts, or both. Many large hydroelectric projects in Washington have undergone efficiency upgrades, and since these upgrades can be used to meet I-937 targets, many other utilities are planning to upgrade existing projects to help them meet their Renewable Portfolio Standard (RPS) requirements.

Most small hydro projects are typically built and maintained by individuals or a small number of employees or specialty contractors. In contrast, efficiency upgrade projects are often very large, costly, and require support from whole teams of engineers, technicians, general contractors and other specialists.

Growth Trends

The electricity industry is seeing a wide range of growth in the application of small hydro technology and hydro efficiency upgrades. Some utilities are pursuing the use of one or the other of these technologies, while others are doing everything they can on both. Still others are not taking any action at all. Inactive utilities usually don't own much (if any) of their own generation, or they tend to be experiencing low growth rates, or both.

Work underway at the utilities we interviewed included economic and engineering feasibility studies, engineering designs, environmental assessments, turbine replacements for efficiency improvements and capacity expansions, computer software expansions, licensing, and transmission expansion.

Businesses that provide products and services related to small hydro and upgrades are seeing growth right now. The types of businesses most often mentioned by respondents include engineering firms that design small hydro systems, developers of software designed to optimize hydro operations, business development consultants, hydrogeologists, fish biologists, water modeling, and turbine manufacturers.

The utilities with the most growth in electricity demand and that are subject to the state's renewable portfolio standard (I-937) are most actively pursuing small hydro and efficiency upgrades. In the words of one utility, "It's only a few megawatts but lots of projects begin to add up." Utilities are drawn to these technologies because they are untapped resources, and they are generally easier to license than large hydro.

Drivers: Employers say climate policy, the national emphasis on energy independence, the growing need for additional electricity resources, and the need for those additional resources to have a minimal environmental impact are driving their interest in efficiency upgrades and small hydro projects. The Washington State Department of Ecology reported that ninety-eight percent of existing dams in the state do not produce electricity – they were created for flood control, irrigation or other reasons. Many of these dams could be retrofitted to generate power, though the rules of I-937 are currently not clear as to whether this type of project qualifies for meeting renewable targets.

Employers noted that hydro plays an increasingly important role stabilizing the power output from renewable sources such as wind, which is expanding rapidly. Because it's an intermittent resource, wind's capacity and reliability are increased when it's accompanied by a flexible back-up power source such as hydro. New hydro resources may be needed to provide stability for new wind generation, but regulations for fish protection, flood control, reserve requirements and weather may constrain any growth in new hydro. Another process, pumped storage, which uses surplus power during off-peak times to pump water to a storage facility until it is needed to meet peak demand, also has potential to add stability to hydro and help balance renewable generation.

Small hydro is of particular interest to utilities with large irrigation loads, where this technology can be used to generate small amounts of power within irrigation canals and ditches. These locations are relatively easy to develop and generally have an easier time receiving operating licenses.

Keys to Growth: As with other renewable technologies, respondents stressed that sustained high energy prices, price protections, or a guaranteed rate of return on investments would be helpful to advancing the technology and are key to hiring. In the words of one employer, "Energy prices make it work for us. We can employ more people when prices are tight."

State and federal policy also impacts the development and use of new hydro technology. Some respondents felt that, for many years, legislation favored the development of fossil fuels, making it harder to develop new hydro projects. Now more is understood about climate change, fish migration patterns and stream flows, and respondents are more optimistic about the prospects for future growth. However, uncertainty in the existing legal language of I-937 needs to be clarified to enhance support for the development of small, low-impact hydro. Expressing clear support of these technologies in the context of I-937 is expected to result in growth in the use of these technologies.

Some respondents felt that licensing and permitting regulations had not kept up with the growth in demand for the resource. They also believe that hydro growth and upgrades are constrained because they are more heavily regulated than other renewable sources, in part because more is known about hydro's impacts. They believe that solar and wind have a permitting and licensing advantage. One employer noted: "We may have water for some other reason, like water supply, and we already have water rights. We just want to add hydro but we have to jump through a bunch of hoops. We don't want to skirt the environmental issues, just that they have been already addressed. Wind and solar aren't regulated like water." Several employers said that as the environmental impacts of wind and solar become better-known, these sectors will also see regulation increase.

Employers reported that one unanticipated result of efficiency upgrade projects was that, while the addition of new system optimization technology helped maximize generation efficiency, it also caused more wear and tear on system components. Parts which were supposed to be replaced in 50 years now need to be replaced in 30 years. But as one hydro manager noted, the long-term gains are worth the investment: "The outcome is worth the investment. The return on investment is very high. And we don't really have a choice, we're dependent on it."

Some utilities are waiting for advancements in small hydro technologies before they deploy new projects. They believe systems need to become truly "plug and play" before significant growth will occur. Others are eager to "double our hydro capacity without building any new large dams." This vision could become reality, they say, if policies are developed to promote further development of hydro-based technologies.

<u>Recession Effects</u>: The economic recession has had a negative impact on the ability of most companies to develop small hydro and efficiency upgrade projects. Most utilities have seen a drop in revenue from electricity sales due to a weakening electricity demand, but the degree to which that impacts the utilities' financial health varies. Some utilities budgeted projects based on income from selling surplus power, yet demand has softened. Utilities are also seeing an increase in payment defaults from customers who are unable to pay their bills. Some companies are delaying projects and are concerned about preventing layoffs.

But several utilities and project developers are still on track to install new turbines and efficiency technologies financed by existing utility revenues, rather than seeking outside financing. And although financing new projects is harder in the current economic climate, hydro often has a financing "edge" compared to some other renewables. As one utility responded, "The recession has raised the visibility of hydro. But it's a proven technology, you know what you'll get, it's clean, produces jobs, etc. Some of the newer resources are less proven, reliability may be unproven, and financing is more speculative." Another respondent noted: "When the economy goes down, energy goes up. I haven't seen any trouble getting financing. Energy prices are the biggest unknown. High prices move projects along."

The recession is also affecting employment in some interesting ways. Some respondents are finding that retirements are being delayed due to the weak economy, and some highly-skilled workers are staying on longer than anticipated. On the other hand, some employers felt that delayed retirements are preventing younger employees from entering or moving up: "We need a fresh perspective, new thinking." Most employers said they are now seeing a flood of applicants when they have job openings. One employer noted: "We just advertised for a hydro-craft worker for one of our projects, due to a retirement. The folks applying seemed pretty well qualified. We got about 50 applicants."

Workforce Issues

Labor Pool Shortages: Despite a boost in the number of job applicants due to the recession, almost every employer said they have had great difficulty finding qualified workers. This respondent's comment was typical: "There are not a lot of new people coming in. We're robbing from each other more than we're creating new workers." Nearly all companies said their most urgent need is for engineers and linemen, and that the competition for those workers is very high. They also say it's difficult to find people with a combination of biology, fish and wildlife science and engineering skills, which they see as an extremely valuable combination for efficiency upgrades and small hydro-related projects, as well as for emerging jobs in the hydroelectric industry in general. They are also seeking new, younger management personnel.

They listed many reasons for this situation including the remoteness of the worksites, the high level of training workers need, the complexity and risks associated with the work, the lack of succession planning by the industry, and that other careers and industries are seen as "more glamorous." Some employers found the recession has improved the labor pool somewhat, but they recognize that it is a temporary situation.

Work Conditions: Most identified hydro as offering good jobs and working conditions compared to other industrial sectors. As one employer explained, "People who know about the jobs here know they are good jobs: good pay, benefits are good, working conditions about as good as you get in an industrial environment. Talk with some of them, they'll tell you that it's way better than some environments, like coal or pulp and paper."

But a major issue for employers working on small hydro and hydro efficiency upgrades is that the majority of these projects are located in rural areas that often lack the amenities available in and around cities. While employers view rural living as a great lifestyle for families, they report that it's hard to attract and retain employees when they learn that the cultural activities, personal services and other amenities typically found in urban areas are limited.

Small Local Labor Pool, Limited Skills: Employers would like to hire as many local people as they can, but in small rural communities finding locals with the necessary skills is difficult. Efficiency upgrades and small hydro projects can be complex, and the level of skills needed to do the work—and the consequences of mistakes—can be high. As one employer explained, "These are multi-billion dollar assets. The amount of skill you need for a rural area is quite important. But it's a challenge to recruit and hire locals. We want to give them the benefits, but the skill levels needed are high, the risks are high." Workforce diversity is also hard to achieve in many small rural communities, and employers find this especially challenging: "It's got to be frustrating to wonder why we don't have a more diverse workforce - we want that."

Lack of Interest Among Youth: In general, employers said they are not seeing young people choosing to pursue careers in hydro-related occupations that equip them to do efficiency upgrade and small hydro work. Employers did not feel that paying a higher salary alone was enough to entice workers into these jobs. Most felt they were paying very competitive wages and still people are not choosing these careers. As one employer said, "My daughter just finished seven years of law school and will make less money than a starting helper position at a utility plant."

Employers noted that many young people are not pursuing jobs in the trades, opting instead for careers in other non-industrial settings and high-tech. They are seeing few applicants that are recent high school graduates, and those that do apply lack the needed skills. Many employers felt strongly that schools needed to emphasize math and science at much younger ages. One respondent stated, "We need to teach math and science – down to the fourth and fifth grades. Our technical literacy is going down in an increasingly technical time. There are a lot of kids that would really do well with voc-ed classes. All of those classes are gone."

<u>Retirement Effects:</u> As with many other traditional energy sectors, retirements are a significant concern for these employers, and they recognize that current and future retirements will cut into their skill base. "It's huge," noted one employer, "In five or six years we'll see a big problem. The amount of knowledge walking out the door is scary." Many employers lamented the instability that this wave of retirements could cause. Some said they were interested in seeing new people with new skills come into the workforce, but one employer noted that the lack of interest among young people will probably limit their ability to balance the age of the workforce: "The problem is, the average age isn't going down like it could because we're not getting applications from high school age students choosing the trades."

One employer offered his perspective on the consequences of retirements, the lack of a qualified labor pool, and how his company has had to reach out globally to fill the void:

> Yes retirements are impacting us. I would have said strongly yes a year ago, prior to the bad economy. People aren't moving out as quickly now but there still just aren't enough engineers as it is. In my vanpool of six engineers, half are foreign nationals or recent citizens. I know what I see when I go to conferences: a lot of folks coming from Southeast Asia: India, Vietnam or Pakistan. They all speak English – English is the language of engineers. It's a growing industry in those countries. They are training their people heavily.

On the up-side, employers are reporting that because of the weak economy some workers eligible for retirement have delayed leaving, which will reduce the loss of experienced workers, at least for the short term. Some retirees are even returning to their former jobs. One employer said he was pleased to be hiring those would-be retirees: "Retirements are helping me because I hire those retired people – they have great skills."

<u>Skill Sets Can Be Unique:</u> Some employers felt that the skills needed to operate a small hydro system or install an energy efficiency upgrade were not notably different from traditional hydropower jobs. Yet, employers who work more closely with small hydro and hydro efficiency upgrades or who specialize in these technologies felt that the unique

skills needed to work on these projects include a broader skill base and more attention to the specifics of these projects. The following quotes identify some of the ways that these employers saw the skills as unique:

- "Small hydro folks need to be trained in a wider variety of areas – we have just a few people to do a lot of different things. Maybe the same or similar skills you see in large hydro – but we need one person to do multiple tasks."
- "There is a unique skill there. If you are going to generate, you have to understand head [amount of power behind falling water], how to build the facility, direct the water, connect it to the grid, monitor it, maintain it. Need to know motors, generators, maintenance and repair. They will have similarities to the large units, but they are different skills."
- "More small projects will need to be integrated into the system. Newer systems tend to have more sensors and controls."

<u>Occupations:</u> The types of occupations employed by the industry reflect a mix of old and new job types: electrical, mechanical and civil engineers, linemen, electricians, power system operators and traditional trade skills are still needed. As shown in Table 7, however, there is also a pressing need for occupations with skills in new technology such as instrument and communications technicians and systems specialists. Advancing small hydro and hydro efficiency upgrades will also require more fish and wildlife biologists, and individuals with legal and regulatory skills, especially in combination with technical skills.

Table 7. Small Hydro and Efficiency Upgrade Occupations, Functions & Technical Skills

Occupation	Functions and Technical Skills
Instrumentation Technicians	• Install controls, sensors, monitoring equipment. Also wireless, fiber-optic, analogue and digital communication and relay systems • Synchronize systems • Skills needed: Programmable Logic Controllers (PLC), basic math, computer application software, networks, file servers and databases
Systems Integration/Optimization Specialists	• Install and integrate applications and components, model systems to determine optimal operation • Skills needed: Programmable Logic Controllers (PLC), modeling, MatLab software
Fish/Wildlife and Environmental Biologists	• Determine and monitor impacts to fish, wildlife and environment of planned or installed projects • Skills needed: Research skills, statistics, analytical modeling, reporting
Regulatory/Permitting/Contract Specialists	• Analyze, interpret and manage contracts for project land use permitting, environmental and regulatory and code requirements • Skills needed: Legal, regulatory and policy skills, fiscal contracting, land use codes and permit requirements
Information System Specialists	• Set up control systems to monitor, build screens (interface) and emergency systems alarms; HMI (human-machine interface) software • Skills needed: Logic, programming, systems integration and networking

In addition to the key jobs listed above, employers noted a growing need for individuals with knowledge of cultural preservation and tribal issues, local history and archeology, information technology specialists, data and economic analysts, technicians with hydromechanics experience, and those who can install sensors for monitoring water levels, oxygen levels and other environmental measurements. Employers stressed that engineers, linemen, meter relay technicians and other occupations that indirectly support efficiency upgrades and small hydro will continue to be in high demand.

One employer outlined the occupations and diversity of skills his company expects to need in the future, "In the next 5-10 years, we'll need mechanical and civil engineers to work in individual sites, people to integrate the power. For the five to ten kilowatt size, the system will need a meter, a controller, system protections, someone like a maintainer or operator. They may need computer skills, knowledge of sensors, controls and instrumentation."

Core Skills and Gaps

The industry is increasingly reliant on electronics-based technologies, and that has altered the kind of skills employers seek. One employer explained, "We're seeing a shift toward more instrumentation techs. We are shifting electricians toward techs and not replacing as many electricians. More use of electronics is driving the shift." The emphasis on advanced technology means there is an increasing need for people who understand programmable logic controllers (PLCs), control and communication systems, and system interface software. Systems integration skills—getting the components to communicate with each other—also require programming. One employer noted: "A Tech who can do that kind of stuff is really valuable." Workers are also expected to have a good grasp of new technical terms. It's an evolving industry and workers need to be innovative. Employers would like to see people who are good project leaders who can work with a team but also lead a project to completion.

Employers also emphasized that workers should like working in the outdoors, be good with their hands, physical, and enjoy lots of camaraderie. As with any energy-sector occupation, the work can be dangerous, and safety is paramount. Employers also said they continue to need workers with some knowledge of the "old skills" such as working with concrete and welding. Some employers said that the emphasis on new technologies and computer-based systems has made it harder to find new employees who are able to use basic hand tools and instruments; older workers tend to have more skills using standard tools.

<u>Basic Skills Critical</u>: Many employers expressed concern about basic skills lacking in the workforce. Some respondents expressed concerns that they may need to revise their training materials to match the lower skill levels of many younger employees; they don't feel prepared to train on these basic subjects. Several employers reported a shortage of basic math skills, and a lack of problem-solving skills such as the ability to understand how systems work, or break problems down into manageable parts. One employer noted:

> If you don't have basic math and algebra skills, you are not going to make it. It's not just learning how to manipulate numbers; it's learning how to think beyond digging a ditch. Our systems are designed with that potential in mind. You don't just flip switches here; you have to understand the impact or you could kill yourself. Some of it is nothing more than basic math and understanding sine waves, geometry and algebra. You have to work safely in this industry.

Some employers hire first for attitude and aptitude, then they expect to train for skills, knowing that it will take time for the employee to become effective on the job. One employer said: “Alarm clock skills. Learning skills. Teamwork skills. If you have all three you can shape them into good employees.” Other employers look for a worker with a particular set of skills they want, then they provide supplemental training to round them out. As one employer said:

> The technicians that we hire usually come from a drafting background with skills in Autocad, Excel, Access, and some front-end experience. Then we generally have to teach them everything else like basic electricity and physics, water pressure flow and temp. They don’t need high level math – computers do that. They should understand units of measure.

The lack of skills can cost time and money in the workplace. One employer described having to hire an engineer to help them integrate their existing communications hardware with new security systems because their existing technicians lacked the technical skills to do the job.

Beyond specific technical skills, employers are also looking to technician-level employees to have basic business and economic analysis skills. One employer put it this way: “We don’t do everything just based on economics but almost everything needs to be analyzed for economics. Engineers can do this but technicians – those with a business background – can do it too. We need more help on the business side.”

“Soft” Skills Important: Communication, social and interpersonal skills were identified by employers as core skills for doing these jobs. These soft skills were also mentioned as being one of the biggest gaps in skills found in the workforce, and they were mentioned frequently as targets for future training. One employer noted, “We have a lot of engineers who are managers, but we need them to communicate clearly and simply or clients can’t understand them.” When communication skills are poor, employers are not confident in the knowledge of their employees and potential new hires, and they begin to question employees’ abilities in other areas. Employers also stressed the importance of good writing skills, because many jobs require writing reports and memos. Respondents said that employees who lack good written and oral communication skills—as well as interpersonal and conflict management skills—are at a great disadvantage. Employers would also like to see employees develop better skills in communicating with the public; one employer said he had a major project terminated due in part to how poorly one employee communicated to the public.

Training Topics (and Gaps)

Energy efficiency upgrades can be very large projects. Most employers acknowledged that they will need to offer specific training on the job, and that the skill needs of each plant and project are different. In general, the input from respondents suggests that bigger plants require more specialization and smaller plants require employees with a somewhat broader skill base; smaller facilities and companies typically prefer generalists.

Regardless of how different the scope and content may be, the advanced nature of these technologies means upgrade training will be needed. And, while technology is changing rapidly, utilities still need to maintain their existing equipment. This has made training more challenging for employers and demands on employees even greater. As one employer explained, “It’s expanded what we need to include in our training programs. Apprentices need to have a level of understanding that they didn’t need before.”

Most employers reported spending a lot of time planning and implementing training to meet the needs of their employees. A few employers did not see any shortage of training opportunities and were generally able to find what they needed. But a number of employers have expanded the amount of training they provide, either in-house or through other sources. One employer noted: “Our technicians get one week per year of advanced training in their specialty; engineers get two weeks per year. We send them to Los Angeles to get interface training.” Another employer added: “We work hard to keep people trained at the proper schools, all over the country, in Texas and Florida. You buy some equipment and the manufacturer does the training, often in nice locations. You need to keep up to date.” But some employers found constraints due to “time and resources” and admitted they need to do more: “We are behind on utilizing these technologies. Other utilities are using these things more. We’re using drafters where others are using people trained in these technologies.”

Specific topical areas where most employers said they would like to have more opportunities for training include the following:

- Computer applications: Employers would like to see more training offered for all types of computer applications. Tracking records, requesting materials and drafting plans are all computerized; everything from paperwork to testing equipment is computer-driven. Employees need to be able to run the common applications such as spreadsheets and word processing.

- Basic Sciences: Almost all employers requested more offerings on physics and electricity basics. The Bureau of Reclamation developed their own “Principles of Hydropower” course to help train their new employees. Employers also felt that a better basic understanding of how electricity is produced and transmitted, what current is, and how transformers work, was vital to getting new people interested in energy careers and to promote the industry.

- Non-Technical Skills: As noted earlier, writing, speaking, interpersonal and problem solving skills were regarded as very important by employers, and the call for training in these areas was repeated many times. One employer noted how apprenticeship programs also focus on these skills as part of the teaching and mentoring relationship between journeymen and apprentices in the workplace:

> Teamwork, how to participate, collaborate, how to teach and pass on knowledge. We taught journeymen how adults learn. It’s part of a deliberate strategy. You can’t get it all from a college program. It needs to come from mentors, the applied part. We have our guys assigned to journey-level folks. They have to prove they’re proficient at a list of

tasks, like communications, typing, computer use. Reading comprehension is very important. They have to know what they're learning. Misunderstanding and misreading can have big consequences.

- Business and emerging technology: Many employers would like to see more offerings in basic business skills and economics. Many already do a lot of management and project management training. Employers also expressed an interest in periodic training on emerging technologies.

- Safety: Employers reported that the emphasis on safety has increased over the years, and new safety topics have emerged. Training needs in safety basics, safety equipment, and training to test and use the equipment has increased. While many employers offer this training internally, one employer noted outsourcing much of this training, "We provide a lot of safety training that we didn't used to do. We bring in people rather than do it ourselves."

Training Delivery

Most employers mentioned the lack of time and resources, including training materials and staff, as challenges to training delivery. Figuring out the best way to provide trainings at remote worksites is also difficult. Smaller employers, who are also frequently on the frontlines of the small hydro industry as consultants to utilities, seemed to have the most difficulty finding funds for training, while they also have the greatest need for broad skill sets.

One utility employer observed that training programs seemed to come in waves to their company, making it difficult to sustain a regular foundation of training. In some instances a lot of programs were offered at the same time, and employees would get "oversaturated" with new information, and then the trainings would taper off. These on-again, off-again cycles were viewed as counterproductive to learning, and promoted training triage rather than supporting a deliberate training strategy.

<u>On-the-Job Training Common</u>: Employers rely primarily on in-house training and local classes to fill their needs. Occasionally employers send workers off-site for specialized training. Some employers rely almost exclusively on on-the-job training for employees. Applied learning is highly-valued by these employers, and for many small companies it is the only feasible approach. In the words of one employer, "People doing that work are the ones that need skills. Very little time is actually spent sending people out for training. We can't do it on a large basis. If you are going to get another degree or something, other bigger companies can afford to pay for that. Would do it too here, but we aren't big enough to have a great need. But we would if an employee really needed it." Some employers would like to see more mentoring and internships in their companies, but those approaches also require coordination, resources and time they say they often cannot afford.

<u>Apprenticeship</u>: Union-company sponsored apprenticeship programs were also often mentioned as a key training delivery system. Several employers said they follow the

IBEW standards for training. The combination of classroom and applied training is especially viewed as valuable because the hands-on components happen in the workplace under the supervision of a skilled journeyman. One employer said he struggled to keep his apprentice programs up to date with technology shifts in the industry: “Things move so fast I feel like I’m always teaching them on the old technology – when they get out in the field and work, it’s on new technology.”

Vendors: Employers rely heavily on equipment vendors for training as well, especially for technology upgrades. For example, many employers have upgraded to make a shift from electric to electronic components, or mechanical to electromechanical systems. Vendors who manufacture or distribute these technologies teach engineers and technical employees how to install, operate and maintain the equipment.

Community and Technical Colleges: Several employers look to local and regional colleges for some of their technical training, and some have sent employees to week-long engineering programs at colleges for upgrade training, which is a requirement for maintaining licensure. Community and technical colleges also work with employers to conduct in-house training focused on upgrading skills of existing workers and provide Related Supplemental Instruction for apprenticeship programs.

Industry Associations: Some companies rely on industry and professional associations for training. The Northwest Public Power Association (NWPPA) was a popular source for technical training and many other topics. One employer noted, “We send our folks to all kinds of NWPPA training as needed. Our line crews go to supervisor and leadership courses. We’ll send them to customer service, billing, accounting classes. Folks from the dam could be more technical. Not every employee goes every year. They may go once every 5 years.”

Online and Distance Learning: Most employers have accessed some sort of online training, and it is a high priority for many employers now and for the future. The convenience of keeping employees on-site for training and avoiding travel and time away from the job is attractive, and there are many new sites and training topics available. For some, it is about making better use of instructors’ time by covering some basics in online courses prior to instructor-led courses where hands-on training is used.

Some employers noted that while they plan to increase their use of online training delivery, there are a number of reasons that limit its use. One employer noted that not everyone in their utility has access to computers. And, some linemen and craft workers don’t use computers as part of their regular job, which limits the types of online training they can participate in. Finally, many employers were cautious about offering some subjects online which might be better suited to a classroom setting or through on-the-job training. As one employer pointed out:

> I think web-based learning is good sometimes but there is a lot to be said for learning in a group, with hands-on instruction. I learned by hand. I started with electronics, making stuff and that’s how I learned. Wasn’t so much from text

> books. A lot of people are like me, we need tactile work to learn. Working in a group helps you develop social skills. Your trouble shooting techniques develop.

Looking Ahead: Many employers said they would like to see more evening and weekend courses for professional development. Week-long focused skill development workshops, and more training being delivered at the jobsite is also of interest. They would like more training offered to suit a variety of learning styles, as many of them considered themselves and their employees "hands-on" learners, rather than learning from textbooks.

Employers also noted they would like to see high schools and community colleges do more to support students who choose vocational education programs over four-year degrees and professional careers. Some employers are concerned that colleges have moved away from vocational-technical education programming. In one employer's words, "They focus too much on moving kids into four year schools. A lot of the voc classes have gone away. [Our local community college] used to have a wonderful program, but when the professor who taught it retired, the program died. We used to have a machinist school, no more. Community colleges need to focus more on the tech programs – and sell those programs to kids. A lot of kids would rather do these things."

Renewable Education and Training

For the purposes of this report, "renewable education and training" programs are categorized into three levels, or tiers. This tiered approach was created to help distinguish among programs that are specifically related to renewable occupations and skills (Tier 1), those that are specific to the energy industry but not specific to renewable jobs (Tier 2), and programs that provide foundational technical training in occupational areas but that are not designed specifically for renewable or traditional energy industry occupations (Tier 3).

Tier 3 programs emphasize the development of general competencies and skills needed to apply technical knowledge in occupations that are commonly found in most industrial sectors. Though the training is not directly tailored to renewables, the trained electrician, mechanic or architect, for example, receives training that develops transferable skills that are important to success in a renewable sector job. The Foundational Industry Skills Programs listed in Tier 3 are a general representation of the programs and jobs available in the State of Washington and are listed in Appendix B.

Tier 2 represents "energy industry core skills" programs that impart the technical skills, knowledge and abilities needed to succeed in the energy industry as a whole. The majority of these are related to "Energy Technology," with seven 2-year associate degrees being offered in the state. Some of these programs and courses are shared among colleges and delivered using distance learning formats and technologies. Other options are 1-year certificates (four in the state) and numerous short-term certificates ranging from 5-20 credits. Other Tier 2 offerings include architecture or interior design programs that add, for instance, a class on passive solar design or geothermal elements to their regular curriculum. Currently-available Tier 2 programs are also described in Appendix B.

Tier 1 represents programs that are specific to renewable energy. A majority of community colleges in Washington have expressed interest in offering renewable energy programs, and some new programs are being developed for delivery in Fall 2009. At the time of this writing, however, very few comprehensive program offerings were available.[55] Columbia Gorge Community College (which is located in Oregon, but is part of a bi-state Renewable Energy Economic Zone) is currently the only 2-year program on wind energy available. Within Washington, there are two 1-year programs, a handful of short-term certificates, and at least four programs being developed or pending approval. Table 8 briefly describes these Tier 1 programs.

Table 8. Tier 1 Renewable Energy Core Skills Programs

Tier 1 Renewable Energy Core Skills Programs		
Program Title	**Degree, Certificate or Course**	**Description**
Cascadia Community College (Bothell)		
Solar Photovoltaic System Specialist	Certificate (51-57 credits)	Program prepares student to serve the growing industry need for solar photovoltaic (PV) system specialists. They will gain the knowledge and skills required to specify, configure, install, inspect, and maintain solar electric systems that meet the performance and reliability needs of customers, incorporate high-quality craftsmanship, and comply with all applicable safety codes and standards.
Centralia College (and via ITV to Wenatchee, Peninsula, and Grays Harbor Colleges)		
Energy Technology Power Operations	AAS	Program provides an introduction to the generation, transmission and distribution of power from hydro, solar, wind, geothermal, and thermal sources. The power cycle is traced from generation to transmission through the power GRID to the point of distribution. Washington State Renewable Energy Portfolio Standards are introduced with a concentration on hydro efficiency upgrades, energy efficiency, and conservation. Energy resources, pollution caused by the generation of power, and global environmental energy issues are discussed. Year two provides an in-depth study of thermal plant cycles and boiler systems fired by gas, coal, nuclear and biomass sources. Courses are delivered via ITV (Interactive Television) broadcast from Centralia in a collaborative effort to deliver the most relevant and appropriate curricula.
Columbia Basin College (Pasco)		
Solar/ Photovoltaic (PV) Design	Short-term Certificate (5 credits)	Program trains people to select and/or certify solar panel systems for residences and commercial buildings. The course will prepare students for the Silicon Energy Manufacturing Solar Installation Certificate and the National Photovoltaic (PV) Installer Certification through the North American Board for Certified Energy Practitioners (NABCEP).
Columbia Gorge Community College (The Dalles, OR)		
Renewable Energy Technology Program	1-year Certificate and a 2-year AAS	Program readies students for the on-site operations, maintenance, repair and replacement of equipment on a wind powered generation plant. **Note**: Columbia Gorge Community College has been added because it is part of a bi-state Renewable Energy Zone.[56]
Lake Washington Technical College (Kirkland and Redmond)		
Energy Technology	Certificate of Completion- (17 credits)	Prepares students for a career in energy management, site assessment or technician level by training, retraining or upgrading skills. Students will learn the basics of energy site assessment, the technologies behind renewable energy and apply the trade-offs associated with implementation of each, both economic and environmental.

Program Title	Degree, Certificate or Course	Description
Shoreline Community College (Shoreline)		
Clean Energy Technology	AS Degree	Program provides students with the theoretical and practical knowledge and skills necessary for a career in sustainable building design, construction, maintenance and management. Emphasis is on residential and commercial building design with specialties in passive solar and sustainable (green) building design and photovoltaic (solar electric) system design.
Solar/Photovoltaic (PV) Designer	Certificate of Completion (5 credits)	Program trains students to specify and/or certify solar panel systems for residences and buildings. Certificate holders will be able to guide and inform the electricians who install solar panels. This training will enable students to prepare for the Silicon Energy Manufacturing Solar Installation Certification and the national PV Installer Certification through the North American Board of Certified Energy Practitioners NABCEP. The program will have a strong hands-on component.
Zero Energy Building Practices	Certificate of Completion (15 credits)	Program provides students with the theoretical and practical knowledge and skills necessary for a career in sustainable building design, construction, maintenance and management. Students will obtain an introductory background in alternative energy and an understanding of high performance and zero energy building practices.
Walla Walla Community College (Walla Walla)		
Wind Technology	AAAS Degree	Two-year degree program recently approved, available Fall 2010. Program provides both theoretical and practical knowledge / skills necessary for a career involving operation, maintenance and management of wind turbine generation systems. Degree training reinforces certificate level safety / maintenance training while emphasizing theory and use of electrical control mechanisms, instrumentation, variable frequency systems and drive motors related to the wind energy industry.
Wind Technology	Certificate of Completion (58 credits)	One-year certificate recently approved, available Fall, 2009. Program provides entry level training ensuring quality, safety and service involving the operation and maintenance of wind turbine units, mechanical and electrical troubleshooting processes, basic electrical circuitry, motors and controls, basic electronic controls and instrumentation, programmable logic controllers and variable frequency drives.

Tier 1 Non-Credit Programs		
Community Colleges of Spokane (Institute of Extended Learning) (Spokane)		
Fundamentals of Solar Hot Water Heating	On-line Course (85 hours)	Course concentrates on the basics of installing code compliant solar hot water systems. This course will be useful for people who currently work in or plan to be employed in the solar hot water industry. Student technicians will learn practical design criteria, installation guidelines, safety issues, maintenance, and legal considerations of solar hot water heating systems.
Photovoltaic System Design & Installation	On-line Course	Course provides the student technician with the fundamental knowledge of photovoltaic system design and installation. This course will be suitable for a supervised, entry-level position with a dealer/installer or other photovoltaic industry company. Student technicians will learn the practical design criteria, installation guidelines, safety issues, maintenance, and legal considerations of photovoltaic systems.
NW Renewable Energy Institute (Vancouver)		
Renewable Energy Technician Program	Certificate (6-month)	Program gives students an understanding of the mechanics of wind, the local effect on wind flow, and the skills to assess wind at a potential site. Students will become familiar with the system design of a wind turbine: aerodynamics, power control, grid integration, how wind is converted to energy, and energy generation. Includes wind site development, financial costs, site design, planning, contract preparation and site management.

Table 8 shows that the total number of programs specifically-designed for renewable sectors and that are currently operating is relatively small. Moreover, there is a wide range in the duration among these programs, from a single course to two-year degree programs.

Some of the single course or short duration certificates offer opportunities for individuals with relevant work experience to build specialty skills in renewables, while programs that are more extensive provide students with little or no experience more comprehensive preparation in a specific renewable occupation.

It should be noted that the programs, certificates and courses listed for all three Tiers may not be complete; new or modified programs may now be under development that were not identified at the time this report was completed. Table 8 also does not list training programs provided by individual renewable companies. Wind turbine manufacturer Vestas, which provides operations and maintenance services to its customers, operates a Oregon-based wind technician program for its employees. As of this writing, however, no Tier 1 wind technician training programs were being offered by Washington-based companies.

Conclusions and Implications

Renewable Energy Industry Trends

Chapter One of this report provided an overview and a detailed analysis (Appendix A) of the growth and development of several renewable energy sectors in Washington State. Developing or expanding renewable energy sources will enhance our ability to achieve important national, regional and state goals and objectives: reducing our dependence on foreign oil, limiting greenhouse gas emissions, re-invigorating our economy, and creating clean energy jobs that offer pathways out of poverty.

In general, the data show some striking growth trends for some renewable sectors, especially wind. There has also been growth in biomass and solar, with more limited development in other sectors such as ocean and tidal, and geothermal energy. These uneven patterns of growth exist for several reasons, including differences in the provision of various financial incentives for businesses and consumers (in the form of tax rebates, discounts, etc.), consumer awareness and support for specific renewables, and the commercial availability of technologies in each sector, which are developing rapidly.

The state's renewable portfolio standard (I-937), which requires major utilities to boost the proportion of renewable energy they provide to consumers, is also a key driver for growth in renewables. In some sectors I-937 has only had a moderate impact on renewable growth.[57] Public opinion and environmental policies have also served to promote development of the state's renewable resources. Industry forecasts show that growth in renewables is likely to continue well into the future, and recent federal legislation and investment in renewable energy development now underway under the American Recovery and Reinvestment Act of 2009 will serve to reinforce and accelerate private-sector investment and new public and private-sector development of renewables in Washington State.

Renewable Energy Workforce Development

Future growth in renewables will also depend on our ability to supply a well-qualified workforce to design, build, operate and maintain renewable energy plants and equipment. Indeed, the availability of a highly-skilled workforce for the renewable energy industry is critical to enable the state to achieve its clean energy goals, and for industry to meet its growth projections.

Chapter Two captured the perspective of renewable energy employers about future trends and workforce development and training issues in wind, solar, biopower, and hydropower efficiency upgrades and small hydro. The goal was to learn directly from a sample of renewable energy managers, business owners and other experts what they view as growth trends for their renewable sectors, and to identify what education and training needs and skills gaps they believe exist. The intent is for the findings in this report to be used by education and training providers in Washington to spur the creation or improvement of renewable programs and services. Equipping the renewable energy workforce with the required skills will advance the competitiveness of the state's renewable energy industry and help ensure that the state achieves its clean energy goals.

Growth Trends

Most renewable sector employers are optimistic about the prospects for future growth in their sectors. Nearly all agreed that the national recession had some negative effects, but these effects were generally viewed as temporary setbacks to planned growth and development. Larger utility employers appeared to be the least affected by the recession. Smaller employers generally have fewer reserves and felt the pinch of the recession more severely; however, even some large utilities have had to delay development plans. Some small contractors saw consumer markets decline along with the economy, but they too anticipate that growth will resume as federal stimulus investments are made and the economy improves. Biopower employers are faced with an acute shortage of feedstock, which is a direct consequence of the recession and sharp declines in industries that are important sources of biomass.

Public support for renewables has grown, and the expansion of wind has been steady and is forecast to continue to be strong for the next several years. But fluctuating tax incentives, existing regulations and codes, and lack of experience with some energy resources have limited broader acceptance of some renewables by utilities and regulators. In other instances, the technologies are being rapidly developed and refined, but consumers—including utilities and the general public—are waiting for further advances and lower costs before investing in some renewables, especially solar, hydroelectric efficiency upgrades and small hydro.

Workforce Issues

A shortage of qualified applicants

Despite their optimism about the future, almost all employers in each of the four renewable sectors reported that there is a shortage of qualified workers. A number of employers had concerns about their ability to fill current openings, and some reported difficulty finding applicants with the required skills and experience. As one employer noted: "There are not a lot of new people coming in. We're robbing from each other more than we're creating new workers."

Structural issues: preparation, interest and skills

But the overriding concern voiced by employers was about the availability of a qualified workforce to support the long-term growth of their sectors. In part, this concern may reflect the impact of the recession, which has increased the size of the current labor pool and caused some employees to delay retirement. But employers' concerns appear to be structural rather than fleeting; they tended to emphasize the lack of required skills and interests, and generally weak preparation of younger workers for renewable jobs as a primary issue.

While some employers saw strong interest among youth for renewable energy as a way to expand the future labor pool, many expressed concern that there continues to be a general lack of interest in energy careers among youth. A general preference for non-industrial careers among high school students, societal and family pressure on students to pursue four-year degrees over two-year degrees or apprenticeships, and the decline of secondary school vocational programs were identified by many employers as contributing to their concerns about the skills and availability of the future workforce. And, a number of employers emphasized that many students and younger applicants already lack both the basic technical skills and the "soft" skills that they require.

Retirements and skill gaps

Moreover, employers recognized that while the economic recession has produced a short-term "bump" in the number of applicants and delayed retirements, once the economy begins to recover the labor pool will likely contract and retirements may accelerate, creating even bigger labor and skills gaps. As competition for qualified technicians heats up, some employers anticipate that wages and benefits will also rise, increasing operating costs.

Although employers' views about the effects of retirements on their operations were somewhat mixed, the majority expressed concern that a large number of retirements are likely to occur in at least some occupational groups in the next several years, and that the overall effect will be a reduction in the skill base of the workforce. One hydro employer noted: "In five or six years we'll see a big problem. The amount of knowledge walking out the door is scary." But employers are also eager to see larger numbers of qualified younger applicants, both to enrich the future labor pool, and to tap into the "fresh perspectives" new workers will bring to the job and their companies.

Work conditions as challenges

The work conditions of renewable occupations were identified as barriers to recruitment and retention of qualified workers by employers in every renewable sector. The basic work in many renewable facilities is similar to that of other industrial settings: it can be physically difficult, involves the use of tools, machines and specialized equipment, and as with most energy-sector jobs, the work environment has a number of potential hazards. In wind and solar, employers especially emphasized how the physical requirements resulted in a short "job life" for technicians. One employer noted: "We need to reduce the number one killer in wind, and that's the physical conditions." Although new equipment and ergonomic improvements have helped, much of the work is inherently physical and hazardous, and job safety was a top issue for employers.

In addition to the rigors of the job and safety, many employers noted that the remote locations of many renewable projects also contributed to their difficulties in finding and retaining employees; the lack of housing and limited amenities available in rural areas was frequently cited as a hiring challenge. Some employers sought to hire locally to circumvent these issues, but the pool of qualified applicants in small communities is often very limited, and the skill requirements of many renewable jobs can be high.

Renewable occupations

Since the primary focus of this research was on technician-level renewable occupations, the amount and quality of employer input about jobs, functions and skills was most complete for those job types that directly support renewable facilities. It quickly became apparent, however, that employers were also interested in a broad range of occupations and skills that directly or indirectly supported renewable energy operations. Although the specific job types for each sector differ, sometimes considerably, there tended to be some common groups of occupations that cut across the four sectors.[58]

Table 9 shows the most common occupational groups identified by employers. The most frequently-identified occupational groups are listed first. However, some of the specialty areas in the sciences (especially environmental) and business, finance and legal (especially regulatory/land use) were identified by fewer employers, and with nearly equal emphasis.

Table 9. Common Occupational Groups Identified by Employers

Occupational Group	Specialty Areas
Technicians	Installation Maintenance Field Service/Repair Instrumentation Controls
Engineers	Electrical Mechanical Computer/Software/Systems Civil Energy systems/Site engineers
Systems Designers or Integrators	Energy systems design Electronic control systems Information technology/networks
Sciences	Environmental Biology Cultural anthropology
Business, Finance and Legal	Regulatory/land use/permitting Finance/budgeting/contracts Site/operations supervisors Sales and marketing Public relations/communications
Operators	Boilers Controls

Multi-skilled employees

It is also important to note that in many instances employers discussed the high added value of employees in one type of occupation having skill sets from other types of jobs. One commonly mentioned combination was engineers who had some financial and legal skills and knowledge; another was technicians who combine knowledge and skills from other craft occupations. The work of wind technicians, for example, requires both mechanical and electrical skills, and the ability to use and understand electronics is becoming increasingly important as the industry adopts more electronics-based technologies. At the same time, most employers indicated that the fundamental work required of renewable sector employees depends on many of the same technical skills and abilities needed in other energy sectors. While some of the technologies may be unique and require employees to acquire new or specialized skills, many of the basic principles, functions and work tasks that underlie renewable energy jobs are very similar to related occupations across the energy industry as a whole.

In general, the renewable energy industry draws on skills from multiple professions, and the need to multi-skill the workforce was often mentioned by employers. Larger employers were more likely to describe the need for specialists than smaller employers who rely more heavily on employees with generalist skills in many functional areas. One solar employer observed: "What we need is a sufficient quantity of skilled trades-people who are generalists in their field. Ideally they would have more tools and be better equipped to adapt to change, and better able to earn a living wage. Their skills would be transferrable skills for the future."

But even large employers emphasized their desire to recruit employees with a broad skill base, or to provide some upgrade training that helps current employees develop some of the skills from multiple job types. This does not mean that specialist occupations are not highly-valued or unnecessary. Indeed, engineers, boiler operators, wind field technicians and other highly-skilled specialists in each renewable sector are pivotal to the success of these operations. Rather, the findings do imply that the lines between one craft and another, or between an engineer and a budget manager, for instance, may be less well-defined in renewables compared to many traditional energy sectors. This shift toward multi-skilled employees is not a new concept, however it may be that rapid growth in renewable sectors coupled with new technologies and more entrepreneurial business models may be fueling the emphasis by employers for expanding the breadth of skills to support renewable operations.

Core skills are foundational

The vast majority of employers reported that the foundational skills and abilities required of employees in the renewable jobs they have are very similar for most types of occupations. Employers generally described these core skills in terms of the academic, general employability, and technical skills that they expect of their current employees and future workers.

<u>Academic Skills</u>: One central theme was the importance of basic academic skills. Employers reported a number of academic skill gaps among existing employees, especially at the entry-level for technicians and related craft occupations. Employers most often described these skill gaps as a problem among younger and less-experienced workers, and often as representing the shortcomings of many young applicants they have seen. Math, writing and basic communications were often identified by employers as

critical skill areas where many new applicants fall short. Problem-solving skills and basic computer skills were also cited as fundamental for most jobs. Applicants' lack of basic math ability was very often mentioned as a concern. One wind sector employer noted: "We have a huge part of the upcoming workforce who can't pass basic tests. Algebra, Trig, just the basics, not Calculus."

Employability Skills: Beyond academics, a number of non-technical "employability" skills and gaps were also identified by employers who emphasized the importance of basic computer literacy, and well-developed communications, organizational, teamwork and interpersonal skills. Understanding how the components and processes used in the sector function together as a system, and the ability to break down and solve problems, were also noted as important by a number of respondents.

These employability skills, in combination with academic and technical knowledge, were also described by employers as critical for ensuring employee safety, which was a pervasive issue considered by employers as central to all renewable sector occupations. As one hydro manager noted: "It's not just learning how to manipulate numbers, it's learning how to think beyond digging a ditch. Our systems are designed with that potential in mind. You don't just flip switches here, you have to understand the impact or you could kill yourself."

For small employers and even some larger firms, basic business skills were highly valued. In larger companies this emphasis was often on developing financial, contracting and legal skills of employees in specialist positions. As noted above, however, employers also look to engineers, technical managers, technicians and others to acquire and use some of these foundational business skills in their jobs. Smaller employers, who typically depend on generalists with skills in multiple areas, were more likely to stress the importance of understanding market dynamics, financing, and sales skills for their industries. This was especially true for small firms in the solar sector, where many small companies are attempting to position themselves to compete and grow as the industry evolves. One solar employer noted: "It's happened in California – the hippies have lost out to the commercial businesses. The few dealers we have will be easily overloaded. Old school installers don't know financing and business skills to compete with big installers."

Technical Foundations: All employers expect that current employees and new hires will possess the requisite technical skills and abilities required to do their jobs, and that they will acquire new skills as technology upgrades occur and as the processes needed to do their jobs evolve. As might be expected, the categories of technical skill requirements and the specialty areas varied considerably between the types of renewable sectors and jobs.[59] Central to nearly every technician-level occupation was the need for electrical and mechanical skills, and for many technicians the need to acquire or advance their electronics-related knowledge and skills was apparent. The ability to work with computer-driven controls, networks and databases, and skills using various diagnostic equipment and software is increasingly prevalent in technician-level jobs and other occupations besides engineering.

At the same time, some employers noted that even with the focus on new technologies, many renewable systems are not unlike traditional power generation systems, and much of the technical work of operators, mechanics, installers, technicians and other occupations remains very basic. Indeed, some employers said that the emphasis on new technologies and computer-based systems has made it harder to find new employees who are able to use basic hand tools and instruments; older workers tend to have more skills using standard tools. One solar employer noted: "If I get a college graduate with no experience holding a screw driver, I send them to Habitat for Humanity. They've got to know some contracting." Another solar employer listed "ladder safety, finding studs, wiring, basic tools, sweating copper pipes" as examples of the basic technical skills needed for installers.

Work ethic lacking among youth

The notion of "work ethic" represents a set of values based on the virtues of hard work and diligence instilled in or held by employees.[60] While work ethics are not skills per se, these values are viewed as fundamental to employee attitudes and behaviors, including work productivity, commitment to the job and employers, and a willingness to acquire new skills and abilities in the workplace. Respondents in each sector commented on the importance of a good work ethic, which they appear to value highly.

Many respondents provided comments on this issue, most often by describing the shortcomings in work ethics among younger employees and job applicants. Several managers noted that the nature of the work requires employees to exercise good judgment and discipline, both because of concerns about safety and productivity, and because electrical power generation is a continuous process that demands constant vigilance. One manager noted: "Work ethic is an issue. The new generation has a different attitude; some are more interested in video games than eight hours of work, and some seem to feel a sense of entitlement at work. It's pervasive." Other employers stressed that developing a good work ethic needs to begin early in life, and that poor work habits often cannot be turned around in the workplace. They noted that compensating for workers who are not productive is expensive. Some employers attributed the lack of work ethics to shifts in societal values; some felt that the emphasis by K-12 education on this issue has eroded and needs to be revisited and strengthened.

Workforce training

Workforce training for renewable occupations can vary substantially depending on the sector, the technologies used, the organization of the workplace, company practices, and the functions of specific jobs. While training topics in each sector also varied based on these and other factors (see specific sector descriptions), there were also several common themes that cut across each sector and many occupations. For example, training content for many technicians and some operator-level occupations typically includes core technical training in mechanics, electrical and electronics-related topics, with specialty training in other areas that relate directly to the technologies and practices used on the job. Upgrade technical training for incumbent workers is a common focus of most employers, and is typically implemented when new components, equipment or work processes are installed, or when existing equipment is modified. A number of companies offer training to all employees that is intended to develop general employability skills (project management, teamwork, problem solving, etc.), and some even provide opportunities to employees to improve their basic academic skills through training.

Lack of training capacity

One of the most common issues raised by employers was the lack of post-secondary programs in the region that offer training specifically in renewable sector occupations. Employers often expressed an interest in having additional training options in the region for upgrading the skills of existing workers, and especially to help prepare and expand the future pool of new technicians. One wind employer reported that the biggest training gap they have is not internal—they have adapted to the needs of their current workforce—but external, meaning they believe there are not enough local or regional programs available to meet the growing demand for trained technicians.

To compensate for this lack of training capacity, some employers attempt to cobble together elements of training from other energy sectors and industries to provide the training their employees need. One biopower employer noted that they look to HVAC industry training programs to provide boiler operator training in control systems, followed by internal training they conduct to round-out their training for operators. Although this approach may be economical and even effective as a just-in-time model for upgrade training, most employers seem to prefer an integrated training solution that includes a greater number of focused programs that could be provided by regional colleges and other training institutions. The desire to expand the availability of sector-specific renewable training in the state was echoed by employers in all renewable sectors, and was seen as pivotal to increasing the pool of qualified workers to meet future employment demand in the renewable energy industry as a whole.

Employers' concerns about the demise of technical preparatory programs in K-12 education and some post-secondary institutions are also related to the lack of training capacity for renewable energy occupations. Indeed, many respondents noted that vocational programs and applied technical courses in secondary schools that prepare students for careers in the energy industry have been consolidated or eliminated over the years. Employers view these programs as providing an important educational foundation in the core skills needed in most renewable energy jobs and careers. Although the level of interest in renewable energy careers has grown among young people, the lack of programs and courses in related technical areas limits their opportunity to participate in preparatory programs, which ultimately constricts the potential pipeline of new workers for the renewable energy industry. Some employers expressed similar concerns about community and technical college programs, which they say have reduced the number of courses in technical areas most needed by the industry, focusing instead on other high-tech sectors and industries that respond to new funding priorities of state policymakers, or where student demand is higher.

Training delivery

All employers identified multiple ways in which training is delivered to employees, ranging from internal on-the-job training (OJT), apprenticeship programs and community and technical colleges, to equipment vendors, manufacturers and professional associations. By far the most common model for delivering training to employees, especially in technician-level occupations, was through some form of OJT. The pairing of an experienced, journey-level worker with a less-skilled employee was the most typical approach used by employers, whether it was part of a formal apprenticeship program, provided by vendors, or delivered through other training providers.

OJT strategies were implemented in a variety of ways, depending on the needs of trainees, training topic and content, the source of instruction, and work schedules. In some cases intense classroom or computer-based training was followed by periods of hands-on learning; in other cases the training is integrated so that concepts and technical aspects of the work are taught and applied simultaneously so that the conceptual learning is immediately linked to the work. Applied learning approaches—learning and doing—were viewed as a critical training feature by all employers. As one biopower employer noted, the development of skill comes through the application of conceptual knowledge: “Most of this stuff you won’t learn from a book. It’s like learning to drive a car by reading a book.”

Training provided by vendors or manufacturers is typically equipment-specific and skills-based, and most employers depend heavily on manufacturers and vendors for technical upgrade training, which they supplement with internal training of their own. Training provided by community and technical colleges includes specific technical training, but college training is typically more general and theoretical than training provided by vendors, which tends to be very applied.

In some sectors, small employers find it difficult to secure adequate time and resources to provide training for employees, and OJT is the most feasible option for many small employers. This was especially prevalent for most solar employers and some small hydro companies. Some employers send employees off-site for training as needed, but for all employers the costs associated with travel and lost productivity to attend off-site training are a concern.

Online training options are becoming increasingly common among employers in each sector, and the majority of employers reported that they plan to increase their use of online training delivery. Although not all companies use these tools, computer and online-based training is becoming a high priority for many employers. The convenience of keeping employees on-site for training, and avoiding travel and time away from the job is attractive, and there are many new sites and training topics available. Some employers noted that online tools can help make better use of an instructor’s time by covering some basics in online courses prior to instructor-led courses, OJT or other applied learning experiences.

But some employers reported several reasons that may limit their use of online training delivery. For some employers, not all employees regularly use computers and some lack basic computer skills. In other cases, computer access is limited due to limited resources. Most often, however, employers who saw limits to the use of online training expressed concern about offering some subjects online that might be better suited to a classroom setting, through on-the-job training, or some other combination of training delivery strategies that, while less convenient, may be more effective.

Employers frequently expressed their concern that the number and availability of training programs in the state is inadequate to prepare and expand the labor pool for renewable occupations, especially technicians. One employer noted: “It’s a challenge to find those individuals when you have only a handful of two-year training programs in the area.” Although some college programs and apprenticeships provide workers with many of the foundation technical skills needed by technicians and other key occupations, many employers said they liked the idea of a program designed specifically for their renewable sector.

Finally, while many employers expressed keen interest in seeing an expanded number of renewable training options through regional community and technical colleges, there were some concerns about colleges’ ability to provide up-to-date equipment and to offer flexible scheduling for their employees. Some employers wondered whether college-based programs would be sufficiently tailored to their needs, and based on industry skill requirements for their renewable sector to ensure that future programs met the training needs of their employees.

Renewable sector training limited

Analysis of renewable sector training in Washington State shows that there are very few public-sector programs or courses specifically designed for renewable sectors or occupations. Indeed, there are only nine Tier 1 programs currently offered by regional colleges or other training providers that are customized for renewable sector occupations, and a number of these consist of short-term certificates intended as upgrade training for individuals with experience in related technical areas. A few new training programs in wind are being planned, and available federal ARRA funding for energy-related education and training may generate new interest among education and industry partners in crafting proposals that develop additional training specifically for renewable sector occupations. For now, however, customized training in any renewable sector in Washington is very limited.

It is important to note that employers have been able to secure much of their needed training through some combination of internal and external sources, such as equipment vendors, professional/trade organizations and community and technical colleges. Although several employers do have some acute training needs, their primary concern is that there is inadequate training capacity to equip current and future workers with the skills needed to support continued growth of the renewable energy industry.

Despite the lack of sector-specific training, it is worth noting that many post-secondary education and training institutions are already providing much of the core training needed by the industry. Indeed, many (if not most) of the foundation technical and non-technical employability skills required of renewable sector employees are the same as those required in similar jobs in non-renewable sectors of the energy industry (Tier 2). The general nature of these foundation skills is noteworthy because it means that employers are able to leverage relevant training offered through an infrastructure of postsecondary energy technology programs and registered apprenticeships that already exists and could be expanded. An even larger number of Tier 3 programs deliver training that is not specific to the energy industry or renewable sectors, but many of these programs provide training in transferrable skill areas that are relevant to renewable sectors and occupations.

Implications

Implications for the Renewable Energy Industry

Growth forecasts noted in this report and feedback from employers suggests that while progress in developing renewable energy is somewhat uneven, overall growth in the state's renewable energy industry is likely to continue and accelerate in the future. A central question is whether Washington State will be prepared to effectively support and sustain growth in this important industry.

The state is a national leader in renewable energy development and has enacted policies and regulations that position renewable energy as a central strategy for achieving energy security and environmental protection goals. Yet, many challenges remain. A concern expressed by several renewable employers is that federal and some state policies regarding long-term incentives for renewables are not stable, which makes it difficult for new businesses to start up, and hard for existing companies to grow. Faced with an uncertain state policy or regulatory structure, anticipating employment and skill needs is also difficult, and these businesses may be reluctant to add new employees, or invest in education and training needed to upgrade and enhance the skills of incumbent workers. A detailed analysis of federal and state policies with input from industry and other stakeholders should be conducted to determine the specific effects of existing policies and incentives for each renewable sector in the state to determine what combination of future policies and investment incentives hold the most promise for Washington's renewable energy industry, and how best to create and implement those changes.

Although these policy and incentive issues currently pose bigger challenges for some renewable sectors and employers than others, each sector is part of a broader state portfolio of clean energy resources that are best viewed as an integrated system rather than as a collection of independent actors; the success or failure of any one renewable sector will affect our ability to grow and sustain a clean energy economy. Thus one implication is that the state should support the development of a deliberate strategic plan in which renewable energy sectors are examined as integrated resources for which a systematic state policy framework and supportive incentive structure is developed. State coordination and leadership for renewable energy is critical for ensuring that we realize the potential of a clean energy economy to achieve state economic, environmental and social equity goals.

State leadership and strategy development that taps the collective wisdom of industry, labor, education and economic development stakeholders is also needed to arrive at informed decisions about investments of federal stimulus funds for renewable energy. ARRA funding provides a unique, one-time opportunity to make significant investments in research and development, and the commercialization of clean technologies, to support new business startups and expansions, and to make strategic investments in the state's education and training infrastructure. Collectively, these investments off great potential for stimulating new job growth and jump-starting our state's clean energy economy, especially if we simultaneously invest wisely in education and training policies and programs that will be needed to ensure that growth in the state's renewable energy sectors are sustained well into the future. Washington's recently convened Clean Energy Leadership Council, created with the passage of Senate Bill 5921, provides an excellent vehicle for developing a clean energy strategy for the state that addresses the important role that the state's education and training system can and should play in supporting future growth in the renewable energy industry.[61]

Implications for Renewable Energy Education and Training

Available studies on the renewable energy workforce and feedback from the employers interviewed for this study provide consistent support for overall predictions that growth in renewable sectors will generate many new jobs, and that the demand for qualified workers will continue to grow. While most employers said they now have some acute shortages in some positions, most respondents are anticipating serious labor shortages as the market for renewable energy expands. Many employers emphasized that there are too few sector-specific programs, and that more training capacity is needed. They want new education and training programs that are responsive to their needs, and they want these programs to be based on industry-defined standards to ensure they are relevant to the needs of their employees, their companies, and the industry as a whole.

Analyses of existing renewable programs in the state suggest that employers' concerns are warranted, as very few sector-specific 'Tier 1' postsecondary education and training programs now exist. Although more programs are being developed, it is unclear whether these new programs will be sufficient to meet future demand. Additional research is needed to estimate job growth in the state's leading renewable sectors. This information should be used along with other economic data to strategically align future investments in new education and training program development initiatives to meet future forecasts.

Currently, most employers rely on a number of sources to get their employees the education and training they need. Much of the upgrade training provided to existing employees is conducted internally via OJT, through manufacturers or equipment vendors, or through sources other than public or private colleges. It is also worth noting that many new employees who are coming into the renewable industry have backgrounds and experience in energy-related industry sectors, including relevant postsecondary education and training in key technical occupations. Most employers reported that the majority of technician-level jobs in renewable energy rely on core skills and abilities that are common to many related occupations and industries. In short, these core technical programs—even if non-specific to renewable sectors—are important because they impart foundational skills that are already required by employers. These foundational programs also provide students and incumbent workers with a range of transferrable skills that increase their career options.

For these reasons, existing technical education and training programs—including apprenticeship and college-level programs—should also be targeted for expansion, but in some specific ways that can directly respond to the skill requirements of renewable energy jobs. Rather than creating entirely new programs, for instance, education and training providers should collaborate to integrate existing technical training programs with a series of new specialty courses and certificates that would give students the sector-specific knowledge and skills needed to qualify them for entry-level employment. These specialty courses should be developed in partnership with sector employers and subject-matter experts to ensure buy-in from the industry and consensus about the standards for course content. A secondary option is to integrate specific renewable content into existing foundational courses or programs, however this approach may require modifications to an entire sequence of courses and the new content may be less evident to industry employers. Expanding the type of program delivery options using online and other technologies will continue to be an attractive option for companies, students and incumbent workers. These and other innovative approaches offer great promise for renewable energy program delivery so long as they also integrate applied learning opportunities and can be delivered regionally.

Career pathways showing the connections between foundational programs, specialty courses and degrees or certificates should be created to clarify for students and employers how the programs and courses fit together, both for new and incumbent workers, and to guide program and curriculum alignment, and to build or expand articulations among K-12, two-year degrees and certificates, apprenticeship programs, and university-level degrees and continuing education. Expanding the renewable energy workforce pipeline and equipping future workers with the skills they need requires that students, employers and incumbent workers have access to a full range of education and training opportunities that can help support and sustain growth in the state's renewable energy industry.

In the end, the ability of Washington's education and training system to respond to the needs of renewable energy employers will depend not only on expanding program capacity, but on having in place a strategic approach. This strategy should include strong statewide coordination for the development and delivery of renewable energy programs that anticipate and meet the growing demand for a renewable energy workforce. State leadership and financial support for the development of these programs is critical, but effective coordination between existing state education and training delivery systems is also essential to ensuring focused and efficient implementation.

The availability of federal stimulus funding has generated intense interest among training providers and their partners in launching renewable programs, but these efforts should be connected to regional industry demand to meet specific sector needs and to prevent duplication of effort. In the two-year college system, the Centers of Excellence model has provided a central hub for energy-sector program development and coordination between industry and training providers, and a number of registered apprenticeship programs are working with their industry and education partners to adapt existing course content to meet the new skill requirements of renewable employers. These collaborative models provide central coordination vehicles for developing and delivering effective workforce education and training that will help to sustain long-term growth in the state's renewable energy industry.

Definitions

Average Megawatt (MWa): 1 average Megawatt is equal to 1 MW x 8760 hours/year and is equal to 8,760 MWh, or 8,760,000 Kilowatt hours.

British thermal unit (Btu): The quantity of heat required to raise the temperature of 1 pound of liquid water by 1 degree Fahrenheit at the temperature at which water has its greatest density (approximately 39 degrees Fahrenheit).

British thermal unit conversion factor: A factor for converting energy data between one unit of measurement and British thermal units (Btu). Btu conversion factors are generally used to convert energy data from physical units of measure (such as barrels, cubic feet, kWh, or short tons) into the energy-equivalent measure of Btu to enable comparisons across fuel types. For more on Btu conversion factors, see: http://www.eia.doe.gov/emeu/mer/append_a.html

Capacity: Capacity is measured in megawatts and refers to the maximum amount of electricity produced at any given moment.

Generation: Generation is measured in megawatt-hours and refers to the cumulative amount of electricity produced over a given time period.

Kilowatt-hours (kWh): A kilowatt-hour is a measure of electricity defined as a unit of work or energy, measured as 1 kilowatt (1,000 watts) of power expended for 1 hour. One kWh is equivalent to 3,412 Btu. One kWh will operate a 40-watt lightbulb for a full day, a 19" color television for about four hours, a personal computer for 2-1/2 hours, an electric hairdryer for 30 to 60 minutes, an electric razor for 36 hours, a clothes dryer for 15 minutes, a microfurnace heater for 40 minutes, a clock radio for up to several days, a portable stereo for as long as a week, and a telephone answering machine for as long as a month.

Megawatt (MW): A standard unit of electrical power equal to 1,000 kilowatts, or 1 million watts. Like watts and kilowatts, the term “megawatt” is used as a standard measure of electric power plant generating capacity, although larger in scale.

Megawatt-hour (MWh): 1 megawatt acting over a period of 1 hour. One megawatt-hour is equal to 1,000 kilowatt-hours or 1 million watt-hours. The primary difference between a megawatt and a megawatt-hour is that “megawatt” measures the capacity of an electric generator and “megawatt-hour” measures the actual amount of electricity it produces over a certain period of time.

Endnotes

[1] *Annual Energy Outlook 2008*," Energy Information Administration, June 2008. When this quote was written energy prices were surging, and the world economic recession had begun to slow development of energy projects. In December 2008, however, the U.S. Energy Information Administration was still projecting strong growth in the use of renewables for electricity generation, spurred in part by state renewable portfolio standards.

[2] Source for Figure 1: *World Renewable Outlook 2008,* International Energy Agency, 2008

[3] The U.S Energy Information Administration projects "high world oil prices that are projected to persist over the long term," although current prices (December 2008) are very low. See: http://www.eia.doe.gov/oiaf/ieo/highlights.html

[4] Source for Figure 2: "2008 World Electricity Information, Part II," International Energy Agency 2008

[5] Source: Clean Edge and New Energy Finance, 2008

[6] Source: 2009 EIA Annual Energy Outlook Reference Case, including ARRA stimulus provisions. The previous year's AEO estimated growth in non-hydro renewables at 3.2% per year through 2030. This figure was prior to ARRA provisions.

[7] For further information on hydro capacity and environmental impacts see "*Feasibility Assessment of the Water Energy Resources of the United States for New Low Power and Small Hydro Classes of Hydroelectric Plants,"* Idaho National Laboratory: http://hydropower.inel.gov/resourceassessment/; EPA's overview of impacts of hydropower: http://www.epa.gov/cleanrgy/energy-and-you/affect/hydro.html, and US DOE's description of advantages and disadvantages of hydropower: http://www1.eere.energy.gov/windandhydro/hydro_ad.html. The text of the Initiative 937 RCW currently defines qualifying hydro as "Incremental electricity produced as a result of efficiency improvements completed after March 31, 1999, to hydroelectric generation projects owned by a qualifying utility and located in the Pacific Northwest or to hydroelectric generation in irrigation pipes and canals located in the Pacific Northwest, where the additional generation in either case does not result in new water diversions or impoundments." See Initiative 937 RCW at: http://apps.leg.wa.gov/RCW/default.aspx?cite=19.285 This language does not clearly specify that small hydro or efficiency upgrades to existing hydro would qualify for meeting I-937 targets. Efforts to clarify this language failed during the 2009 legislative session, however changes to clarify this issue are expected in the future.

[8] *Annual Energy Outlook 2008*," Energy Information Administration, March 2009

[9] Source for Figure 3: *Annual Energy Outlook 2008*," Energy Information Administration, March 2009

[10] Renewable Energy Certificates (RECs), also called Green Tags, allow renewable generators to sell the electricity commodity separately from the higher valued environmental attributes of that electricity. This makes scheduling and delivering the power much easier and allows the generation to occur regardless of the proximity to the purchaser (a REC can be delivered anywhere, whereas electricity must be synchronized to the grid). Washington Initiative I-937 requires that RECs be certified by the Western Regional Energy Generating Information System (WREGIS). See: http://www.wregis.org/

[11] *New York Times*, February 18, 2009 "E.P.A Expected to Regulate Carbon Dioxide" http://www.nytimes.com/2009/02/19/science/earth/19epa.html?_r=3&ref=science

[12] National Venture Capital Association and PriceWaterhouseCoopers, "Venture Investment in Clean Technology Accelerates Significantly in 2008, Despite Economic Uncertainty," 2009

[13] EIA *Annual Energy Outlook 2009*: http://www.eia.doe.gov/neic/press/press312.html

[14] Source: Recovery.gov website: http://www.recovery.gov/?q=content/act

[15] Washington State Climate Action Team documents: http://www.ecy.wa.gov/climatechange/2008CAT_overview.htm

[16] See statement from Mayor's office: http://mayor.lacity.org/stellent/groups/electedofficials/@myr_ch_contributor/documents/contributor_web_content/lacity_004982.pdf

[17] The second largest power plant in the U.S is the 3,872 MW Palo Verde Nuclear Power Plant in Arizona. http://www.eia.doe.gov/neic/rankings/plantsbycapacity.htm

[18] Washington state does not target large conventional hydropower with policies designed to promote the development of new renewable resources. In addition to being a mature resource, the hydro system has had a negative impact on fish and wildlife, local ecosystems and native cultures. (see the Columbia River History Project: http://www.nwcouncil.org/history/FishPassage.asp) While mitigations have reduced these effects somewhat, there is pressure to remove some of the most damaging dams. The Elwha and Glines Canyon Dams on the Olympic Peninsula will be the first significant dams to be removed, and in November of 2008 agreement was reached to remove four dams on the Klamath River, making it the largest dam removal project in history. Environmental campaigns are underway regarding removal of dams on the lower Snake, Sandy and White Salmon rivers (see American Rivers: http://www.americanrivers.org/site/PageServer?pagename=AR7_Region_Northwest_work). For all of these reasons, Washington State policies promoting renewables are intended to target development of non-hydro renewable resources, efficiency upgrades and small, low-impact hydro.

[19] Source for Figure 4: *2008 World Energy Outlook*, International Energy Agency and *2008 Annual Electricity Report* and *2007 State Energy Data Report* Energy Information Administration

[20] Source for Figure 5: *2008 World Energy Outlook*, International Energy Agency and *2008 Annual Electricity Report* and *2007 State Energy Data Report.* Energy Information Administration

[21] For detailed information about power exchanges, see the Western Electricity Coordinating Council Loads and Resources Report, the Northwest Power Pool Historical Energy Summaries, and Washington State Department of Community, Trade and Economic Development (CTED) Energy Policy Fuel Mix Disclosure data.

[22] In the 1950s, the regional electricity forecasts showed an increasingly urgent need for additional resources. Bonneville Power Administration (BPA) and the Washington Public Power Supply System (WPPSS, a consortium of public utilities) developed a plan to build twenty new nuclear power plants to meet the expected growth. Due to faulty forecasts and financing, lack of transparency, cost overruns and public concerns, the plans fell apart when only three plants were completed and two others were under construction. The result was the largest default of public bonds in U.S. history. The revolutionary concept in the mid 1970s that energy conservation could avert the need for new generation led several utilities to switch their investments and growth plans away from nuclear power and towards conservation.

[23] It is worth noting that the demand for summer cooling in the Northwest is expected to be exacerbated by global climate change.

[24] The problem was exacerbated by deregulation policies which allowed Enron and other power marketers to manipulate the market and create artificial power shortages.

[25] Washington CTED Fuel Mix Disclosure Database. Data differs from electricity generation shown in Fig 4 due to the different years presented

[26] I-937 definitions for renewable: Incremental hydro upgrades and small hydro (though the hydro language is currently vague), gas from sewage treatment, biodiesel fuel, biomass from animal waste, wood, forest (excluding old growth forest products) or field residues, wind, solar, geothermal, landfill gas, tidal, wave. For a complete description and details about determining 'cost effectiveness' of efficiency measures, see: http://www.cted.wa.gov/site/1001/default.aspx

[27] See: http://www.westernclimateinitiative.org/

[28] Northwest Power Planning Council. "Planned projects" have a firm date to start construction. "Proposed projects" are under development but do not have a start date. See: http://www.nwcouncil.org/energy/powersupply/Default.htm

[29] A summary report, the utility resource plans and charts can be found here: http://www.cted.wa.gov/site/1140/default.aspx

[30] As previously noted, renewables have higher up-front costs than non-renewables. The cost of all generation has grown rapidly in recent years. See the background documentation to the Northwest Power and Conservation Council's *Sixth Power Plan*: http://www.nwcouncil.org/energy/powerplan/6/default.htm

[31] Washington State Department of Ecology's Green Economy website: http://www.ecy.wa.gov/climatechange/GreenEconomy.htm#wil

[32] Forbes environmental rankings: http://www.forbes.com/2008/03/17/miami-seattle-orlando-biz-logistics-cx_tvr_0317cleanest.html and business ranking: http://www.forbes.com/2007/07/10/washington-virginia-utah-biz-cz_kb_0711bizstates.html. For the ACEEE ranking on green energy policies, see: http://www.theolympian.com/southsound/story/610086.html

[33] 2009-2011 Budget Highlights – Natural Resources: http://www.ofm.wa.gov/budget09/highlights/naturalresources.pdf

[34] Bezdek, R. (2008). "Defining, estimating and forecasting the renewable energy and energy efficiency industries in the U.S. and in Colorado." ASES and Management Information Systems.

[35] Kammen, D., Kapadia, K, and Fripp, M. (2004). *Putting Renewables to Work: How Many Jobs Can the Clean Energy Industry Generate?* Berkeley, CA: Renewable and Appropriate Energy Laboratory, University of California, Berkeley. **Also**: Deyette, J. & Clemmer, S. (2006). *The Washington Clean Energy Initiative: Effects of I-937 on Consumers, Jobs and the Economy*. Washington, DC: Union of Concerned Scientists (October), www.ucsusa.org. **Also**: *Green Recovery: A Program to Create Good Jobs and Start Building a Low-Carbon Economy*. Amherst, MA: Center for American Progress and the Political Economy Research Institute, University of Massachusetts, Amherst (September 2008). **Also**: Brower, M., Tennis, M., and Denzler, E. (1993). *Powering the Midwest: Renewable Electricity for the Economy and the Environment*, Washington, DC: Union of Concerned Scientists, (107-108). Washington DC: The Renewable Energy Policy Project, (November).

[36] See: "Green-collar jobs in America's cities: Building pathways out of poverty and careers in the clean energy economy." Washington, DC: The Apollo Alliance and Green For All, 2008. **See also**: "Green Jobs: Towards decent work in a sustainable, low-carbon world. United Nations Environment Programme (September 2008). **Also see**: Bournakis, A., Cuttica, J., Mueller, S. & G. Hewings (2005). "The economic and environmental impacts of clean energy development in Illinois." Chicago, IL: The Energy Resources

Center, University of Illinois at Chicago, and the Regional Economics Application Laboratory, University of Illinois at Urbana-Champaign (June). **Also**: "Massachusetts Clean Energy Industry Census." Global Insight for the Massachusetts Renewable Energy Trust, 2007 (August).

[37] Hardcastle, A. (2009). *2008 Washington State Green Economy Jobs*. Washington State Employment Security Department, prepared by Washington State University Extension Energy Program, Olympia, WA.

[38] See: Suter, C. (2005). "A 2005 look at the renewable energy, energy efficiency, and smart energy industries in Washington State." Olympia, WA: Energy Policy Office, Department of Community, Trade and Economic Development.

[39] U.S. Department of Energy, Energy Information Administration, 2009.

[40] Maintenance of PSE's two wind farms is provided primarily under contract with wind turbine manufacturer Vestas, a multi-national corporation which has a regional office in Portland, Oregon.

[41] See: Singh, V., BBC Research and Consulting, and Fehrs, J. (2001). "The work that goes into renewable energy." **See also:** "Occupational profiles for the solar industry." Interstate Renewable Energy Council, 2007 (March). Current research by the author on the skill requirements of wind technicians also supports the notion that the majority of core technical and employability skills include those acquired through foundational courses and training in the electrical and mechanical trades through existing apprenticeship and community and technical college programs.

[42] Hardcastle, A. (2008). *Workforce Challenges of Electric Sector Employers in Washington and Oregon*. WSU Extension Energy Program (January).

[43] Some companies operate several types of renewable facilities, and some provided data for several renewable sectors.

[44] Due to the large size of the protocol document it is not included here. Interested readers may access the protocol through the following weblink: www.energy.wsu.edu/workforce/REStudyProtocol

[45] Puget Sound Energy and RES Americas plan to break ground for a new wind farm near the lower Snake River in Garfield and Columbia County in 2010. The initial Conditional Use Permit application calls for approximately 800 megawatts (MW) of wind energy and approximately 444 wind turbines in Garfield County. An additional 632 MW and approximately 351 wind turbines in Columbia County is also being considered. Also, Energy Northwest is planning to build the first large-scale wind project on state land on Radar Ridge in the Willapa Hills of Pacific County. The project, which may break ground in 2010, could generate approximately 80 MW of electricity. The site is close to several population centers and existing transmission facilities.

[46] This summary table presents the skill categories in priority order based on employer comments and descriptions. Data in the table also incorporates core conceptual and applied topics and skills that were identified through a separate skill standards development project which included focus group research with site managers, subject matter experts and wind technicians. The research was led by WSU Extension Energy Program, and the full wind technician skill standards report will be available in 2009 through the study sponsors and at: www.wa-skills.com.

[47] The respondent mentioned that the American Solar Energy Society is a good resource for more information.

[48] A "big" system for Washington was reported as 30 KW, while in California the average system is 70 KW and there are three systems over a million KW. Oregon and Louisiana were mentioned as having model incentives for large projects, which are driving significant growth in those states.

[49] NABCEP PV Installer Task Analysis: http://www.nabcep.org/wp-content/uploads/2008/11/pv-task-analysis-10_06-version-2-2.pdf

[50] NABCEP Solar Thermal Task Analysis: http://www.nabcep.org/wp-content/uploads/2008/11/solarthermaltaskanalysisapr05.pdf

[51] Refers to the use of water as the heat-transfer medium in heating and cooling systems. This skill is not required in traditional plumbing.

[52] Shoreline and Cascadia Community College both offer certificates in solar PV system specialist.

[53] This section of the report does not go into detail on dairy digesters but they are a good example of co-products and additional sources of revenue for farmers. A dairy can use a biodigester to collect methane, then use this methane to generate biopower. Such an operation can sell power, green tags (a separately sold certificate representing the environmental attributes of the power), carbon credits, fiber (used in nurseries for potting soil), extracted nitrogen and phosphorus for fertilizer, and the remaining waste can go onto fields for fertilizer. The waste heat can be used to heat greenhouses. A diary can add local food waste to the digester to get added benefits. All of these co-products are in addition to the dairy products the farm produces.

[54] Technically, 'small hydro' refers to hydropower potential between one and thirty average megawatts and 'low power hydro' refers to hydropower potential less than one average megawatt. Conventional turbines, unconventional systems, and microhydro power technology classes are subclasses of the low power class defined by their operating envelopes. For the purposes of this report, the term 'small hydro' includes small and low hydropower, or, all hydro potential less than thirty average megawatts.

[55] This finding is based on a review of existing program descriptions and the results of a 2008 survey of green economy workforce education and training program at public two-year college conducted by the Washington State Board for Community and Technical Colleges.

[56] More information on the Columbia Gorge Bi-state Renewable Energy Zone can be found at their website: http://www.cgbrez.org/

[57] Incentives for solar do not currently apply to large utility-scale projects, and the state's renewable portfolio standard is not viewed as having much impact on the solar industry, limiting the level of interest among utilities in including solar in their Integrated Resource Plans.

[58] The reader is advised to review the individual sector summaries for more detail on job types, functions and skills identified by respondents.

[59] The reader should refer to the individual sector summaries for a breakdown of skills by occupation type.

[60] Work ethics generally describes the belief that work itself is as important and fulfilling as the end result. The notion of work ethics originated among Protestants and was central to the views of influential religious leaders such as Martin Luther, and has been linked to the achievements of the Industrial Revolution.

[61] See: http://apps.leg.wa.gov/billinfo/summary.aspx?bill=5921&year=2009

Appendix A

Washington's Renewable Energy Industry

Washington's Renewable Energy Industry in Detail

Washington State has developed and used renewable energy resources to meet significant portions of its energy needs for many years. Renewable energy covers a wide spectrum of resources. In this report we focus on six renewable energy industries that appear to have the most relevance and growth potential for Washington. This section provides an overview of the existing consumption and production status for hydro, bioenergy, wind, solar, geothermal, and ocean/tidal renewable energy industries in Washington.

Industry Overview – Current Production and Consumption

The renewable energy industry is quite diverse. Each of the six industry sectors covered here is unique. Some are fairly complicated and consist of a number of different energy resources/technologies, while others are much simpler. Some are well-established and have provided significant renewable energy to the state for decades. Some are growing rapidly, while others are looking for a breakthrough technology or new opportunity to propel them forward. Table A-1 summarizes each of these six industry sectors, and the following sections provide greater detail for each type.

Table A-1. Renewable Energy Source Consumption and Production Estimates for Washington

	Hydro	Bioenergy	Wind	Solar	Geothermal [iii]	Ocean and Tidal
Total Consumption (MWh)	60 million	29 million [i]	< 3 million [ii]	2,500 - 4,200	3,200	0
Current Generation Capacity (MW)	20,311	400	1,366	3	0	0
Current Electrical Production (MWh/yr)	70 - 75 million	2 million	appx 3 million	2,500 - 4,200	0	0
Current Fuel Production (MWh/yr)	NA	2 – 3 [iv] million	NA	NA	NA	NA

Table notes: Values are order of magnitude estimates to allow different renewable energy resources to be compared. Actual consumption/production in any given year can vary significantly due to a variety of factors.

i. Bioenergy includes the consumption of a variety of renewable, organic feedstocks (such as wood and wood waste) for thermal energy and power, plus the consumption of biofuels (such as ethanol and bio-diesel). This differs from some of the other renewable resources that are used only for electrical generation.
ii. The portion of current wind production consumed in-state is not currently available.
iii. Geothermal does not include ground source heat pumps, which some may consider to be a geothermal resource. A lack of data and the nature of this application make it difficult to calculate a value that is comparable to the other resources.
iv. This value is the energy in bio-diesel produced in Washington. Current production is below capacity, but the actual amount is uncertain. Much of this bio-diesel is not consumed in Washington and much of the feedstock to produce it comes from outside of the state.

Hydro

Hydro-electricity is the predominant electricity resource in Washington, accounting for almost three-quarters of electricity generation in the state. Typically, this is on the order of

70 to 75 million MWh of electricity, although actual generation can vary depending on stream flows. In the drought year of 2001, production was less than this, contributing to significant shortages in electricity that year. Production capacity has been stable for the last 30 to 40 years. Only one new hydro project has been completed in Washington in the last 10 years, and most projects added in the last 30 years have been small. Six other large dams were added to the Columbia River in the 1950s and 1960s. There are more than 90 hydro-electric power plants operating in Washington. More than half of these plants are small facilities that are less than 100 MW in capacity.

The federal government (Corp of Engineers, Bureau of Reclamation, and Bureau of Indian Affairs) owns the largest portion of hydro capacity in Washington. Public and private utilities in Washington are the other significant hydro owners. There are a small number of firms (20-30) in Washington that deal with small scale hydro.

Hydro-electricity generated in Washington serves electricity consumers throughout the western half of the United States. Power generated by federal dams goes to the Bonneville Power Administration for distribution throughout the region. For many years, some of this hydro-electricity has been allocated directly to a small number of direct service industrial customers that use significant amounts of electricity. The historically low-cost hydro-electricity helped these electricity-intensive industries to remain competitive, contributing to the state's economy. At one time, aluminum smelters accounted for most of these direct service customers, but changes in world aluminum markets and higher electricity prices has led to the shutdown of nearly all of these plants.

Washington accounts for approximately a quarter of all U.S. hydro-electricity generation. Hydro-electricity accounts for about 8 percent of U.S. electricity production and about three-quarters of the electricity generation from renewable sources. Like Washington, there has been little change in U.S. hydro-electric generation capacity for the last 30 years.

Bioenergy

Bioenergy is a complex and diversified resource. Bioenergy feedstocks are renewable, organic materials such as agricultural and forest crops and residues, wood, agricultural, and food processing waste, and gases from landfills and sewage treatment plants.

Today it focuses on three primary elements:

- Biopower: electricity production, combined heat and power, and thermal energy (includes anaerobic digestion, wood/waste incineration, gasification and municipal solid waste (MSW)/landfill gas recovery)
- Biofuels: such as ethanol and bio-diesel, used primarily for transportation
- Bioproducts: such as plastics and fertilizers that replace fossil fuel feedstocks (petroleum and natural gas)

Behind hydro power, bioenergy is currently the next-largest renewable resource in Washington. In 2005, biomass (primarily wood and wood waste inputs into a biopower facility) supplied a little over 6 percent of the state's primary energy use (since 1960 this value has ranged from 5 to 10 percent). Wood biomass has been used for decades in the forest and wood products industries for generating power and thermal energy (heat, steam or hot water). Other biomass consumption is used for residential space heating, and electricity production in the electric power sector. Biomass-powered electricity production capacity in Washington is currently a little more than 400 MW. Other bioenergy users include landfills and wastewater treatment facilities.

An example of trends in bioenergy is the recent announcement by Simpson Tacoma Kraft Co. to install a 50 MW power generator onto the existing biomass-fueled steam lines used in their pulp and paper processing.[1] The addition of this electricity generator will add a new, high-value product to their manufacturing facility. The electricity also meets I-937 requirements. Energy Northwest recently announced that they intend to establish several biomass-driven power plants in the Northwest in the coming years.[2]

The production of biofuels is more recent. There are a small number of biodiesel production facilities, but no ethanol production in the state (although one is planned and several others are on hold). There are a wide range of players in the bioenergy industry from biofuel producers, distributers, and retailers to utilities, research organizations, industrial users, and the agriculture industry. The bioenergy industry is in flux as market opportunities and challenges emerge and evolve and research and development leads to the commercialization of new production processes and products.

Currently there is one large producer, and a number of smaller biodiesel refineries in Washington, with a capacity of 135 million gallons/year. Actual consumption of biodiesel in Washington is less than 10 million gallons/year (approximately one percent of diesel sales). Ethanol produced outside the state is blended with gasoline and currently accounts for just over five percent of gasoline sales in Washington.

Fleet use accounts for a significant portion of biodiesel consumption in Washington (particularly government entities). However, fleet use is declining because many institutions cannot afford the higher biodiesel prices in their budgets. Since ethanol is blended with gasoline, all gasoline consumers use ethanol.

Bioenergy accounted for about five percent of U.S. primary energy consumption in 2005. Washington accounted for about 3.7 percent of this consumption. U.S. bioenergy consumption has increased 15 percent since 2000. U.S. production of both biodiesel and ethanol has grown significantly in the last 5 years. The U.S. is the largest producer of ethanol accounting for 50 percent of the 13 billion gallons of world production in 2007.[3]

Wind

Washington is endowed with abundant wind resources and is fifth nationally in installed wind capacity. The first utility-scale electricity from wind in Washington was generated in 2001. Since then nine operating wind projects have been developed in Washington and capacity has grown to 1366 MW, 204 MW were added in 2008, 137 MW have been added as of September 2009, and another 260 is now under construction. While wind is the renewable resource of choice for new electricity generation, competing favorably with other fossil fuel resource options, it accounted for just two percent of the electricity generated in Washington in 2007.

All these wind generation facilities are located in Eastern Washington, with the largest share in Klickitat County, however a large, 120 MW wind facility was recently proposed west of Chehalis in Lewis County[4] and at least one other 80 MW wind project is being considered in Western Washington.[5]

There are currently no manufacturers of wind turbines in Washington (Vestas Americas' office is in Portland, Oregon), although there are some service firms that support the industry. Puget Sound Energy is the largest owner of wind capacity in Washington and is 10th nationally among managing owners of wind projects. Other project owners include international firms like Iberdola Renewables, national firms like FPL Energy (which owns the most U.S. wind capacity), other utilities like PacifiCorp, and other regional/local firms like Energy Northwest.

Washington's electric utilities purchase (or own) wind generation resources for their customers. Some of the electricity from wind generation is sold to out-of-state utilities and users.

Wind generation accounted for approximately 1 percent of U.S. electricity generation in 2006. Washington produced about 4 percent of this generation (U.S 26.6 GWh and Washington estimated to be 1.04 GWh). However, wind generation capacity is growing significantly nationally and globally. In 2007 the U.S. wind industry installed 5.2 GW of generation capacity to reach over 16.8 GW in total capacity. This was 30 percent of new electricity generation capacity in the U.S. The U.S. led the world in new wind installations followed by Spain and China at 3,515 MW and 3,449 MW.

The Global Wind Energy Council estimates that over 20 GW of wind power was installed in 2007, bringing worldwide installed capacity to 94 GW. The top five countries in terms of installed capacity are Germany (22.3 GW), the US (16.8 GW), Spain (15.1 GW), India (8 GW) and China (6.1 GW).

Solar

The solar industry includes three elements: solar photovoltaic (PV) systems that convert sunlight to electricity, solar thermal systems that use sunlight to heat water (domestic solar water heating and swimming pool heating), and concentrating solar power for utility scale electricity generation. Most activity in Washington is focused on PV. Washington's solar PV industry has its roots in the marine power industry (inverters), work at Boeing in the 1970s (space power), and U.S. Department of Energy (DOE) projects in the 1980s (silicon purification).

Washington has a major manufacturer of silicon, as well as manufacturers of inverters/chargers and some balance of system components. In addition, a PV module manufacturer is starting operations. There is a solar distributor in Washington, along with a number of small businesses (20-30) that sell/design/install PV systems. Washington has lost some of its solar industry to other states through purchases by out-of-state/country firms, and movement of production off-shore. However, policies to support Washington's solar industry have spurred Washington residential PV system installations, and the growth in residential installations is expected to continue.

There are six firms known to offer solar hot water systems in the state. Additionally, six utilities offer incentives for installing these systems. There is no data available on the size of this market, but it is probably small. There are no solar concentrating power systems in Washington, although a firm in the Tri-Cities has developed a unique prototype concentrating solar system it plans to use for some solar farms in Spain.

There are more than 1,300 small-scale PV systems installed in Washington. About 600 of these have been installed in the last year and a half, since the state's solar production payment was put in place. The total capacity of these systems is still relatively small at about 2 MW and electricity production from these systems is a small fraction of total state electricity generation.

Washington's PV systems are mostly small residential systems. While most of these systems are tied to the electricity grid, the electricity is mostly consumed by the homeowners. However, there is one large utility-scale solar PV facility, the Wild Horse Solar Facility in Kittitas County (500 kW) and several smaller utility projects, including the Orcas Power and Light Project which combined equal 97.5 kW, the Chelan Community Solar Project which combined equal 78 kW, the White Bluffs Solar Station near Hanford (40 kW), the Washington Public Utility District Association Building in Olympia (38 kW) and the Ellensburg Community Solar Project (36 kW). There are several smaller community projects not listed here.[6] The White Bluffs project is in its first phase and is expected to grow to 1 MW. These are small systems relative to systems being installed in many other states. Policies in Washington are designed to favor smaller systems.

Solar electricity generation is much less than one percent of total U.S. generation. U.S. solar PV capacity has grown significantly in the last 6 years to about 800 MW. Washington is not among the leading states in installed capacity. World PV production has grown dramatically in the last ten years (approximately 3 GW) and is expected to increase by an order of magnitude in the next ten years. Japan is the leading producer of PV systems, followed by Europe, China, Taiwan, and the U.S.

Nationwide, there has been growth in solar thermal installations in the last few years. Many of these systems are in states like Hawaii, California, and Florida. No Northwest states are in the top ten. There are a number of proposed solar concentrating electricity generation projects in the Southwest with a capacity of 4 GW in the feasibility/planning stage.

Geothermal

Geothermal electric power production requires high temperature resources (typically greater than 150° C, but temperatures in the 100° C range are viable), which exist around Washington's Cascade volcanoes. There is currently no geothermal electric production in

Washington. However, recently an Oregon firm has submitted lease applications at Mt. Baker and some exploratory development work is expected. In addition, a Washington firm has attracted venture capital to apply some new techniques for geothermal electricity development.

Low- to mid-temperature geothermal sources are best for direct hot water uses. There are six hot spring resorts in Washington, some of which were developed in the early 1900s that use geothermal energy for hot tubs and pools and heating/hot water. There is potential to develop direct use applications, particularly in the Columbia River Basin area of southeast Washington where there are over 900 thermal wells, but there is no activity under way to develop this resource.

Geothermal heat pumps use the ground or ground water as a heat source or sink and could also be considered a geothermal resource. There is no available data on the number of geothermal heat pumps in Washington or the size of this renewable resource, although it is larger than the consumption at the six mineral/hot spring resorts and is the most developed geothermal application in Washington. Ground-source heat pumps can be installed in most places.

Many of the notable geothermal heat pump systems in Washington are institutional users in Eastern Washington (e.g., Ephrata Court House, Yakima County Jail, Walla Walla Community College).

Geothermal energy accounts for less than half a percent of U.S. energy consumption and around half a percent of U.S. electricity generation. The U.S. is the largest world producer of geothermal electricity, but Iceland and Indonesia have added the most capacity recently. World geothermal electricity production has shown steady but modest growth over the last 40 years approaching 10 GW of capacity in 2007. U.S. capacity has been relatively static since a growth period in the 1980s.

There are signs of renewed interest in geothermal. The Western Governors Association estimates there is 5.6 GW of geothermal electricity production that could feasibly be developed by 2015. Most of this capacity is in California and Nevada. Only 50 MW is in Washington.

The U.S. capacity of geothermal heat pumps is estimated to be 7.2 to 9.6 GW thermal. About 8 percent of this capacity is estimated to be in the Western U.S.

Ocean and Tidal

Electricity can be generated from the movement of waves in the ocean or tidal flows (referred to as hydrokinetic). These emerging technologies are in their infancy, with most projects in the development/pilot stage. Although several projects have been planned or proposed, there currently are no ocean/tidal electricity generation projects in Washington, though there could be significant possibilities for this resource as the technology advances.

One project had been proposed off the Washington coast - the Makah Bay Offshore Wave Pilot Project. This project has been the subject of legal challenges based on the need for further environmental review and appears to be canceled. Several tidal power projects are being explored in the region including seven potential sites in the Puget Sound (Snohomish Co PUD). These projects are still in an exploratory phase and it may be a number of years before they are developed. There are some commercial ventures, utilities, and universities (research and development) looking into this resource.

Washington-based businesses are on the leading edge of advancing this technology. Grays Harbor Ocean Energy recently proposed to generate 100 MW of hydro-kinetic projects off the coast of Hawaii.[7]

The situation for ocean/tidal electric generation systems globally and nationally is similar to the Northwest. Globally, there are a few operating systems and some under construction. In the U.S. there are a few small, demonstration projects and some small proposed projects. While there is significant energy potential in the oceans and tides, it may be some time before the technology to capture this energy matures.

Renewable Energy Industry Drivers, Challenges and Trends

Washington State's renewable energy industry is growing and changing, in some cases quite significantly. This section considers the specific factors that contribute to the growth of the hydro, bioenergy, wind, solar, geothermal, and ocean/tidal renewable energy industries and offers projections of future growth.

Drivers and Challenges: An Overview

Government policies and market circumstances are spurring growth in the renewable energy industries. However, each of the renewable industries discussed here has a variety of challenges and obstacles that have slowed growth.

Historically higher costs relative to other conventional fossil fuel resources have been the primary obstacle to the development of renewable resources.[8] There are a number of federal and state policies designed to address this obstacle:

- Federal renewable energy production tax credit and investment tax credit
- Washington's renewable portfolio standard
- Washington's emission performance standard for electricity generation
- Renewable portfolio standards in other states (particularly California) that have created competition for renewable resources
- Washington's integrated resource planning requirement for utilities
- Legislation to promote utility green power programs and net metering[9] for renewables
- Legislation to promote the creation of green jobs and energy independence
- Development of policies in Washington and west coast states (Western Climate Initiative) to address climate change

The cost of conventional fossil fuel resources has been increasing. Oil, natural gas, and coal prices have increased significantly in recent years as demand has grown without a similar increase in supply. These market conditions make it easier for renewable energy resources to compete. This is particularly true for wind energy, which has become a viable electricity generation option. There has been renewed interest in other renewable energy options as well. However, oil prices have dropped considerably since July 2008, creating uncertainty in energy markets and dampening investment interest in renewable energy options.

Advances in technology have also improved the prospects of renewable energy resources. Venture capitalists have been pouring money into the development of these resources in recent years as the potential financial reward has grown.

However, the renewable energy industries still face significant obstacles. Siting renewable energy facilities can be a challenge because they may be located in environmentally sensitive areas, there can be local opposition, and regulations and jurisdictional authority can be unclear. Uncertainty about government policies and incentives create risks for development. For example, the expiration of the federal production tax credit at the end of 2008 and the failure of Congress to renew it was a significant concern, but late in the year the tax credit was extended. The U.S. financial crisis is constraining the availability of capital and lowering energy prices, although renewable energy appears to be outperforming other venture capital investments.[10]

Specific challenges, opportunities, and drivers for each industry are listed below.

Hydro

Hydro-electricity is a proven renewable energy resource. It is a reliable and flexible resource. However, there are challenges to growth in the hydro-electric industry.

Challenges:

- Licensing/re-licensing process for dams
- Regulations and environmental challenges of developing new hydro projects on waterways
- Impacts on fish and local ecosystems (including potential for dam removal in some locations)
- Competition for water for other uses such as crop irrigation and stream flow (for fish)
- Climate change could impact stream flows; hydro capacity can decrease significantly in drought years
- The most favorable sites for hydro have already been developed
- Upgrades at large hydro facilities are major projects that take many years

Drivers of Change:

- Development of advanced turbine technologies (fish friendly, higher efficiency)
- Older hydro projects that could benefit by upgrading to more advanced, efficient turbines
- Evolving technology is improving opportunities to expand microturbines in irrigation canals and other existing infrastructure

Bioenergy

The bioenergy industry is very diverse with potential in a variety of areas. There is a large and varied supply of biomass resources and the use of these resources (often viewed as waste) provides benefits for agriculture, industry, and governments.

Challenges:

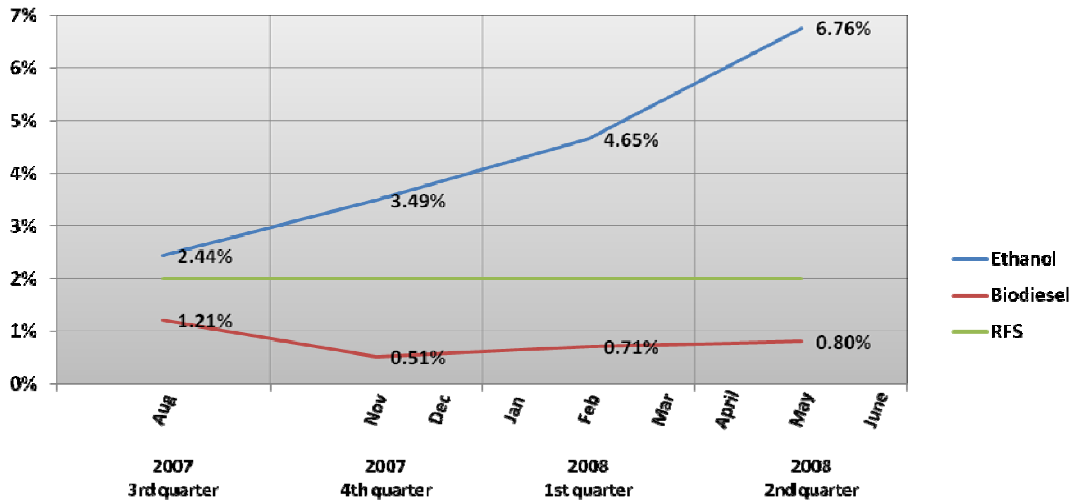
- Increasing cost of biomass feedstock is outpacing the rise in energy prices
- Collecting and transporting the feedstock is expensive and can use a lot of energy
- Current biofuels technology uses food crops or waste oils (waste oils have limited availability)
- There is a very limited supply of Washington-produced feedstocks for biofuels, which results in most feedstock being imported. There is a lack of widespread (local) knowledge of the agronomics of potential biofuels crops.

- Biodiesel capacity is currently being under utilized because of high feedstock costs and reduced demand. This is limiting entry of new players and production.
- Limited capital for biofuel development.
- Many bioenergy technologies are not mature – anaerobic digestion, biofuel production from non-food feedstock (e.g. cellulosic ethanol), and bio-products. There is a lot of research and development in the assembly line, but it is not commercially ready.
- The biopower industry is closely linked to construction waste. The current downturn in the construction sector is resulting in increased competition for lumber waste for use in biopower.
- Biopower may compete with paper mills for biomass.

Drivers of Change:

- Energy independence – the use of biofuels displaces imported petroleum.
- The use of waste as a resource contributes to policies to reduce the size of our waste stream (the movement to zero waste). The use of solid wastes and residues produces benefits for agriculture, forestry and forest products industries, municipal solid waste providers, wastewater treatment plants, etc.
- Rural (and local) economic development is an important driver for bioenergy development.
- Government policies and incentives for bioenergy. These include federal biofuel production standards, grants, loans, and tax credits. Washington's I-937 encourages growth of biopower output. Washington also provides tax incentives (B&O tax, property tax, sales tax) and the Energy Freedom Loan Fund. Washington's renewable fuel standard (RFS) requires that 2 percent of diesel sales are biodiesel by November 30, 2008 (increasing to 5 percent once in-state feedstock can meet a 3 percent requirement) and ethanol must account for 2 percent of gasoline sales by December 1, 2008 (increasing to 10 percent if it does not jeopardize Clean Air Act attainment). See Figure 1 below.
- Significant bioenergy research and development activity funded by public and private sources

Figure 1. Washington State Biofuel Use as a Percent of Total Fuel Use[11]



Wind

Washington has abundant wind resources. Wind is cost competitive with other electricity options. Once the initial investment is made, wind provides price stability compared to other options like natural gas turbines, which are subject to volatile fuel prices. Wind is a clean resource with no emissions or requirements for water (unlike many other electricity generation resources).

Challenges:

- Local opposition to wind projects, mostly due to visual impacts.
- Transmission: access to transmission is the critical issue for developing wind capacity in the West (Western Governors Association). Policies and expansion of the transmission system are necessary.
- Wind is an intermittent resource and actual output can be significantly different than nameplate capacity. On average a wind turbine might operate at a 30 percent capacity factor, but at times may produce very little electricity. The intermittent nature of wind creates electrical system integration and reliability issues that add an additional cost for integrating wind into the electrical system. Experience is being gained to address these issues.
- Turbine manufacturers have a production backlog and there are shortages of some wind turbine components. Shortages of raw materials are driving up capital costs.

Drivers of Change:

- Advances in turbine technology (such as larger turbines) have improved the efficiency of turbines, expanding where wind is viable and improving capacity factors.
- Rural development: wind projects produce county tax revenues, royalty payments to rural landowners (while still being able to use the land), and create jobs.

- Counties such as Klickitat County have created zoning and other policies to encourage wind development.

Solar

The use of PV systems to generate electricity from solar energy has grown significantly in Washington in recent years. While the solar industry in Washington is small, there is potential for continued strong growth if some of the challenges can be overcome. One of the advantages of solar energy compared to most other resources is that it can be developed on a small scale and can be located almost anywhere (e.g., roofs).

Challenges:

- Solar energy systems are relatively expensive.
- Regulations/requirements for installing a solar system (lack of familiarity by inspectors can be an obstacle).
- Some solar firms that were located in Washington have moved out of state.
- Having enough Washington demand to support a local solar industry (instead of being consumers of out-of-state solar products).

Drivers of Change:

- Government policies for solar. In Washington this includes a net metering law, tax breaks, and a renewable energy “feed-in” production incentive for small systems.
- Technology improvements that reduce costs and simplify systems, installation requirements, and inspections.
- Increases in PV production capacity that lead to economies of scale and cost reductions.
- Availability of innovative financing options (e.g. municipal or utility financing) and incentives (e.g. green power programs that support local system development).

Geothermal

There has been little geothermal development in Washington, likely due to the challenges of developing this resource. However, Washington has high temperature geothermal resources near the Cascade volcanoes and many moderate to lower temperature resources that can be used for direct use applications (heating, cooling, and hot water). Geothermal electricity production has existed for many years and is a stable, base load resource (in contrast to many other renewable sources).

Challenges:

- Exploration, drilling and development of geothermal sites is expensive with risk of failure
- Leasing and siting can be difficult and time consuming because of overlapping jurisdictions and lack of clarity in regulations.
- The best sites for electric production are in scenic areas (Mt Adams, Wind River, Mt. Baker), national recreation areas, other protected zones, and Indian reservations.

- Power transmission can be expensive (and difficult to site) if the generation is in a remote area.

Drivers of Change:

- Improvements in oil and gas drilling technology benefit geothermal.
- Government supported geothermal research, resource development, and support.
- Develop expedited siting and review for geothermal applications and related government support to help minimize development risk.
- Create a more viable geothermal heat pump industry to take advantage of low temperature geothermal resources in Washington.
- Utility incentives for geothermal and ground source heat pumps.

Ocean and Tidal

The ocean and tidal energy industry is in a research and development and testing phase. Washington has a great deal of potential for ocean and tidal energy, but there are some significant challenges to developing commercially viable technology to tap this potential.

Challenges:

- Difficult ocean environment due to storms and the corrosive nature of saltwater.
- High capital costs resulting in high electricity production costs.
- Few systems tested in real ocean conditions; no proven, commercially viable technology.
- Potential disturbance or destruction of marine ecosystems, fisheries, and coastal shorelines.
- Possible threat to navigation due to low profile device not easily seen.
- Concern about the impact on scenic ocean-front views by devices or transmission lines.

Drivers of Change:

- Recent government policies and legislation have recognized ocean and tidal energy as renewable energy resources.
- Development of a DOE ocean energy program and the establishment of "National Marine Renewable Energy Research, Development, and Demonstration Centers." One of these is associated with Oregon State University with research sites off the coast of Oregon.

Growth Projections for Renewable Energy in Washington

Wind electricity generation has been the most significant new renewable energy resource in Washington State in the last 5 years (Table A-2). Washington's renewable portfolio standard is expected to result in the development of approximately 1300 MW (average) of new renewable electricity generation resources by 2020. Wind generation is likely to contribute a significant portion of this energy,[12] but other renewable resources will likely be needed as well.

The near future estimates are intended to reflect what might happen in a 10-year time frame for electricity generation from renewable sources. There are a variety of market and technology factors that could significantly affect the actual outcomes. In addition, some renewable resources (bioenergy and geothermal in particular) can be used to produce energy in other forms in addition to electricity. The following points briefly summarize the situation for each of the renewable energy resources.

Table A-2. Renewable Energy Source Recent Electricity Capacity Additions and Projected (2020) Capacity and Production Additions for Washington

	Hydro	Bioenergy	Wind	Solar	Geothermal [i]	Ocean and Tidal
Generation Capacity Additions in Last 5 Years (MW)	13.6	65.9	922.6	1-2	0	0
Generation Capacity Under Construction (MW)	0	55	171.4	0-1	0	0
Near Future [ii] Additional Generation Capacity (MW)	100-500	300-800	1,000-2,200	100-300	50-100	1-100
Near Future [iii] Additional Electrical Production (MWh/yr)	0.4 - 2.2 million	2.2 - 6.0 million	2.2 - 5.8 million	125,000-420,000	220,000-440,000	4,000-400,000

Table Notes: Values are order of magnitude estimates to allow different renewable energy resources to be compared.

i. Geothermal does not include ground source heat pumps, which some may consider to be a geothermal resource. A lack of data and the nature of this application make it difficult to calculate a value that is comparable to the other resources.
ii. Near future additional electrical capacity from new renewable electrical production facilities that might reasonably be expected to come on-line over the next 10 years or so (in the 2015 to 2020 timeframe). Changes in technology or other market factors could accelerate or delay the growth in particular renewable resources. Washington's renewable portfolio standard (and standards in other states) suggests that a significant portion of these potential capacity additions will occur.
iii. Near future additional annual electrical production from new renewable electrical production facilities that might reasonably be expected to come on-line in the next 10 years or so (in the 2015 to 2020 timeframe). Production assumes typical capacity factors, which vary for each of the renewable resources.

Hydro - Very few new large hydro projects have come on-line in recent years. Remaining potential is for upgrades to existing facilities or smaller new hydro projects.

Bioenergy – Bioenergy consists of a diverse resource mix that is used for electricity generation, production of biofuels, and thermal energy for heating. Some elements of the bioenergy industry are mature, while others are in research and development. Significant growth depends on the success of some of the new technologies and processes under development along with the development and use of in-state feedstock for biofuel production.

Wind is the renewable energy choice for new electricity generation in Washington. There has been significant growth in the use of wind turbines for electricity generation in recent years. It is a proven and cost-competitive resource. Achieving upper end growth estimates would require transmission system investments, which are included in the 2009 federal economic stimulus package. There may be significant ocean wind potential if research and development efforts show this is feasible.

Solar contributes a very small portion of Washington's energy resources. The number of solar photovoltaic (PV) systems in Washington that generate electricity from solar energy has grown in recent years. However, the output of these systems is small. Most PV development in Washington consists of relatively small-scale projects. There are other existing and potential solar technologies besides PV, but none are currently being applied (or expected to be applied) in significant amounts in Washington. Growth in solar applications is particularly dependent on the supply and price point of the solar technology. If technology advances and/or production efficiencies allow prices to drop with adequate supply, then growth could increase significantly.

Geothermal applications in Washington currently consist of a few hot spring resorts and ground source heat pumps. While geothermal electricity generation is a proven technology, it has not been applied in Washington. Future electricity generation from geothermal in the near term is likely to be small, but a few successful projects along with technology advances could spur growth.

Ocean and tidal electricity generation has not yet proven itself to be commercially viable in the Northwest. If demonstration projects prove successful, there is potential, but it is likely to be small in the near term.

[1] *Puget Sound Business Journal*, January 2009

[2] See: http://seattletimes.nwsource.com/html/businesstechnology/2008762889_webbiomassplants19.html

[3] Renewable Fuels Association: http://www.ethanolrfa.org/industry/statistics/#E

[4] The Chronicle, Sept 12, 2009
http://www.chronline.com/articles/2009/09/12/news/doc4aab4d0f15d74501771813.txt

[5] [5] The Chinook Observer, Nov. 11, 2008:
http://www.chinookobserver.com/Main.asp?SectionID=1&ArticleID=25745

[6] Renewables Northwest Project: http://www.rnp.org/Projects/projectlist.php

[7] *Puget Sound Business Journal*, January 2-8, 2009

[8] Northwest Power and Conservation Plan: http://www.nwcouncil.org/energy/powerplan/6/default.htm

[9] "Net metering" allows small renewable system operators to sell back to the local utility at least a portion of the net electricity they generate.

[10] See discussion in section "U.S. Energy Overview" in main body of document.

[11] Washington Department of Community, Trade and Economic Development Energy Policy Division, *Energy Freedom Report*, December 2008

[12] Wind generation facilities typically operate at a capacity factor of 30 percent because wind is an intermittent resource. Thus a 1000 MW wind facility operating at a 30 percent capacity factor is equivalent to a capacity of 300 average MW (MW_a)

Appendix B

Industry Core Skills Programs and Foundational Industry Skills Programs

Tier 2 Energy Industry Core Skills Programs		
Program Title	**Degree, Certificate or Course**	**Description**
Bellevue Community College (Bellevue)		
Sustainable Designer Certificate (SDC) Program	(15 credits)	Program includes three sequential courses that cover the history of environmental issues in relation to the built interior environment, bioregional resources, sustainable design theory, methods and materials, and evaluation of sustainable design.
Bellingham Technical College (Bellingham)		
Electro Mechanical Technology	AAS	Program provides a broad knowledge base about various industrial processes including electricity, hydraulics, pneumatics, engineering graphics, welding, boilers, etc.
Process Technology and Instrumentation & Control Technology	AAS	Program prepares students as Plant Operators for the processing industries, like petroleum refineries, chemical plants, pharmaceutical plants, co-generation power plants, pulp and paper mills, food processing industries and waste water treatment plants.
Big Bend Community College (Moses Lake)		
Industrial Electrical Technology	AAS-T	Program prepares students for career opportunities as industrial electrical technicians. Students receive instruction in safety, electrical and electronic theory, process control, instrumentation, and Programmable Logic Controllers.
Electronics Technology	Certificate of Achievement (46 credits)	Program is designed for students who wish to take specialized courses in a particular field and desire certification acknowledging completion of specific program modules. These modules contain the mathematics, written and oral communications, and human relations general education requirements and accepted course requirements for certification.
Cascadia Community College (Bothell)		
Energy Management Specialist	Certificate (64-68 credits)	Program emphasizes energy conservation and efficiency while working in the evaluation, planning, design, installation, and maintenance of a wide range of energy-related systems and processes in new and existing commercial and residential buildings.
Environmental Technologies and Sustainable Practices (ETSP)	AAS-T	Program outcomes include the ability to measure, monitor, and recommend actions to reduce and innovate energy use and applications in commercial settings.
Clark Community College (Vancouver)		
Power Utilities Technology	Certificate of Proficiency (50-51 credits)	Program prepares the student for various entry level positions in electric utilities, firms servicing the utilities and industrial firms using power level electrical equipment in their operations. Electric power system operation involves high power level generation, transmission and distribution facilities and related monitoring, control and protection equipment

Program Title	Degree, Certificate or Course	Description
Clover Park Community College (Lakewood and Tacoma)		
Interior Design – Green Design	Short-term Certificate (19 credits)	This certificate focuses on topics such as historic preservation and sustainable environments.
Edmonds Community College (Edmonds)		
Energy Management Program	ATA (90-credits)	Program teaches student to apply basic energy management and technical skills in support of businesses as well as electric, gas, and water utility companies and community action agencies engaged in developing energy- efficiency applications for homes and businesses.
Gonzaga University (Spokane)		
Energy Transmission and Distribution Program	Short-term Certificate (15- credits)	Program is designed to train and educate engineers that are fully capable of designing and constructing the nation's future electrical power grid, the program blends academic rigor with engineering. Each course incorporates aspects of civil, electrical, and mechanical engineering disciplines typically used in modern electrical grid design.
Lake Washington Technical College (Kirkland and Redmond)		
Energy & Science Technician	AAS- (91-99 credits)	Program is aimed at preparing students to work in both the public and private sectors. The program prepares students for employment as technicians in many areas such as: manufacturing operations, oil and gas companies, environmental positions in public and private jobs, and technical representatives.
Bio-Energy Technology	Certificate of Completion- (19 credits)	Program will prepare the student for a career in energy, environmental toxicology, and industrial practices, and provide a general understanding of the new biological technology in the energy sector.
Industrial/Laboratory	Certificate of Completion- (19 credits)	Program prepares student for employment in the Industrial or Laboratory sectors. Students will learn the basics behind good lab practices that will be useful for managing and working within a laboratory setting such as healthcare, agricultural labs, wet labs, or other analysis careers, as well as information about energy, process control, and the impact of industry/laboratory on the environment.
Shoreline Community College (Shoreline)		
Zero Energy Building Practices	Certificate of Proficiency (59-63 credits)	Program gives background in alternative energy and an understanding of high performance and zero energy building practices including alternative energy systems, green building techniques, and designing and installing residential and commercial electric, metering and control systems.

Program Title	Degree, Certificate or Course	Description
Spokane Community College (Spokane)		
Avista Line Construction	Unknown credits 624 hours training	Participants will learn the skills and knowledge required of a line crew helper. They will learn to set and climb poles, install crossarms, hardware, line and transformers along with learning how to use various tools and equipment of the trade through actual field experience. Classroom training will cover safety, electrical theory, transformers, switching and the importance of attitude and teamwork to succeed in today's work environment.
Electrical Workers	Unknown	Lay out, repair, test and install electrical wiring, equipment, etc.
Independent Electrical Contractors	Unknown	Install electrical wiring and equipment.
Walla Walla Community College (Walla Walla)		
Energy Systems Technology- Electrical	Associate I Applied Arts and Sciences	Program encompasses three sub-specialty areas of study: Electrical, Mechanical, and Refrigeration and Air Conditioning. Electrical technicians often work with installation, testing, operation, design, and maintenance of electrical equipment in residential, commercial and high voltage industrial electrical wiring, as well as DC and AC motor controls and electrical distribution systems.
Energy Systems Technology- Electrical	Certificate (56 credits)	(Same as above)

Program Title	Degree, Certificate or Course	Description
Washington State University (Pullman)		
Electrical Engineering and Computer Science		WSU's School of Electrical Engineering and Computer Science will offer the state's first college-level engineering course in renewable energy engineering in the fall of 2009. The course will focus on wind, solar, biomass, and fuel-cell energy as well as exploring emerging technologies. Work will be geared for senior-level majors in engineering, electrical engineering and the sciences.
University of Washington (Seattle)		
Engineer- Energy and Environment Concentration		BSME (Bachelors of Science in Mechanical Engineering) MSE (Masters of Science in Engineering) EDGE (Education at a Distance for Growth and Excellence) GNM (Graduate Non-Matriculated)

Tier 2 Non-Credit Programs		
Program Title	Degree, Certificate or Course	Description
National Sustainable Building Advisor Program		
Whatcom Community College Olympic College Seattle Central Community College Community Colleges of Spokane (Institute of Extended Learning)	Certificate (9 months)	Program is specifically designed for working professionals eager to apply sustainable concepts to the buildings they design, develop, and construct. The SBA course provides attendees the information they need to create buildings that are energy and resource efficient, healthy working and living environments, environmentally responsible and cost effective.
Power Plant Operations Certificate		
Community Colleges of Spokane (Institute of Extended Learning)	Certificate (240 hour, on-line)	Program is designed for people who seek entry-level operator's job in a power plant. This course is designed to prepare a person to apply for an entry-level job.
Green Building Technical Professional		
Community Colleges of Spokane (Institute of Extended Learning)	On- line (40 hours)	Designed specifically for those individuals who are involved green building and those engineers, architects, builders, who would like to have a more in-depth approach to green building. Topics covered: Intro Green Building, Environmental Quality, Resource Efficiency Advantages, Sustainable Preventative Maintenance and Advanced Green Technologies.

Tier 3 Foundational Industry Skills Programs			
Program Category/ Job Title	**4 year colleges**	**2 year colleges**	**Apprentice-ships**
Architectural Engineering/ Drafting	✓	✓	
Assembly Machinist			✓
Boiler Operator		✓	
Boilermaker			✓
Building Construction Management		✓	
Carpenter, Industrial			✓
Carpenter, Piledriver			✓
Carpentry		✓	✓
Combustion Turbine Specialist		✓	✓
Construction Equipment Operator			✓
Construction Management	✓	✓	
Construction Technology	✓		
Control Systems Technician			✓
Drainage And Wastewater Collection			✓
Electrical & Electronics Equip. Installer & Repairer		✓	
Electrical Design Technician		✓	
Electrical Maintenance Technician			✓
Electrician- Construction and Industrial		✓	✓
Electrician- Industrial Maintenance			✓
Electromechanical Technician		✓	
Electronic Systems Technician		✓	✓
Engineer- Technical			✓
Engineering and Design	✓	✓	
Engineering- Construction	✓		
Engineering- Electrical	✓		
Engineering Technology	✓	✓	
Engineering Technology - Mechanical		✓	
Environmental Studies	✓	✓	
Equipment Operator			✓
Facilities Maintenance Mechanic			✓
Facility Management	✓	✓	
Gear Machinist			✓
Heating/Air Conditioning/Ventilation/ Refrigeration(HVAC) Tech. or Installer		✓	✓
Heavy Equipment Maintenance. Mechanic/Tech.		✓	✓

Program Category/ Job Title	4 year colleges	2 year colleges	Apprentice-ships
Hydraulic & Fluid Power Technician			✓
Industrial and Engineering Technology	✓		
Industrial Electronics Technician		✓	✓
Industrial Meter & Instrument Technician			✓
Instrumentation Technician		✓	
Land Surveyor		✓	
Machinist- Industrial (Maintenance)			✓
Mechanic- Industrial Maintenance			✓
Mechanical Technology		✓	
Millwright- Industrial			✓
Piledriver			✓
Plumber			✓
Plumber- Steamfitter			✓
Project management	✓		
Roofer			✓
Sheet Metal Technician		✓	
Sheet Metal Worker/ Welder- Industrial			✓
Welder- Industrial Maintenance			✓
Welder/Fabricator- Industrial			✓
Welding Technician		✓	✓

Appendix C

Renewable Energy and Workforce Development in the Pacific Mountain Workforce Development Area (WDA-2)

Renewable Energy and Workforce Development in the Pacific Mountain Workforce Development Area (WDA-2)

As noted earlier in this report, the recent green economy jobs study[1] found that while renewable energy is an emerging and fast-growing part of Washington's economy, it represents a comparatively small proportion (4.3 percent) of green economy jobs in the state. However, the information collected from employers was extremely useful for establishing a baseline of information about the distribution of employment across the state, and for tracking job growth over time.

The green economy jobs study data also enabled a general breakdown of renewable employment by Workforce Development Area (WDA). Although the level of detail is limited, the data enables a general comparison of employment within the renewable sector and other green economy sectors by WDA (see Table C-1), including the Pacific Mountain region (WDA-2).[2]

The results show that nearly 65 percent of green jobs in the Pacific Mountain region relate to energy efficiency, especially construction and construction-related occupations (including skilled trades and professional-technical jobs). Just 3.3 percent of the region's green jobs were in renewable energy, which is lower than the state average of 4.3 percent.

Table C-1. Renewable Energy Employment by WDA[3]

	ENERGY EFFICIENCY		RENEWABLE ENERGY		REDUCING POLLUTION		MITIGATION OR POLLUTION CLEANUP			***TOTAL COVERED	GREEN JOBS AS A
WDA	GREEN JOBS	PERCENT OF TOTAL EFFICIENCY	GREEN JOBS	PERCENT OF TOTAL RENEWABLE	GREEN JOBS	PERCENT OF TOTAL POLLUTION	GREEN JOBS	PERCENT OF TOTAL CLEANUP	TOTAL GREEN JOBS	EMPLOYMENT 2007 THIRD QUARTER	PERCENT OF TOTAL EMPLOYMENT
5 - Seattle-King County	9,962	69.2%	581	4.0%	2,649	18.4%	1,193	8.3%	14,387	1,158,441	1.2%
8 - North Central Wash/Columbia Basin	783	14.5%	34	0.6%	4,451	82.5%	126	2.3%	5,394	123,932	4.4%
9 - South Central	432	12.4%	147	4.2%	2,832	81.3%	75	2.2%	3,485	126,563	2.8%
11 - Benton-Franklin	1,101	34.6%	79	2.5%	931	29.3%	1,067	33.6%	3,178	97,906	3.2%
3 - Northwest Washington	1,285	46.1%	247	8.9%	963	34.5%	295	10.6%	2,790	155,992	1.8%
6 - Pierce County	1,401	52.6%	165	6.2%	892	33.5%	205	7.7%	2,663	275,515	1.0%
12 - Spokane	1,516	65.8%	225	9.8%	305	13.2%	259	11.2%	2,305	208,014	1.1%
4 - Snohomish County	1,199	60.2%	144	7.2%	369	18.5%	286	14.4%	1,992	250,953	0.8%
7 - Southwest Washington	1,254	66.9%	31	1.7%	350	18.7%	240	12.8%	1,876	171,920	1.1%
2 - Pacific Mountain	1,122	64.5%	57	3.3%	420	24.1%	141	8.1%	1,740	172,262	1.0%
1 - Olympic Consortium	970	68.3%	56	3.9%	322	22.7%	75	5.3%	1,420	116,809	1.2%
10 - Eastern Washington	520	51.4%	68	6.7%	320	31.7%	103	10.2%	1,012	68,754	1.5%
99 - Other*	3,431	69.3%	191	3.9%	871	17.6%	417	8.4%	4,952	8,187	60.5%
TOTAL	24,976	52.9%	2,027	4.3%	15,676	33.2%	4,483	9.5%	47,194 **	2,974,524	1.6%

*This primarily consists of firms with green jobs in more than one area

**The totals of all green jobs (47,194) is greater than the row and column total by 32 jobs because some respondents did not report green jobs by any core area.

***Covered employment are all those workers covered by unemployment insurance. The data comes from the Quarterly Census of Employment and Wages data series.

Further analysis of the data also revealed some of the industry sectors and job titles associated with renewable employment, and it was possible for this report to disaggregate these results by WDA. Since employers were assured confidentiality for participating in the survey, individual company names are not available.

For the Pacific Mountain region, the majority of renewable employment was in farming and ranching, followed by electrical, machining and wood products-related occupations, such as the following:

- Crop Manager
- Herder
- Livestock Feeder
- Milker
- Calf Feeder
- Machinist
- Electrician
- (Wood) Chipper Operator

Since employers classified their own employment data in the survey, it is difficult to determine why some occupations were included while others were not. Also, the small sample size limits our ability to generalize the survey findings across the region. As Table C-2 shows, there are a number of renewable energy industry companies in the Pacific Mountain region. A review of the renewable sectors associated with the companies in Table C-2 suggests that these companies were either not captured in the green economy jobs study sample (represented in Table C-1), or that they chose not to participate in the survey.

Table C-2. Renewable Energy-Related Companies in the Pacific Mountain Workforce Development Area

	Company name	City, County	Repeat
Wind			
	Bruce Hopkins	Olympia, Thurston	H, S
	Energy Freedom Inc.	Cosmopolis, Grays Harbor	S, SD
Hydro			
	Bruce Hopkins	Olympia, Thurston	
Geothermal			
	Smart Energy Systems	Yelm, Thurston	
	Sierra Geothermal Power Inc.	Olympia, Thurston	
Solar			
	Bruce Hopkins	Olympia, Thurston	W, H
	American Capital energy Inc.	Olympia, Thurston	SD
	Energy Freedom Inc.	Cosmopolis, Grays Harbor	W, SD
	Suntrek Energy Systems LLC	Rainier, Thurston	SD
	AEE Solar Inc.	Olympia, Thurston	SD
	Cardinal Glass	Chehalis, Lewis Co	EQUIP
Solar Design and Installation			
	American Capital energy Inc.	Olympia, Thurston	S
	Energy Freedom Inc.	Cosmopolis, Grays Harbor	W, S
	Suntrek Energy Systems LLC	Rainier, Thurston	S, SD
Solar Equipment and Design			
	AEE Solar Inc.	Olympia, Thurston	S
	Cardinal Glass	Chehalis, Lewis Co	S
	Sun Wize Technologies Inc.	Olympia, Thurston	
Biomass, Anaeorbic Digesters and Wood			
	Environmental Energy and Energy Company	Olympia, Thurston	
	Syntec Biofuels Inc.	Olympia, Thurston	
	Vaughan Company Inc.	Montesano, Grays Harbor	
Fuels, Alternative-Biofuels and Others			
	Olympia Green Fuels	Olympia, Thurston	
Biofuels Retailers			
	Acme Service Group		
	Fast Fuel Automated Fueling	Olympia, Thurston	
	Fast Fuel	Olympia, Thurston	
	Future Fuels Inc.	Olympia, Thurston	
	Pettit Oil Company CFN	Hoquiam, Grays Harbor	
	Pettit Oil Company Pacific Pride	Lacey, Thurston	
	Safeway	Olympia, Thurston	

Despite these limitations, it seems reasonable and useful to speculate about ways that these companies and jobs have links to renewable energy. Some of the farm-related occupations may relate to renewable energy through the collection of farm animal waste for use in anaerobic biodigesters, which are being used on a small scale by farmers and ranchers. For example, a dairy can use a biodigester to collect methane from manure, then use this methane to generate biopower. Such an operation can sell power, green tags (a separately sold certificate representing the higher value of the environmental attributes of the power), carbon credits, fiber (used for in nurseries for potting soil), extracted nitrogen and phosphorus for fertilizer, and the remaining waste can go onto fields for fertilizer. The waste heat can be used to heat greenhouses. A diary can add local food waste to the digester to get added benefits. All of these energy and agricultural resources are in addition to the usual dairy products that are generated.

Similarly, wood waste has become increasingly used as a secondary fuel source by pulp and paper mills and lumber mills to fire steam-generating boilers for heating or to power an electric generator. Finally, electricians and machinists may be employed by companies that produce parts or provide services to renewable energy manufacturers or operators.

Future Renewable Growth in the Pacific Mountain Region

Although the *2008 Washington State Green Economy Jobs* report provided a baseline estimate of green jobs in renewable energy at the regional level, the estimates depended largely on information submitted by employers, and it is likely that renewable employers in some sectors in each WDA chose not to participate. For this reason the results likely do not include some individual renewable sectors, companies and employment. For example, it seems reasonable to expect that with the many rivers and small streams in the Pacific Mountain region that at least some microhydro operations exist.

In addition, there have been a number of discussions among local utilities and regional stakeholders about the potential for future development of these and other renewable resources. Some projects are well into the planning stages and seem likely to be implemented. One leading example is Energy Northwest's plan to build the first large-scale wind project on state land on Radar Ridge in the Willapa Hills of Pacific County. The project, which may break ground in 2010, could generate approximately 80 MW of electricity. The site is close to several population centers and existing transmission facilities.[4] Another example is the recently proposed Coyote Crest Wind Park in west Lewis County. This 120 MW, 50 turbine facility is estimated to employ 150 people during the construction phase and 23 long-term maintenance and operations workers.[5] The $230 million plan is estimated to bring $16 million in economic benefits to the community through the construction phase, and an additional $2 million in annual property tax revenue.

Other renewable sources in the region will likely develop more slowly. For example, while the region's proximity to the Pacific Ocean and new advances in tidal and wave energy technologies offer great future potential, these developments are still in the research and testing phases, and significant technical challenges remain to developing commercially viable systems to tap into this potential. To date, no ocean wave or tidal energy projects are operating in the state, and it may be several more years before such projects are implemented in the Pacific Mountain region.

Renewable education and training providers

The only education and training program offered in the region which covers renewable energy topics is at Centralia Community College. Also, a Regional Education and Training Center (RETC) is now being developed to serve the Pacific Mountain region. This facility is located at the Satsop Development Park and leverages facilities, equipment, offices and classroom space that were originally developed to support the Satsop nuclear energy plant, which was never completed. The RETC is already being used by some businesses, government and military clients for specialized training, and additional programs in energy, construction, manufacturing and other high-tech sectors is being planned. Table C-3 provides details from Appendix B which are specific to the Pacific Mountain Workforce Development Area.

Table C-3 Renewable Education and Training Opportunities in the Pacific Mountain Workforce Development Area

Program Title	Degree, Certificate or Course	Description
Centralia/Wenatchee/Peninsula/Grays Harbor College		
Energy Technology Power Operations	AAS	Program provides an introduction to the generation, transmission and distribution of power from hydro, solar, wind, geothermal, and thermal sources. The power cycle is traced from generation to transmission through the power GRID to the point of distribution. Washington State Renewable Energy Portfolio Standards are introduced with a concentration on hydro efficiency upgrades, energy efficiency, and conservation. Energy resources, pollution caused by the generation of power, and global environmental energy issues are discussed. Year two provides an in-depth study of thermal plant cycles and boiler systems fired by gas, coal, nuclear and biomass sources. Courses are delivered via ITV (Interactive Television) broadcast from Centralia in a collaborative effort to deliver the most relevant and appropriate curricula.
National Sustainable Building Advisor Program		
Olympic College Course also offered at: Whatcom Community College, Seattle Central Community College and Community Colleges of Spokane (Institute of Extended Learning)	Certificate (9 months)	Program is specifically designed for working professionals eager to apply sustainable concepts to the buildings they design, develop, and construct. The SBA course provides attendees the information they need to create buildings that are energy and resource efficient, healthy working and living environments, environmentally responsible and cost effective.

Combined Heat and Power (CHP) Projects in the Pacific Mountain Region

Washington has a number of CHP projects online, clustered around forest products, wastewater treatment facilities and university campuses. These projects tend to be developed to take advantage of opportunity fuels. These include forest products, wastewater facilities, anaerobic digesters with the dairy/feedlot industry and waste heat to power projects. The Pacific Mountain region contains several operational CHP projects, including the following.

Projects completed:

1. George DeRuyter & Sons Dairy, Outlook—Project start-up was completed November 2006. It was funded in part with a $499,219 Renewable Energy Grant from the U.S. Department of Agriculture (USDA). A 1.2 MWc system was installed. This project was awarded a $1,972,715 loan at 1 percent interest from the Washington Energy Freedom Program. It is a cold climate GHD/Andgar digester designed for 4300 cows. A third gen-set could be added.

2. Grays Harbor Paper, Hoquiam—Grays Harbor Paper has completed two upgrades of its CHP capacity (2006 and December 2007) using hog fuel. Total mill capacity is now 18.5 MWc with a combined increase of 8.0 MWc. Their original goal was to be electrical energy self sufficient (11-12 MW). They can now sell power to Puget Sound Energy in addition to their own needs. In 2001 the company purchased a turbine but lacked the funding to install it. A complex package—involving the pre-purchase of power, Grays Harbor PUD ownership of the turbine and boiler with a lease back, state financing of a $6 million grant, and two loan packages—has enabled this project to move forward. The pending closure of the nearby Cosmopolis, Washington, Weyerhaeuser mill spurred this economic development project as part of the new Energy Freedom Program established by the state legislature.

Projects under construction:

3. Dairy CHP, Hood Canal—Hood Canal has low levels of dissolved oxygen. One of the causes is animal waste. The Washington State Legislature appropriated $560,000 to study the problem. A biogas-fueled CHP/digester system is being considered. A feasibility study has been completed and developer selected.

4. Wood waste project, Forks—Located in the northwest corner of the Olympic Peninsula, Forks has recently shut down wigwam hog fuel burners and is looking for alternatives to use the waste wood. A feasibility study was completed on May 12, 2006 for Clallam networks Economic Development Council by Siemens Energy & Environmental Solutions. A 1.2 MWc CHP system co-located with an Interfor sawmill in the Forks Industrial Park is recommended. The Port of Port Angeles hired a consultant (September 2008) to move this project forward.

5. S'Kallam Tribe, Port Gamble – This project is in the early stages of development using biomass as the fuel. A combination of power production and heat for the casino is under consideration.

6. Quillayute Valley School District, Forks – This is a 120 kW microturbine project. The Hoh Indian Tribe is considering buying the power with Clallam PUD wheeling it. This project has WA Energy Freedom Program financial support.

7. Farm Power, Rexville – This is a 1.5 MWc community dairy digester CHP system. The project has a memorandum of understanding with Puget Sound Energy. Project financing includes a $500,000 grant from the WA Energy Freedom Program, $500,000 grant from USDA Rural development and a $575,000 USDA loan guarantee. The project is in the permitting stage with co-digestion concerns.

8. Wastewater Treatment Facility, Olympia – This is a biogas CHP project at the Olympia/LOTT wastewater treatment facility. A project development team has been selected including Allied Electric.

9. Ocean Spray Cranberries, Markham – This is a hog fuel CHP project that has completed an initial assessment. This facility operates full-time, year round drying and processing Craisin™ brand food products. It is currently using diesel fuel.

Utilities and Green Power Programs in the Region

Table C-3 provides a list of the electric utilities which serve the Pacific Mountain Workforce Development Area and whether these utilities offer customer green power programs. The state requires utilities with more than 25,000 customers to offer green power programs, though customer participation is voluntary. Almost 100% of the green power sales to the region's utility customers are from wind.[6]

Table C-3. Utilities Serving the PacMt Region

	PacMt region	Offers Green Power Program to Customers
Mason County PUD #1	Entirely w/in region	No
Mason County PUD #3	Entirely w/in region	Yes
Grays Harbor County PUD	Entirely w/in region	Yes
Lewis County PUD	Entirely w/in region	Yes
Pacific County PUD #2	Entirely w/in region	Yes
Puget Sound Energy	Partially w/in region	Yes

Conclusions

The number of renewable energy companies and related employment in the Pacific Mountain region is currently modest. Indeed, as the state's recent green jobs study showed, the preponderance of green jobs in the region resides in industries and occupations that are associated with energy efficiency. But there are significant plans underway which, if developed, would increase employment in renewable energy and related support jobs. These new renewable energy projects, which are sponsored by utilities and other regional partners, have been encouraged through state policy, state renewable energy requirements, and the availability of tax incentives and federal stimulus funding. To the extent that renewable energy is also embraced by investors as a viable and attractive market opportunity for new investment, further development of renewables in the Pacific Mountain region may see accelerated growth that will ultimately boost the economic prospects for the region and the state.

[1] Hardcastle, A. (2009). *2008 Washington State Green Economy Jobs*. Washington State Employment Security Department, prepared by Washington State University Extension Energy Program, Olympia, WA.

[2] The Pacific Mountain Workforce Development Area (WDA2) includes Thurston, Pacific, Mason, Lewis and Grays Harbor counties.

[3] Source: *Washington State Green Jobs Survey*, Employment Security Department, Labor Market and Economic Analysis, 2008

[4] The Chinook Observer, Nov. 11, 2008:
http://www.chinookobserver.com/Main.asp?SectionID=1&ArticleID=25745

[5] The Chronicle, Sept 12, 2009:
http://www.chronline.com/articles/2009/09/12/news/doc4aab4d0f15d74501771813.txt

[6] More information on utility green power programs can be found at :
http://www.cted.wa.gov/site/837/default.aspx