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Review of the Economic and Workforce Effects of Biomass and Solar Electricity Generation in Washington State

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Executive Summary

This report provides a review of existing economic and employment research and data for Washington state related to the production of electricity from renewable biomass and solar resources. Employment Security did not conduct new research or gather new data for this report.

This research was mandated and funded by the 2011-13 Omnibus Operating Budget, 2011 Supplemental Budget.[1]

What are renewable biomass and solar resources?

Biomass is organic matter used as fuel. The types of biomass resources used to produce electricity include wood waste, such as hog fuel and sawmill residuals, crops and residues harvested or collected directly from the land, gases from the anaerobic digestion of animal manures or organic materials, and the gases produced from landfill waste. Electricity generated from biomass sources is called biopower.

Solar energy is energy that makes use of the radiated heat and light from the sun. Many individual homeowners have installed solar panels, and several utilities have invested in solar installations in Washington.

Washington's biomass and solar-electricity industries

As part of Washington's green economy, the biomass and solar-electricity industries are small, yet growing components of the renewable-energy portfolio in Washington state. The amount of electricity generated in Washington state from non-hydroelectric, renewable sources has grown from 2.3 percent of the total state net generation in 2006 to 6.4 percent in 2010.[2] This is greater than the national average of 4 percent in 2010 for non-hydroelectric, renewable energy.[3]

No systematic, reliable data currently exist regarding the economic outcomes, employment or wages specific to the biomass and solar industries in Washington state. There are notable variations in the employment data provided by various sources.

Because employment and wage data are not available specifically for biomass workers, this report attempts to match several of the most-common biomass job functions with existing occupations that have similar functions; and from there wages can be estimated. Wage estimates range from a low of $10.83 to $16.16 an hour for basic manufacturing-production workers to a high of $35.84 to $53.22 an hour for engineers.

While available data suggest the employment picture for biomass is currently small, it *is* growing, due in part to tax incentives and subsidies and an emphasis on expanding renewable-energy sources. As for the solar industry, an increased emphasis on renewable energy, cost reductions and tax incentives may result in increased jobs.

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[1] State of Washington Legislative Budget Notes 2011-13 Biennium – 2011 Supplemental Budget, October 2011. Page 225. http://leap.leg.wa.gov/leap/budget/lbns/2011lbn.pdf

[2] U.S. Energy Information Administration – Washington State Renewable Electricity Profile 2010. Table 5. www.eia.gov/electricity/state/washington/index.cfm

[3] Edison Electric Institute – Key Facts about the Electric Power Industry. Page13. www.eei.org/whoweare/AboutIndustry/Documents/KeyFacts.pdf

Introduction

This report is a review of existing data and research related to biomass and solar energy employment and economic activity in Washington state. This research was mandated and funded by the 2011-13 Omnibus Operating Budget, 2011 Supplemental Budget.[4]

No standardized measures exist to count firms or jobs held by employees in the biomass and solar power industries. The information and data cited in this report are based on personal interviews with state experts, local studies and reports, as well as several national studies. Although the available data are not exact or consistent, enough information exists to provide a summary of the potential economic and employment implications for Washington state.

Context

Washington state is a national leader in many environmental-protection and clean-energy policies and programs. The state is continuing to "green" its economy through the development of environmentally friendly products and services, and by business processes that support renewable energy and energy efficiency.

State leadership for clean energy stems, in large part, from Initiative 937 (I-937), the state's 2006 voter-approved renewable-portfolio standard that requires major utilities with 25,000 or more customers to boost the proportion of renewable energy they provide.

Further support for clean energy comes from the passage of several subsequent bills, including the Washington state evergreen jobs initiative, House Bill (HB) 2227, which passed in 2010. HB 2227 promotes the growth of clean-energy jobs in Washington state as an important step toward growing the state's green economy.[5]

As part of Washington's green economy, the biomass and solar-electricity industries are small, yet growing components of the renewable-energy portfolio in Washington state. While power from conventional hydroelectricity plants has long dominated the state's energy portfolio, this resource has been decreasing steadily since at least 2006, and there is growing recognition that alternative energy sources are needed to meet future electricity needs. The amount of electricity generated in Washington from non-hydroelectric, renewable sources has grown from 2.3 percent of the total state net generation in 2006 to 6.4 percent in 2010.[6] This is greater than the national average of non-hydroelectric, renewable generation of 4 percent in 2010.[7]

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[4] State of Washington Legislative Budget Notes 2011-13 Biennium - 2011 Supplemental Budget, October 2011. Page 225. http://leap.leg.wa.gov/leap/budget/lbns/2011lbn.pdf

[5] Evergreen Jobs Act http://apps.leg.wa.gov/documents/billdocs/2009-10/Pdf/Bills/Session%20Law%202009/2227-S2.SL.pdf

[6] U.S. Energy Information Administration – Washington State Renewable Electricity Profile 2010. Table 5. www.eia.gov/electricity/state/washington/index.cfm

[7] Edison Electric Institute – Key Facts about the Electric Power Industry. Page13. www.eei.org/whoweare/AboutIndustry/Documents/KeyFacts.pdf

Senate Bill (SB) 5575, which was signed into law in 2012 and took effect June 7, changes the definition of eligible renewable resources for purposes of I-937. With the passage of SB 5575, eligible biomass fuels now include organic by-products of the pulping process and the wood manufacturing process, untreated wooden demolition or construction debris, yard waste, food waste and processing residuals, animal manure (previously termed animal waste), liquors derived from algae and qualified biomass energy.[8]

[8] http://apps.leg.wa.gov/documents/billdocs/2011-12/Pdf/Bills/Session%20Law%202012/5575-S.SL.pdf

Biomass

Biomass is renewable organic matter, such as agricultural crops and residue, wood and wood waste, animal manure, and organic components of municipal and industrial waste. Biomass is used as an energy source in producing electricity and heat (biopower), liquid and gaseous fuels (biofuel), and various bioproducts.[9]

A stand-alone biopower facility generates only electricity and does not make use of the co-generated heat. An example of a large, stand-alone biopower plant in Washington is the Kettle Falls facility owned by Avista.

Biopower CHP (clean heat and power), also known as cogeneration (co-gen), is a well established and highly efficient process that produces both electricity and heat, primarily from woody biomass. The electrical power can be used to supplement or replace electricity provided by utilities, and the heat can be used in industrial processes or to heat space or water.

An anaerobic digester produces biogas from animal and food waste. This biogas can be burned to generate electricity and heat, injected into existing natural gas pipelines or used in natural gas vehicles. Electrical power and heat from anaerobic digesters often are used to supplement energy used in farming operations.

Secondary products from generating biopower can provide additional revenue streams. These secondary products include renewable-energy and carbon credits, nitrogen and phosphorus fertilizers, soil amendments, and precursor chemicals for industry and manufacturing.[10]

National context

Biomass is the largest non-hydroelectric renewable source of electricity produced in the United States. Most biopower is produced in pulp and paper mills, with pulping liquors, sawdust and other mill wastes used as fuel. Biomass is supported through a series of federal incentives.[11]

In May 2011, the national dairy industry announced a goal of 1,300 anaerobic digesters to be in operation in the country by 2020.[12] As of March 2012, 186 digesters operating in 35 states were producing electrical or thermal energy from captured biogas. The total amount of electricity produced annually from these digesters is an estimated 521,000 megawatt-hours.[13]

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[9] Biofuels and bioproducts are a growing part of Washington's alternative energy portfolio, but are not directly related to this report. See www.bioenergy.wa.gov/ for more details.

[10] Clean Heat and Power Using Biomass Gasification for Industrial and Agricultural Projects. U.S. Department of Energy. February 2010, www.energy.wsu.edu/Documents/BiomassGasification_2010.pdf. Page 2.

[11] For more detail on federal incentives, see: *Beyond Boom and Bust: Putting Clean Tech On a Path To Subsidy Independence*. Brookings Institute. April 2012: www.brookings.edu/~/media/research/files/papers/2012/4/18%20clean%20investments%20muro/0418_clean_investments_final%20paper_pdf.pdf

[12] *Washington Dairies and Digesters*, October 2011. Washington State Department of Agriculture: http://agr.wa.gov/FP/Pubs/docs/343-WashingtonDairiesAndDigesters-web.pdf. Page 16

[13] AgStar website, EPA: www.epa.gov/agstar/projects/index.html

In March 2012, the U.S. Army reported that it will partner with industry to invest up to $7 billion over the next 10 years in renewable-energy sources, including biomass and solar. The Army intends to purchase renewable-generated electricity primarily through power-purchase agreements. The Army has a goal of using renewable sources to meet 25 percent of its annual electricity needs (estimated at 2.1 million megawatt-hours) by 2025.[14]

Biomass in Washington state

As shown in *Figure 1*, biopower generation in Washington state grew from 1,465 thousand megawatt-hours in 2006 to 1,872 thousand megawatt-hours in 2010, an increase of 28 percent. In 2010, biomass was used to generate about 1.8 percent of the state's total electricity, up from 2006, when biomass was used to generate 1.4 percent of the state's total electricity.[15]

Figure 1. Electricity production from biomass in Washington (thousands of megawatt-hours)

Energy source	2006	2007	2008	2009	2010
Wood/wood waste	1,281	1,116	1,113	1,305	1,676
Municipal solid waste biogenic/landfill gas	165	163	156	156	185
Other biomass	19	13	12	11	11
Subtotal biomass	**1,465**	**1,292**	**1,281**	**1,472**	**1,872**
Other non-biomass renewables	**83,045**	**81,268**	**81,294**	**76,505**	**73,033**
Total all renewables	**84,510**	**82,560**	**82,575**	**77,977**	**74,905**
Total net generation (Mega-watt hours)[1]	**108,203**	**106,990**	**110,828**	**104,470**	**103,473**
Biomass as percent of state total of net generation	1.4%	1.2%	1.2%	1.4%	1.8%
Percent of biomass growth over previous year		-12.0%	-1.0%	15.0%	27.0%
Percent of biomass growth from 2006 to 2010					28.0%

[1]U.S. Energy Information Administration – Washington State Electric Power Industry Generation by Primary Energy Source, 1990-2010, www.eia.gov/electricity/state/washington/xls/sept05wa.xls

Biopower generation in Washington state grew 28 percent from 2006 to 2010. In 2010, biomass was used to generate about 1.8 percent in the state's total electricity.

Washington state ranks fourth among 19 Western states in estimated available biomass.[16] This bodes well for developing more biomass energy in the state. A 2005 inventory of organic material resources found that more than 16.9 million tons of biomass were underused each year. This underused biomass is capable of producing more than 1.5 billion kilowatt-hours of electrical energy, or 1.769 megawatts of electrical power – about 50 percent of Washington's annual residential electrical consumption.[17] Although most of these resources are in forms that are not readily available, about 15 percent of this biomass is in readily biodegradable and concentrated forms that can be used now.

[14] www.sustainablebusiness.com/index.cfm/go/news.display/id/22776

[15] U.S. Energy Information Administration – Washington State Renewable Electricity Profile 2010. Table 5. www.eia.gov/renewable/state/washington/xls/rspt05wa.xls

[16] Yoder, Jonathan. Biofuel Economics and Policy for Washington State, Washington State University School of Economic Sciences, 2008 (some updates in 2009 and 2010). Publication XB1047E. Pullman, Wash. http://cru.cahe.wsu.edu/CEPublications/XB1047E/XB1047E.pdf. Page 1.

[17] Biomass Inventory and Bioenergy Assessment: An Evaluation of Organic Material Resources for Bioenergy Production in Washington State. December 2005. Ecology, Washington State University, pub 05-07-047.

Wood-waste biomass

Currently, Washington uses only a portion of its wood-waste biomass for energy generation. In the 1990s, approximately 3.3 million tons of wood waste were used each year for energy production. In 2009, less than 1.4 million tons of wood waste were used to produce energy, and it is projected to remain below that mark for 2011 through 2013. However, with the approval of I-937 in November 2006, electric utilities with 25,000 or more customers must meet specific renewable-energy targets using sources such as wood waste. Because of this and the recovery of the wood-products industry,[18] the use of forest biomass and other wood waste for energy generation may increase in future years.[19]

Anaerobic digesters

Washington ranks ninth in the country in the number of dairy digesters. These digesters benefit water quality by managing dairy nutrients and increasing economic benefits to dairies, digester owners and related businesses. It is likely that digesters will be incorporated into existing composting facilities, but the number of jobs this would create is unknown.

There are six anaerobic digesters in Washington and a seventh under construction,[20] all located on dairy farms. These produce up to 4,150 kilowatt-hours of electricity per year, enough to power more than 2,700 homes. Approximately 4 percent of Washington's commercial dairy cows contribute to electricity production.[21]

The Washington State Department of Agriculture suggests that an additional six to nine digesters could be operating by 2020.[22] One bioenergy expert noted that this estimate could increase if financial, policy and regulatory obstacles can be overcome and environmental costs and benefits are better documented.[23]

Bellingham Technical College recently implemented a certificate program in sustainable technology for anaerobic-digester technicians. The program is designed to train the skilled workers needed to maintain and operate the digesters.[24] Cascadia Community College in Bothell also offers classes in biomass-generation systems and alternative-energy generation systems.

Biopower CHP (clean heat and power)

Aside from the anaerobic digesters, 18 CHP facilities in Washington use woody debris, municipal waste or other biomass to produce electricity.[25] Of these, five use biomass that would otherwise be considered a waste product of their operations – municipal waste at solid-waste and

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[18] Email correspondence with Peter Moulton, Washington State Bioenergy Coordinator, Washington State Department of Commerce, May 29, 2012.

[19] 2011 Tax Preference Performance Reviews, January 2012, Joint Legislative Audit & Review Committee: www.leg.wa.gov/JLARC/AuditAndStudyReports/2011/Documents/2011TaxPreferencesProposedFinalReport.pdf. Page 79.

[20] The seventh digester is the Rainier Farm Biogas Project in Enumclaw, Wash.

[21] *Washington Dairies and Digesters,* October 2011. Washington State Department of Agriculture: http://agr.wa.gov/FP/Pubs/docs/343-WashingtonDairiesAndDigesters-web.pdf. Pages 4, 16.

[22] *Washington Dairies and Digesters,* October 2011. Washington State Department of Agriculture: http://agr.wa.gov/FP/Pubs/docs/343-WashingtonDairiesAndDigesters-web.pdf. Page 17.

[23] Interview with Peter Moulton, Washington State Bioenergy Coordinator, Washington State Department of Commerce, April 10, 2012.

[24] Bellingham Technical College digester program: http://nwfarmsandfood.com/index.php/training-for-renewable-energy-jobs

[25] Combined heat and power units located in Washington: www.eea-inc.com/chpdata/States/WA.html

wastewater treatment plants. The other 13 plants are mostly pulp, paper and wood mills that use waste-wood products for energy generation.[26] It is very difficult to estimate the number of jobs dedicated to producing biomass energy at these plants because production of energy is not their primary purpose.

One stand-alone biopower facility in the state

The only Washington plant dedicated solely to generating power from biomass is Avista's Kettle Falls Generating Station, which uses wood to produce electricity. Other attempts in recent years by the private sector to build biopower plants have not come to fruition, primarily due to the slowed economy, volatility in biomass supply markets and saturated markets for renewable-energy credits. There is also some public opposition to biopower plants based on environmental concerns about carbon emissions and health effects.[27]

Structure, policies and trends

Washington state supports the biopower industry through a multi-agency group called the Washington State Bioenergy Team. The team is composed of state agencies and universities, including the Washington State University Energy Program, the University of Washington, and the Washington state departments of Commerce, Ecology, Agriculture and Natural Resources, among others. The Washington State Bioenergy Team promotes bioenergy through research, policy development and implementation, legislation, incentives and public-private partnerships.[28]

Numerous legislative actions and tax incentives have helped to promote the biopower industry in Washington. For example:

- Washington is one of 12 states and territories that offers a sales-tax exemption for machinery and equipment used to produce electricity through biomass.[29]
- In 2009, the state legislature passed a temporary sales and use tax exemption for wood biomass sold or used to generate electricity, steam, heat or biofuel.[30]
- There is a reduced business and occupations (B&O) tax rate for manufacturing wood biomass (RCW 82.04.260(1)f) and a B&O tax credit for forest-derived biomass used for producing biopower (RCW 82.04.4494).
- Other incentives include a state property-tax exemption for anaerobic-digester projects (RCW 82.29A.135); a retail-sales-tax exemption for equipment, components, materials and services for constructing digesters (RCW 82.08.900); a B&O tax credit and sales-and-use tax exemption for hog fuel and forest-derived biomass (RCW 82.08.962); and an incentive for harvesters of forest-derived biomass used to produce biopower.

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[26] Interview with Dave Sjoding, Renewable Energy Specialist, Washington State University Energy Program. April 13, 2012.

[27] http://seattletimes.nwsource.com/html/localnews/2014572972_biomass23m.html

[28] www.bioenergy.wa.gov/

[29] 2011 Tax Preference Performance Reviews, January 2012, Joint Legislative Audit & Review Committee: www.leg.wa.gov/JLARC/AuditAndStudyReports/2011/Documents/2011TaxPreferencesProposedFinalReport.pdf. Page 212.

[30] 2011 Tax Preference Performance Reviews, January 2012, Joint Legislative Audit & Review Committee: www.leg.wa.gov/JLARC/AuditAndStudyReports/2011/Documents/2011TaxPreferencesProposedFinalReport.pdf. Page 77.

Some of these tax credits are due to expire as early as 2013, which could hinder employment growth.[31]

Notably, in a 2011 review of tax preferences, Washington's Joint Legislative Audit & Review Committee (JLARC) found no readily available information to determine whether the public-policy objectives of the wood biomass sales-and-use tax preferences were being achieved. Seven sellers of wood-biomass fuel reported using the sales tax exemption.[32]

Employment and wage data are limited

While biomass efforts in Washington are organized, structured and supported by legislation and tax incentives, a review of existing data reveals that there is little comprehensive research that tracks the employment and economic outcomes of biomass.

The state's Department of Commerce maintains a directory of renewable-energy companies. However, there is currently no systematic attempt to document the types of biomass employment and number of people working in biomass-related jobs in Washington.[33] While the Commerce directory provides a useful starting point, and this report provides a review of existing data, there appears to be a lack of specialized economic and labor-market research that includes a systematic collection of data from these industries. This level of research may be needed to accurately specify the economic and employment effects of biomass activities in the state; however, that would require a significant investment.

Biomass experts in the state suggest that the employment picture for biomass is relatively small, but growing. Based on anecdotal information from these experts, there are an estimated 28 biomass firms in the state, employing fewer than 100 people performing biomass-related functions.[34] While these numbers are small, if taken in combination with the related biofuels and bioproducts sectors, the employment numbers would more than double.[35]

Biopower employment and wage profile

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. However, in the process of generating electricity from biomass, if the biomass material is not directly generated by the facility, such as a sawmill, then workers are needed to collect the biomass, haul it to the generator site, prepare it and burn it. Engineers and boiler operators are needed to design, operate and maintain the onsite boilers and turbines. As the power is generated, electricians and engineers are needed to manage the power supply and perform routine maintenance and repairs.

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[31] http://www.bioenergy.wa.gov/BiofuelIncentives.aspx

[32] 2011 Tax Preference Performance Reviews, January 2012, Joint Legislative Audit & Review Committee: www.leg.wa.gov/JLARC/AuditAndStudyReports/2011/Documents/2011TaxPreferencesProposedFinalReport.pdf. Page 81.

[33] www.commerce.wa.gov/DesktopModules/CTEDPublications/CTEDPublicationsView.aspx?tabID=0&ItemID=5008&MId=863&wversion=Staging

[34] Interview with Dave Sjoding, Renewable Energy Specialist, Washington State University Energy Program

[35] Interview with Peter Moulton, Washington State Bioenergy Coordinator, Washington State Department of Commerce. April 10, 2012.

Because employment and wage data are not available specifically for biomass workers, the details in *Figure 2* about occupations, job functions and wage ranges are based on existing data for similar occupations in Washington. These data represent approximate wages for biomass workers.

Figure 2. Biopower occupations, typical job functions and wages

Biopower occupation	Typical job functions	Comparable occupation/wage	Approximate hourly wage rate[1]
Boiler operators	Manage boiler operations and turbines	Stationary engineer/boiler operator	$23.81 to $30.99
Boiler technicians	Prepare fuel, assist in boiler operations and repair	Mechanical engineering technician	$22.54 to $34.53
Business/economics	Market, research and price feedstock options, co-products	Marketing research analyst	$25.55 to $51.67
Control operators	Install and maintain control systems and programmable logic-controller systems (PLC)	Electrical and electronic engineering technician	$25.52 to $36.16
Electricians	Install and maintain power supply systems and components	Electrician	$22.82 to $36.98
Engineers (energy, mechanical, electrical)	System design, installation, upgrades and repair	Engineers, all other	$35.84 to $53.22
Manufacturing supervisor	Supervise solar-manufacturing and assembly operations	1st-line supervisors of production and operating workers	$21.64 to $37.46
Production worker	General labor in manufacturing setting	Production workers, all other	$10.83 to $16.16

[1]Wages are from the 2011 Occupational Employment and Wage Estimates, July 2011, Washington State Employment Security Department. Wage ranges are the 25th to 75th percentile. https://fortress.wa.gov/esd/employmentdata/reports-publications/occupational-reports/occupational-employment-and-wage-estimates.

Though data specific to occupations related to biopower are not available, existing data for comparable occupations provide estimated earnings information for jobs in the biomass/bioenergy industry.

Solar Power

Solar energy is received by the earth from the sun in the form of solar radiation, and it is used to produce electricity, heat space and water, and provide lighting. Solar electricity relies on manmade devices such as solar photovoltaic (PV) panels or solar cells that capture solar radiation and convert it into energy.

National context

Nationally, solar-electricity generation increased 62 percent from 2005 to 2009.[36] The solar industry in the United States experienced increases in installations, power generation and employment in 2011 compared to 2010. A total of 1,855 megawatts of PV were installed in 2011, compared with 887 megawatts in 2010. Solar power is supported through a series of federal incentives.[37]

2011 was also a record year for solar installations. The increase can be traced to several factors: a large drop in the price of PV systems, the Section 1603 Treasury Program that provides subsidies for solar and other renewable-energy systems, and the completion of a large number of PV installations by utilities. New large-scale leasing programs also have offered homeowners a lower-cost opportunity to have PV systems installed.

The weighted average cost of a PV system fell 20 percent during 2011 due to lower component prices, improved installation efficiency and a shift toward larger systems. Solar-panel prices fell more than 50 percent during 2011, causing some U.S. module-manufacturing plants to close because prices were too low to realize a profit. The drop in prices was driven, in part, by global oversupply and competition from foreign manufacturers. While cost reductions are beneficial for end-users, they have put a strain on solar manufacturers worldwide.

Even with the drop in component prices, U.S. module manufacturers expanded their production capacity by 28 percent in 2011, and production levels remained the same compared to 2010.[38]

The Section 1603 Treasury Program has stimulated PV solar growth since its inception in 2009. As a program under the American Recovery and Reinvestment Act, it offered renewable-energy project developers a one-time cash payment of 30 percent of total eligible costs. While that program ended on Dec. 31, 2011,[39] there is still a 30 percent federal-tax credit available through 2016 for qualifying solar projects.[40]

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[36] Solar Thermal/PV line: www.eia.gov/renewable/annual/trends/pdf/table1_11.pdf

[37] For more detail on federal incentives, see: *Beyond Boom and Bust: Putting Clean Tech On a Path To Subsidy Independence*. Brookings Institute, April 2012: www.brookings.edu/~/media/research/files/papers/2012/4/18%20clean%20investments%20muro/0418_clean_investments_final%20paper_pdf.pdf

[38] U.S. Solar Market Insight Report - 2011 Year-In-Review – Executive Summary, Solar Energy Industries Association, www.greentechmedia.com/research/ussmi. Pages 2, 3.

[39] *Preliminary Analysis of the Jobs and Economic Impacts of Renewable Energy Projects Supported by the Section 1603 Treasury Grant Program*, Daniel Steinberg, Gian Porro, and Marshall Goldberg, April 2012, NREL/TP-6A20-52739: www.nrel.gov/docs/fy12osti/52739.pdf

[40] Credit for Residential Energy Efficient Property, Internal Revenue Service, www.irs.gov/irb/2009-19_IRB/ar08.html2012

An important outcome of the Section 1603 program is the near-term goal of creating and retaining jobs in the renewable-energy sector. From 2009 to 2011, an estimated 8,300 to 9,700 direct and indirect PV jobs were created during PV project construction. PV systems require very little ongoing maintenance. Once installed, the PV systems are expected to create just 610 to 630 jobs nationwide.[41]

There are variations in how solar businesses and jobs related to solar power are counted. No occupational classification pertains specifically to solar, and some jobs may be indirectly related to solar or comprise only a portion of an employee's work responsibilities. In addition, the units of measurement vary depending on whether direct or indirect employment is included. For example, the National Renewable Energy Laboratory defines renewable-energy jobs as direct (onsite – project development, labor), indirect (supply chain, financing) and induced (employment created or sustained by local economic activity stimulated by the first two job types).[42]

These variations in definition, measurement and research methods have led to a range of estimates for solar employment and forecasts for future job creation. For example, the Solar Foundation reported an estimated 93,000 solar workers in the United States in August 2010.[43] A study conducted by Navigant Consulting estimated that if the federal investment-tax credit were extended (which it has been), 440,000 jobs would be created in the U.S. solar industry by 2016. Of these jobs, 110,000 are estimated to be direct, 130,000 indirect and 200,000 induced.[44]

Solar power in Washington state

Washington state has polysilicon-manufacturing capacity. Polysilicon is a basic component used in constructing solar panels. If the demand for solar panels continues to increase, Washington manufacturers may see their businesses grow. Washington also is home to leading inverter and solar-panel manufacturers.

Structure, policies and trends

The state currently is experiencing job growth in PV manufacturing, sales and installations.[45] Future growth seems likely due to the declining cost of solar PV systems and a number of supportive state policies and financial incentives, including a state solar-production incentive.

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[41] *Preliminary Analysis of the Jobs and Economic Impacts of Renewable Energy Projects Supported by the Section 1603 Treasury Grant Program*, Daniel Steinberg, Gian Porro, and Marshall Goldberg, April 2012: NREL/TP-6A20-52739. www.nrel.gov/docs/fy12osti/52739.pdf. Table ES-1

[42] *Preliminary Analysis of the Jobs and Economic Impacts of Renewable Energy Projects Supported by the Section 1603 Treasury Grant Program*, Daniel Steinberg, Gian Porro, and Marshall Goldberg, April 2012, NREL/TP-6A20-52739: www.nrel.gov/docs/fy12osti/52739.pdf. Page 8

[43] *National Solar Jobs Census 2010*, October 2010, The Solar Foundation. Cornell University ILR School, Green LMI: www.solarelectricpower.org/media/157830/final%20tsf%20national%20solar%20jobs%20census%202010%20web%20version.pdf

[44] *2008 Solar Technologies Market Report*, January 2010, EERE: www.nrel.gov/analysis/pdfs/46025.pdf. Page 42

[45] *National Solar Jobs Census 2010, October 2010, The Solar Foundation, Cornell University ILR School, Green LMI*: www.solarelectricpower.org/media/157830/final%20tsf%20national%20solar%20jobs%20census%202010%20web%20version.pdf. Section 5.4.48

Washington's state legislature has supported solar energy production over the years with numerous tax incentives. Beginning in 1996, the legislature temporarily exempted from retail sales-and-use taxes machinery and equipment used directly in generating electricity through solar energy. This tax exemption has been renewed through 2013, although the specific requirements of the exemption have changed with each renewal.[46]

The Renewable-Energy Cost-Recovery Program (adopted in 2005) provides funding to qualified individuals to install solar systems on their properties. The incentives are greater if the components of the system are made in Washington. The bill was expanded in 2009 (and modified in 2010 as SB 6658) to include community solar projects and qualified government entities. These incentives are due to end in 2020.[47]

The Solar Energy Systems and Components of Solar Energy Systems Manufacturers program reduces the B&O tax rate for solar-energy system manufacturers (expires 2014) and provides a sales-and-use tax exemption for electricity generation up to 10 kilowatts using certain renewable sources, including biomass and solar sources (expires 2013). A sales-tax exemption allows 100 percent exemption for PV systems that generate 10 kilowatts or less annually and 75 percent for more than 10 kilowatts. This is due to expire on June 30, 2013.[48]

Although the growth in solar PV system installations is due primarily to the actions of individual homeowners, some utilities also are investing in solar. In Washington, Puget Sound Energy operates the 500-kilowatt Wild Horse facility in Vantage, and Energy Northwest operates the 38.7-kilowatt White Bluffs Solar Station in Richland. Seattle City Light completed its 24-kilowatt Jefferson Park Community Solar project in March 2012. There are about 10 community solar projects in the state, some commercial systems and numerous uncounted single systems.[49]

In addition to Washington, 19 other states and territories provide a sales-and-use tax exemption for machinery and equipment used to produce solar energy. However, Puerto Rico is the only state or territory besides Washington to provide tax incentives for all sources of renewable energy.[50]

Employment and wage data are limited

The federal Bureau of Labor Statistics (BLS) does not currently have employment data for the solar power industry, but the BLS has started collecting green-jobs data, which are expected to be available in June 2012.[51] Employment Security's *2011 Green-Economy Jobs Report*, to be published in June 2012, provides estimates of the number of green jobs in the state.

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[46] 2011 Tax Preference Performance Reviews, January 2012, Joint Legislative Audit & Review Committee: www.leg.wa.gov/JLARC/AuditAndStudyReports/2011/Documents/2011TaxPreferencesProposedFinalReport.pdf. Page 203.

[47] http://apps.leg.wa.gov/WAC/default.aspx?cite=458-20-273

[48] http://dor.wa.gov/Content/FindTaxesAndRates/TaxIncentives/IncentivePrograms.aspx

[49] Interview with Phil Lou, Solar Energy Specialist, Washington State University Energy Program, April 16, 2012.

[50] 2011 Tax Preference Performance Reviews, January 2012, Joint Legislative Audit & Review Committee: www.leg.wa.gov/JLARC/AuditAndStudyReports/2011/Documents/2011TaxPreferencesProposedFinalReport.pdf. Page 212.

[51] For more information on the BLS green jobs initiatives, please see: www.bls.gov/green

Nine firms located in Washington manufacture solar-energy components, such as inverters, modules and polysilicon for solar panels. These firms have more than 925 employees, with at least 650 working exclusively in the solar field.[52] REC Silicon is the largest solar employer in the state, with approximately 575 employees. An expansion is planned for REC Silicon, but the estimated increase in jobs at the company has not been estimated yet.[53]

In addition to the manufacturing sector, solar-energy staff at the Washington State University Energy Program estimates that 72 firms in the state install solar systems. There are also two distribution firms in the state, with an unknown number of employees working with solar energy.[54]

Solar wages and employment profile

The majority of occupations in the solar-energy field are PV installers and technicians, followed closely by sales representatives and cost estimators, and – in decreasing numbers – solar designers and engineers, installation managers, electricians, site assessors, energy auditors, plumbers, roofers and HVAC technicians.

Figure 3 lists the skill sets required by some of the major solar occupations. Wages for jobs in solar vary based on experience. Wage ranges listed below are from existing labor market and wage information for similar occupations typically associated with designing and installing solar PV systems.[55]

Employment numbers in solar are not collected in a consistent way. There is variation in the numbers reported in various reports. A source summary of the estimated numbers of firms and employment for Washington is provided in *Figure 4*.

[52] Interview with Phil Lou, Solar Energy Specialist, Washington State University Energy Program, April 16, 2012.

[53] "Rec Silicon may expand Moses Lake factory further," September 22, 2011, article in the *Puget Sound GBusiness Journal*: www.bizjournals.com/seattle/news/2011/09/, April 16, 2012.

[54] Interview with Phil Lou, Solar Energy Specialist, Washington State University Energy Program, April 16, 2012.

[55] For a more detailed analysis of the national solar PV industry, related occupations and wage estimates, see: www.bls.gov/green/solar_power/solar_power.pdf

Figure 3. Select solar occupations, skills and wages

Key solar occupations	Functions and skills	Comparable occupation	Comparable approximate hourly wage rate[1]
Electrician	• Responsible for installing, 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 and site survey skills	Electrician	$22.82 to $36.98
Manufacturing supervisors	Supervise solar-manufacturing and assembly operations	1st-line supervisors of production and operating workers	$21.64 to $37.46
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 • Knowledgeable about CAD, Solidworks or Sketch-up • Models sun path and effects of adjacent structures	Electrical engineer	$34.58 to $51.89
Production worker	General labor in manufacturing setting	Production workers, all others	$10.83 to $16.16
Solar PV installer, roofer, glazier or framer	Responsible for installing PV systems	Electronic equipment installer/repairer	$13.11 to $22.28

[1]Wages are from the 2011 Occupational Employment and Wage Estimates, July 2011, Washington State Employment Security Department. Wage ranges are the 25th to 75th percentile. https://fortress.wa.gov/esd/employmentdata/reports-publications/occupational-reports/occupational-employment-and-wage-estimates.

Although data specific to occupations in the solar industry are not available, existing data for comparable occupations can provide estimated earnings for jobs in the solar industry.

Figure 4. Comparison of employment reports in the solar industry

	Solar Foundation[1]	Solar Works[3]
Firms	Not reported	93 (as of 2011)
Jobs	1,022 (as of 2011)	Estimate 4,050 by 2016
Percent increase	25 percent increase over 2010 (exceeds national 19 percent increase)	

[1] National Solar Jobs Census 2010, October 2010, The Solar Foundation, Cornell University ILR School, Green LMI: http://www.solarelectricpower.org/media/157830/final%20tsf%20national%20solar%20jobs%20census%202010%20web%20version.pdf, Section 5.4.48.

[2] Solar Works for America, Solar Energy Industries Association: http://www.solarworksforamerica.com/States/washington.html.

Estimated employment in Washington state in the solar industry varies widely depending on the source.