Solar Works for Washington

How Expanding Solar Power Will Protect Our Environment and Benefit Our Economy

ENVIRONMENT WASHINGTON
RESEARCH & POLICY CENTER

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Spring 2013

Acknowledgments

The authors thank Lynne Dial with the Northwest Energy Coalition, Linda Irvine with Northwest SEED, and Michael O'Brien with the Renewable Northwest Project for their review and insightful feedback on drafts of this report. Additional thanks to Tony Dutzik and Judee Burr at Frontier Group for editorial support.

The authors bear responsibility for any factual errors. The views expressed in this report are those of the authors and do not necessarily reflect the views of our funders or expert reviewers.

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Graphic Design: Harriet Eckstein Graphic Design

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Executive Summary

Washington's strong clean energy policies have made it a national leader in wind energy and in energy efficiency. However, the state's potential for solar power remains virtually untapped. Washington can start taking advantage of its full potential for solar energy by developing its capacity for rooftop solar power.

By 2025, Washington can install more than 650,000 rooftop solar PV systems—equivalent to about 3,200 megawatts (MW) of solar energy capacity.* Rooftop solar power can help the state reduce its contribution to global warming and protect our environment. More solar power would also create jobs and boost manufacturing in Washington. Putting policies in place to accelerate the growth of the solar energy market will allow Washington to start reaping these benefits immediately.

Sunlight is a significant source of untapped energy potential in Washington.

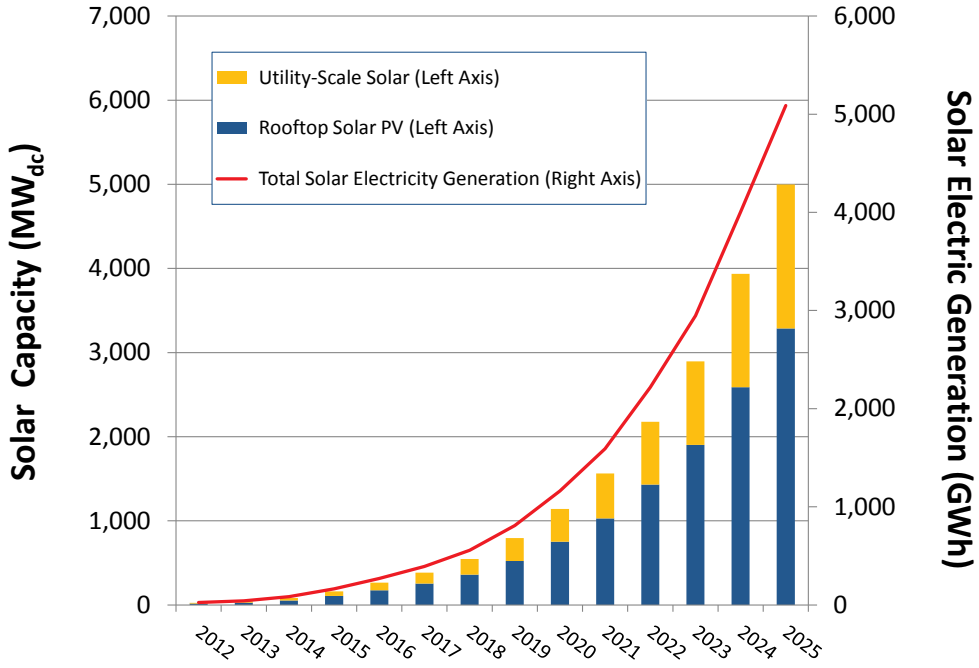
- By placing solar panels on all available and appropriate rooftop space, Washington could technically install 14,800 megawatts (MW) of rooftop solar photovoltaic (PV) power systems by 2025. Achieving this "technical potential" would result in enough solar PV capacity to generate the equivalent of 14 percent of Washington's forecasted electricity use in 2025.

Combined, rooftop solar power, solar water heating and utility-scale solar power can replace 5.5 percent of Washington's total electricity use by 2025—or nearly as much as the electricity produced by the Columbia nuclear power plant each year. (See Figure ES-1.)

- By developing about 22 percent of its full technical potential for rooftop solar power over the next 12 years, Washington can get at least 3 percent of its annual electricity needs from the sun through rooftop solar PV systems alone. That is enough electricity to power 246,000 typical Washington homes—or more than all the homes in Spokane, Tacoma, and Vancouver combined.

**For the purposes of this report, we assume rooftop systems to be 5 kW in size.*

Figure ES-1. Potential Solar Photovoltaic Market Growth in Washington Through 2025



- At the same time, developing 22 percent of Washington's full solar water heating potential would save enough electricity and natural gas to meet the full water heating needs of more than 400,000 Washington households.

- New utility-scale solar power plants built on vacant land could generate another 1.7 million MWh annually by 2025.

Solar energy prevents global warming pollution and protects Washington's environment.

- By 2025, solar energy in Washington would annually prevent more than 2.4 million metric tons of carbon dioxide pollution. This would be equivalent to eliminating the emissions from 460,000 passenger cars on the road today.

- Global warming threatens to increase average temperatures in Washington by as much as 10°F by the 2080s, reducing winter snowpack, threatening urban and rural water supplies, interfering with agriculture and salmon habitat, and harming public health through increased air pollution, exposure to extreme heat and weather events, and increased spread of some diseases. Carbon dioxide pollution is also acidifying the ocean, threatening salmon, shellfish and other sea life.

Increasing the market for solar power in Washington could make the state a leader in the regional solar power industry, create jobs and boost the state economy.

- As of 2011, Washington's solar industry employed 2,300 people at 93 firms—a 180 percent increase from

2010, according to The Solar Foundation and the Solar Energy Industries Association.

- Since 2006, solar PV manufacturing companies, such as Silicon Energy and Itek Energy in western Washington, have drawn more than $1.6 billion in capital investments to the state, while solar PV construction and installation have drawn another $55 million.

- Expanding Washington's solar energy market would create thousands of additional jobs in solar energy installation and maintenance—creating jobs that cannot be outsourced—as well as in manufacturing.

Washington should set a goal of installing solar PV systems on 150,000 rooftops by 2020 and on 650,000 rooftops by 2025. The state should also set a goal to install 400,000 residential and commercial solar water heating systems by 2025 and to develop more of the state's utility-scale solar energy potential.

The state can achieve these goals by:

- **Enabling third-party financing** — Third-party financing lowers the upfront cost of solar PV for consumers. In these agreements, a solar electricity company installs rooftop solar panels at little or no initial cost to its customers. The company retains ownership of the panels, but the customer gains access to the solar electricity the panels provide.

- **Renewing and expanding incentive programs** — Under Washington's Cost Recovery Incentive program, utilities may elect to pay homeowners with rooftop solar PV systems for every kilowatt-hour of electricity they produce, helping them pay off the cost of their systems at a faster rate. The state should extend this program beyond its 2020 expiration date and guarantee solar production incentives to consumers for at least 10 years.

- **Expand opportunities for net metering by raising the net metering cap statewide** — The state's net metering policies require utilities to credit customers who produce solar electricity at the retail rate for every kilowatt-hour they produce. However, these policies limit the amount of solar electricity that can be credited and will soon hamper small-scale solar PV development. The cap should be raised to a minimum of 5 percent of utility peak aggregate demand, and the state should allow systems of any size to qualify for net metering, provided that they do not generate any more electricity than the home or facility uses in a year.

- **Establishing a feed-in tariff program for large solar energy systems** — Feed-in tariffs encourage development of commercial-scale and utility-scale solar installations by requiring utilities to purchase solar electricity at a fixed rate from producers, which guarantees producers a reasonable return on their investments.

- **Strengthening the state's renewable electricity standard** — To drive development of solar power in Washington, the state should strengthen its renewable electricity standard (RES) to get 25 percent of its total electricity use from renewable sources by 2030.

- **Eliminating siting restrictions for community solar projects** — The state should remove siting restrictions

that currently limit community solar projects to local government-owned properties, which prevents private schools, churches, or other non-profit organizations from using their own facilities to house solar arrays.

- **Create a net-zero energy building code** — Washington should require all new homes to generate the equivalent of their entire energy use annually by 2020 and all new commercial buildings to do the same by 2030.

Introduction

Washington is emerging as a national leader in clean energy. The state now ranks seventh in the nation for wind energy installations.[1] Washington is also a recognized national leader in energy efficiency, ranking eighth on American Council for an Energy Efficient Economy's annual state energy efficiency scorecard.[2] Many states have now adopted renewable electricity standards, but Washington was the second state in the country—behind Colorado—to set one through a popular vote.[3]

Entrepreneurs, researchers and government agencies in Washington are also pioneering cutting-edge clean energy technology. For example, in 2013 construction will begin on one of three new tidal energy projects to be built off of Washington's coast.[4] The Department of Energy's Pacific Northwest National Laboratory, based in Richland, is advancing battery technology to dramatically reduce the time required to fully charge electric vehicles.[5] In 2011, King County Metro made more than half of its entire fleet either hybrid-electric or fully electric; it is also investing in all-electric vehicles for its vanpool and recently won a federal grant to design and build an all-electric bus.[6]

Strong energy policies have helped spur the growth of clean energy development in the state, but Washington has potential to further expand its role as a clean energy leader, particularly through the use of solar energy. Despite its reputation for abundant rainfall, the solar resource in Puget Sound matches that of the world's solar energy leader, Germany.[7] In Eastern Washington, the solar resource is even better.

Despite this potential, Washington ranks a lowly 22nd in the United States in installed solar PV capacity.[8] Washington has taken important steps to promote solar energy—including financial incentives for solar energy production and support for community solar projects—but the state will need to do more in order to reach its solar energy potential.

In this report, Environment Washington Research & Policy Center examines the potential for solar energy to contribute to Washington's electricity and water heating needs, as well as the environmental and economic benefits of developing a stronger market for solar energy in the state.

Solar energy can open the door for every citizen to play an important role in firmly securing Washington's position as a clean energy leader in the 21st century.

Washington Has Untapped Solar Potential

Solar energy can help power Washington's future. Capturing this energy can provide electricity and hot water for households and businesses across the state.

By developing just a fraction of its full potential for solar power, Washington can replace 5.5 percent of its electricity use by 2025—or nearly as much electricity as that produced by the Columbia nuclear power plant each year.[9] This level of solar energy production could be achieved through a combination of rooftop solar photovoltaic panels, rooftop solar water heating systems, and utility-scale solar power stations.

The Sun Shines on Washington

Despite the often-cloudy skies in Western Washington, the Puget Sound region is still sunny enough to benefit from solar energy. East of the Cascades, in the sunnier, drier part of the state, Washington's solar potential is even greater.

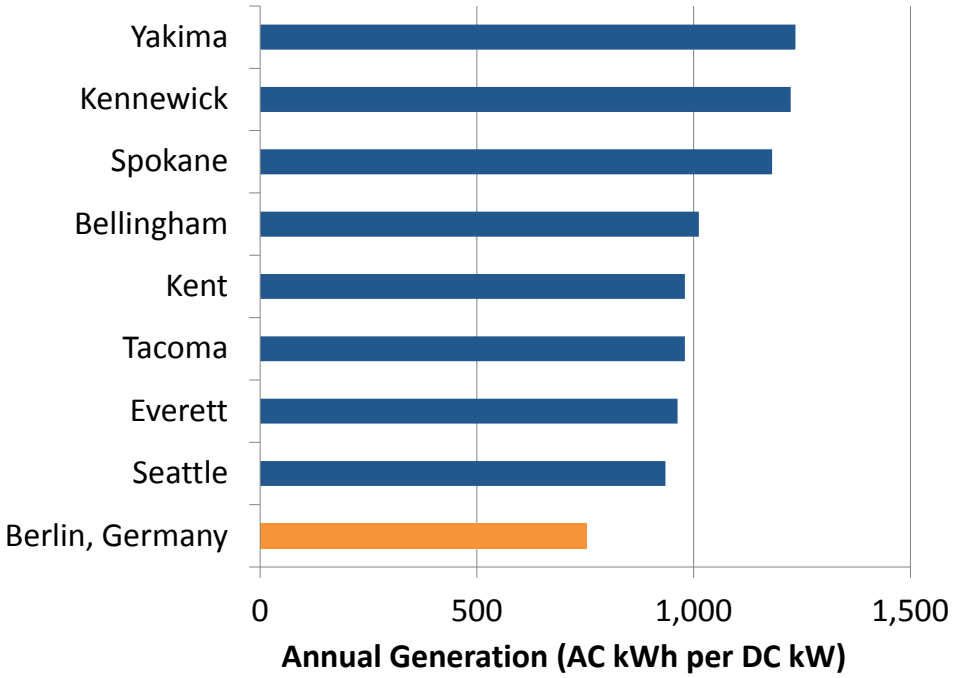
The world's leading country for solar energy development—Germany—now produces 5 percent of its electricity from the sun, despite a climate that is cloudier than the Puget Sound region.[10] (See Figure 1.)

Solar resource quality at a given location can be measured by the average output of a solar photovoltaic panel over the course of a year. Output depends on the intensity of the sunlight reaching the panel, which varies from hour to hour with the weather and the passing of day and night, and from season to season with the angle of the sun and the length of the day.

In Puget Sound, a one kilowatt solar PV system using today's technology will capture enough sunlight to generate 980 kWh of electricity over the course of an entire year.[12] By comparison, the same solar panel in Kennewick, in the eastern part of the state, would capture enough sunlight to deliver about 1,224 kWh per year.[13] On average, a one kilowatt solar PV system installed in Washington will generate 1,018 kWh of electricity per year.[14]

Washington's solar resource compares favorably with other locations where solar energy is taking off. A one kilowatt

Figure 1: Solar Energy Resources Compared[11]



solar PV system in Germany—by far the world's most developed photovoltaic market—would deliver only 754 kWh per year.[15] (See Figure 1.)

Millions of Washington Buildings Are Suitable for Solar Energy

Empty rooftops represent a prime location for solar energy systems. In Washington, many buildings can take advantage of both solar photovoltaic and solar hot water systems.

Rooftop Solar Photovoltaic Panels

Solar photovoltaic panels produce the most power when they are placed on a roof with optimal sun exposure. Appropriate locations face south and are not shaded by trees or other objects for most of the day. A typical home solar PV installation ranges from 3 to 8 kilowatts (kW) in capacity, taking up 300 to 800 square feet of rooftop area.[18] Solar PV systems on commercial buildings can run from 25 kW up to 2 MW in size.[19]

In 2008, the U.S. National Renewable Energy Laboratory estimated how much residential and commercial rooftop area in each state was appropriate for solar power, taking into account shading, building orientation, roof structural soundness, and anticipated improvement in solar PV technology.[20] The agency calculated that Washington rooftops could accommodate more than 14,000 megawatts (MW) of solar power capacity in the year 2015.[21]

Ignoring the potential for new building construction or for improvements in solar technology beyond the year 2015 (both conservative assumptions), Washington will technically be able to support about 14,800 MW of solar PV capacity on

Rooftop Solar Power Systems Work

Rooftop solar energy technologies turn sunlight into electricity and use heat from the sun to provide hot water for local consumption.

Solar photovoltaic (PV) panels turn sunlight into electricity. Buildings with rooftop solar PV systems are typically connected to the electric grid, enabling a building to feed extra electricity into the grid when production exceeds demand and to draw electricity from the grid at night, when the panels aren't producing electricity. Since rooftop solar panels generate electricity close to where it will be used, solar technology can reduce the need to invest in cross-country power lines and help increase the reliability of electricity service.

Solar water heating systems use simple technology to capture solar energy and heat water for a home, commercial building or factory. Tens of millions of households worldwide—particularly in Israel and China, but also increasingly in the United States—use solar water heating extensively.[16] Solar water heating systems work by preheating water before storing it in an insulated tank, reducing the amount of electricity or natural gas required to further heat the water to a usable temperature. In Washington, solar water heating systems can cut the energy use of a standard water heater by half.[17]

Utility-scale solar power plants can use photovoltaic technology or solar thermal technology. They can be installed anywhere with open land area, adequate exposure to sunlight, and access to a transmission line to deliver electricity to market.

rooftops by 2025.[22] That much solar PV capacity could generate 15 million MWh of electricity annually by 2025—equivalent to about 14 percent of the state's forecasted electricity use in that year.[23]

Because solar water heating systems also require rooftop space, developing Washington's potential for solar water heating will reduce space available for solar PV systems. Excluding the rooftop area required for full penetration of solar water heating systems, Washington's net technical rooftop solar PV potential would be reduced to 12,600 MW.

Rooftop Solar Hot Water Systems

Most buildings with a need for hot water and a roof exposed to the sun can take advantage of solar water heating. The U.S. Department of Energy's National Renewable Energy Laboratory estimates that 55 percent of homes and 65 percent of commercial buildings in the Pacific Northwest have appropriate characteristics to support a solar hot water system.[24]

Moreover, solar water heating systems take up very little space. Solar water heating technology is simple and compact. A dark surface and liquid-filled tubes are enough to effectively capture the heat energy in sunlight.[25]

At full technical market penetration in 2025, Washington could host more than 1.8 million residential solar hot water systems and 128,000 commercial-scale solar hot water systems. Those systems could save 4.2 million MWh of electricity and 14.3 billion cubic feet of natural gas each year, the equivalent of the water heating energy needs of more than 1.8 million Washington

residences.[26] Altogether, these systems would reduce Washington's energy use for water heating by nearly 60 percent.[27]

Utility-Scale Solar Power

Solar energy systems can also be placed on vacant land with adequate sun exposure—or on creative locations such as attached to utility poles—rather than on buildings. The technical potential for this type of solar energy in Washington is limited only by the availability of appropriate locations and transmission lines to carry the electricity to market. The Wild Horse Wind farm in Kittitas County, for example, has a 500 kilowatt solar array.[28] Other arrays are much bigger. In neighboring Oregon, a 5.7 megawatt (MW) solar array came online in January 2013.[29] Nationwide, the 10 largest operational utility-scale solar arrays in 2012 all exceeded 20 MW, according to the Energy Information Administration.[30]

Utility-scale solar PV arrays can be installed in a variety of locations. Washington could install solar PV panels in ground-mounted arrays, along highways, on utility poles, or in other vacant spaces.

Washington may also be able to take advantage of utility-scale solar thermal power technologies in the sunniest, driest parts of the state. Solar thermal power stations concentrate the heat of the sun to generate electricity.[31]

Solar Power Can Replace 5.5 Percent of Washington's Electricity Use by 2025

The Benefits of Solar Power in Washington

Solar power can make an important contribution to a stable, sustainable and affordable regional electricity system.

The Northwest's population is expected to grow by nearly a third in the next two decades.[32] Demand for electricity could grow as well, especially in the summer months when power demand is growing faster than demand for power overall, driven by increases in the use of air conditioning and consumer electronics.[33]

The hydroelectric power system is unlikely to provide more electricity than it does now—and it may provide less as global warming affects river flow patterns or as salmon management plans require changes to dam operation. The state's laws limiting global warming pollution make new coal-fired power plants unlikely to be built, and the state is unlikely to use new transmission lines to import more coal-generated electricity from other states such as Montana and Idaho.[34]

Some of Washington's additional electricity needs will be met by renewable power sources—especially wind—that will be required to meet renewable electricity standards. Energy efficiency can also meet a large portion of demand at the least cost and least risk.[35] Despite these additions, Washington's electricity system will likely still need additional resources.

Solar power can make a unique contribution to Washington's electricity system. The Northwest Power and Conservation Council (NPCC), the organization charged with planning for changes in the regional electricity system, notes in its latest planning document that "the region needs to devote significant effort to expanding the supply of cost-effective renewable resources, many of which may be small scale and local in nature."[36] Rooftop solar is generally small in scale and is often installed at the location where the power is used. Solar energy's unique characteristics bring many advantages:

- Rooftop solar PV systems reduce the need to invest in new power lines and reduce the electricity losses that result

from long-distance transmission of power from large, centralized power plants.[37]

- Solar panels provide energy for decades at a fixed cost. Natural gas and other fossil fuels often experience wild price swings. Solar PV can act as an effective hedge against these price fluctuations, helping to maintain stable electricity prices.[38]

- Solar energy benefits society at large by reducing global warming pollution.[39] (See page 14 for more discussion of the environmental benefits of solar power.)

Solar Photovoltaic Technology Is Becoming Increasingly Cost-Effective

Solar energy has great benefits for Washington and is becoming increasingly attractive as the price of solar PV systems plummets.

The increasing demand for solar technology here in the United States and around the world is rapidly driving down the cost for raw materials and for manufacturing of solar panels. Between 2010 and 2011, the installed cost of solar photovoltaic panels declined by 11 percent for systems smaller than 10 kW and by 14 percent for systems larger than 10 kW, partially as a result of increasing economies of scale in solar panel production and falling prices for solar modules.[40] The price of solar PV modules has dropped precipitously, falling from an annual average price of $3.4/W in 2008 to $1.3/W in 2011.[41] No other type of major power generation technology is achieving cost reductions at such a furious pace.[42] This mirrors consumer experience with cell phones, digital cameras, flat-screen televisions and other modular electronic technologies, which have all rapidly become better and cheaper as manufacturers produce more devices.

As the market for solar PV grows in Washington, the industry is likely to develop economies of scale in manufacturing and installation, which will further reduce costs. For example, in Germany, with the world's most developed solar market, average installed costs for solar PV in the final quarters of 2011 were 50 percent less than in the United States.[43]

Launching a Market for Rooftop Solar Power

Washington has less solar energy capacity installed per person than the national average. At the end of 2012, Washington had about 16.2 megawatts (MW) of solar photovoltaic capacity installed in total, or about 2.4 watts per resident.[44] In comparison, the national average is 13 watts per resident.[45] Leading states, such as California and New Jersey, had as much as 42 and 64 watts per resident, respectively.[46]

What makes New Jersey and California different from Washington is not so much the quality of their solar resources but more the effectiveness of the policies these states have put into place to accelerate the market for solar power. The main hurdle facing solar power in Washington is the same hurdle facing any new energy technology—developing the experience and economies of scale needed to make it cost-competitive with established forms of energy generation, many of which have benefited from decades of government and consumer investment and support.

With a sustained commitment to progress, however, Washington can install 3,200 megawatts (MW) of rooftop solar PV capacity and 428,000 commercial and residential solar water heating systems by 2025.[47]

Reaching 3,200 MW of rooftop solar PV capacity by the year 2025 would roughly approximate the trajectory of development of the solar markets in California and New Jersey, where strong clean energy policies

have driven solar PV development. (See Figure 2.) In Germany, strong policy support helped its solar market grow from 2 MW to more than 32,000 MW—a 16,000-fold increase—in just 22 years.[48]

In Washington, reaching 3,200 MW of solar capacity would generate the equivalent of 3 percent of Washington's anticipated annual electricity needs in 2025, or 3.3 million MWh.[49] That is enough electricity to power 246,000 Washington homes—or more than all the residences in Spokane, Tacoma and Vancouver combined.[50]

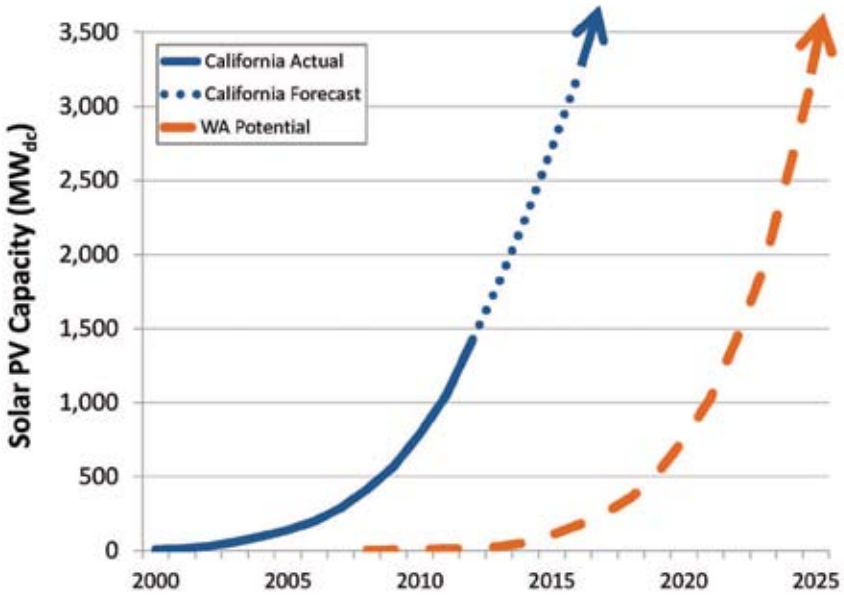
Achieving an equivalent market penetration for solar water heating in Washington would yield nearly 400,000 residential-scale and 28,000 commercial-scale solar water heating systems by 2025.[52] At this level of development, solar water heating technology would reduce Washington's water heating energy use by 13 percent, saving 930,000 MWh of electricity and 3.2 billion cubic feet of natural gas per year.[53] That much energy could meet the water heating needs of nearly 400,000 Washington households.[54]

In total, this much solar energy capacity would use only 22 percent of the state's available rooftop area suitable for solar development, leaving the state a great deal of room to continue expanding the solar energy market in the years beyond 2025.

Accelerating Development of Utility-Scale Solar Energy

Solar development on vacant land at utility scale can also contribute to Washington's solar-powered future. With appropriate policy support, Washington could build enough new utility-scale solar power plants to generate 1.7 million MWh of electricity annually by 2025.[55] If the utility-scale solar energy took the form of ground-mounted photovoltaic panels on appropriate vacant

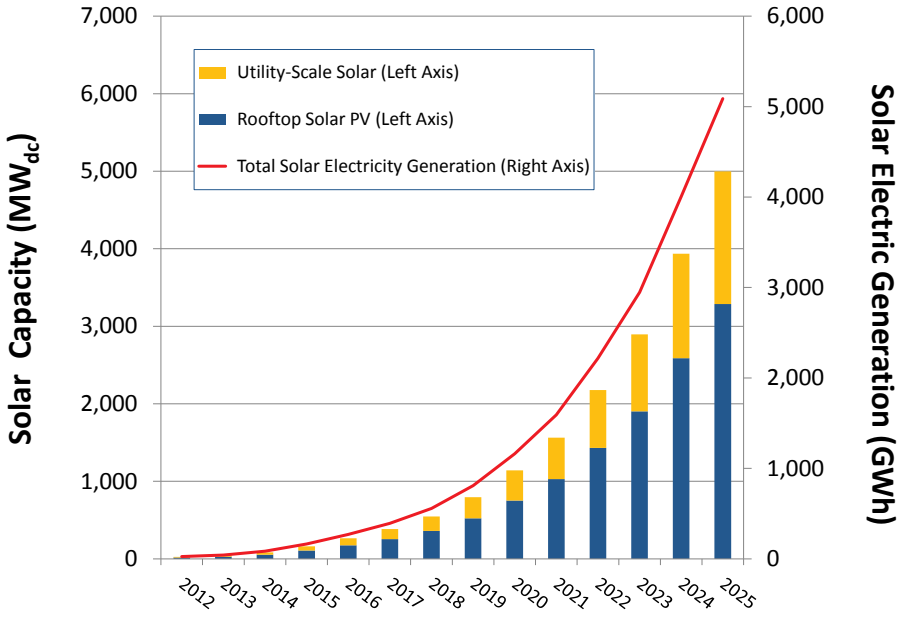
Figure 2: Washington's Potential Rooftop Solar PV Development Trajectory Compared to California's Actual and Forecast Progress[51]



land, the state would need to install about 1,700 megawatts of capacity to achieve this level of performance, depending on location.[56] (See Figure 3.)

Combined with the electricity generated by rooftop solar PV and solar water heating systems in 2025, utility scale solar installations in Washington can help the state replace 6 million MWh of electricity per year with solar power—equivalent to 5.5 percent of the state's projected annual electricity consumption in 2025.[57]

Figure 3. Potential Solar Photovoltaic Market Growth in Washington Through 2025[58]



Solar Energy Protects Washington's Environment and Strengthens the Economy

Solar energy prevents global warming pollution, helping to protect Washington's environment for current and future generations. Increasing the market for solar power will also have benefits for the state's economy, creating jobs in manufacturing and installing solar energy equipment.

Global Warming Threatens Washington

Like the rest of the country, Washington is vulnerable to the impacts of global warming.

Average temperatures in the Pacific Northwest increased by 1.5°F during the 20th century.[59] If greenhouse gas emissions continue unchecked, Washington temperatures could increase by another 10°F by the 2080s.[60]

Washington-based experts have warned about the impacts our state could face as a result of global warming, including:

- Water supplies will become more limited. Warmer temperatures will cause precipitation to fall more often as rain, rather than snow. This affects water availability in Washington because in the Northwest, more water is stored as snow than in reservoirs. Snow effectively holds precipitation in place during the winter, releasing it during the spring snowmelt. As more precipitation falls as rain instead of snow, Washington's streams and rivers will be altered. Higher streamflows will occur in the winter and spring, but will decrease in the summer.[61] This will reduce the availability of water for farmland irrigation, spawning salmon and other water users during the summer.[62]

- The increased likelihood of droughts and heat waves will pose a threat to Washington agriculture.[63] For example, water shortages in the Yakima basin reservoir system are likely to reduce water available for irrigation, causing the average production of apples and cherries to decline by approximately $23 million (about 5 percent) in the 2020s and $70 million

(about 16 percent) in the 2080s, according to experts at the University of Washington.[64] Other important crops in the Yakima Valley that could be impacted by water shortages include mint, hops and white grapes.[65]

- Climate change is also altering the Pacific Ocean and Puget Sound. Higher surface water temperatures and the more frequent upwelling of nutrient-rich water expected to result from climate change are likely to increase the frequency of harmful algal blooms. These blooms produce toxins that can kill shellfish and fish, and have been shown to harm humans who consume contaminated seafood.[66] Additionally, global warming pollution is directly increasing the acidity of the ocean. Acidification threatens to reduce the population of shellfish, which could cause the collapse of Washington's robust oyster industry.[67] The additional impacts of shellfish collapse would be felt through the ocean food chain, putting many species, including some salmon, at risk of extinction, damaging Washington fisheries.[68]

- Erosion is likely to become more severe. The Pacific Northwest is expected to receive heavier winter rainfall. Experience with El Niño and La Niña events has shown that heavy rain saturates soils, causing landslides, and causes coastal flooding from overflowing rivers. Higher sea level will further increase coastal erosion.[69]

- Key Washington natural resources will be damaged. Salmon will struggle with winter flooding, higher water temperatures in streams, and declining water availability in the summer. Forest fires are also expected to become more frequent, threatening rural communities and destroying habitat for many species.[70]

- Global warming is likely to harm human health. Hotter temperatures are likely to increase health-threatening air pollution levels and expose people to more extreme heat and weather events. The elderly, infants, the chronically ill and outdoor workers are particularly vulnerable to increased risk of illness or death during extreme heat waves. Warmer temperatures are also likely to introduce new diseases and pests to Washington. For example, West Nile Virus, Hantavirus and *Cryptococcus Gattii* have all emerged recently in the Pacific Northwest.[71]

- Extreme weather events are likely to harm roads, bridges, buildings and other key elements of Washington's built environment, particularly around Puget Sound.[72]

Solar Energy Prevents Global Warming Pollution

Increased deployment of solar PV panels and solar water heating systems can reduce Washington's dependence on fossil fuels and lessen the state's contribution to global warming. Solar energy can replace fossil fuel combustion—especially natural gas—reducing the state's emissions of carbon dioxide, which is the leading pollutant driving global warming.[73]

In the Western Electricity Coordinating Council, the regional electricity grid of which Washington is a part, energy sources used to meet daily peak electricity needs emit about 1,400 pounds of carbon dioxide pollution for every megawatt-hour of electricity generated.[74] In comparison,

solar panels emit zero carbon dioxide pollution.

Generating 3 percent of Washington's electricity from rooftop solar energy would enable a significant reduction in the state's contribution to global warming. By 2025, this much solar generation would annually prevent 1.2 million metric tons of carbon dioxide pollution per year.[75] Electricity generated by utility-scale solar PV systems can help replace even more of Washington's grid electricity, preventing another 650,000 metric tons of carbon dioxide annually by 2025.[76]

Finally, reducing Washington's energy use for water heating by 13 percent through solar hot water systems would additionally prevent 345,000 metric tons of global warming pollution from the electricity system and 171,000 metric tons of global warming from natural gas consumption.[77]

Altogether, by 2025, Washington could prevent more than 2.4 million metric tons of global warming pollution per year through increased deployment of rooftop and utility-scale solar energy systems. That amount of pollution is comparable to the annual emissions of 460,000 of today's passenger vehicles.[78]

Solar Energy Can Create Jobs and Strengthen Washington's Economy

Increasing the market for solar power in Washington would create jobs in solar panel manufacturing, sales and installation, and it would boost the state's economy. In 2011, 2,300 Washingtonians were employed at 93 firms in the solar industry—a 180 percent increase over 2010.[79] Nationwide, more than half of all jobs in the solar industry are in system installation. Many more are in sales and distribution.[80] These kinds of jobs cannot be outsourced. As Washington's solar market grows, so will local employment.

In addition, since 2006, solar PV manufacturing companies, such as Silicon Energy and Itek Energy in western Washington, have brought more than $1.6 billion in capital investments to the state, while solar PV construction and installation has drawn in another $55 million.[81] Large solar manufacturers also support local communities by paying property taxes—totaling more than $47 million since 2009—that help pay for schools, fire services, roads, and hospitals.[82]

Expanding demand for solar energy systems could create thousands of additional jobs throughout Washington's economy. Workers would be needed to design and manufacture solar energy system technology, to install solar energy systems on buildings, and to inspect and maintain systems periodically. A 2009 study from the University of California, Berkeley, concludes that every MW of solar capacity installed results in 25 job-years of employment in manufacturing, installation and maintenance of solar panels—although only the installation and maintenance labor is guaranteed to be local.[83]

In addition to creating jobs directly in solar manufacturing, installation and maintenance, an expanded local solar power market would drive increased economic activity in other areas of the economy, including education, real estate and services.[84]

Policy Recommendations

Washington should set a goal of installing solar PV systems on 150,000 rooftops by 2020 and on 650,000 rooftops by 2025. The state should also set a goal to install 400,000 residential and commercial solar water heating systems by 2025, and to develop more of its utility-scale solar energy potential. The state can achieve these goals by:

- **Enabling third-party financing** — Third-party financing lowers the up-front cost of solar PV for homeowners, businesses, non-profits, and even government agencies. In these agreements, a solar electricity company (the "third party") installs rooftop solar panels at little or no initial cost to its customers. The solar electricity company retains ownership of the panels, but the customer gains access to the solar electricity the panels provide. This is especially attractive for customers who cannot take advantage of the federal solar investment tax credit, such as government agencies, non-profits and churches.

- **Renewing and expanding incentive programs** — Under Washington's Cost Recovery Incentive program, utilities may elect to pay homeowners with rooftop solar PV systems for every kilowatt-hour of electricity they produce, helping them pay off the cost of their systems at a faster rate. The state should extend this program beyond its 2020 expiration date, and guarantee solar production incentives to consumers for at least 10 years.

- **Expand opportunities for net metering by raising the net-metering cap statewide** — The state's net metering policies require utilities to credit customers who produce electricity through rooftop solar panels at the retail rate for every kilowatt-hour they produce. However, the amount of solar electricity that can be credited is capped a level that is too low and will soon hamper small-scale solar PV development. The cap should be raised to a minimum of 5 percent of utility peak aggregate demand. In

addition, the state should allow systems of any size to qualify for net metering, provided that they do not generate any more electricity than the home or facility uses in a year. Net-metering should allow every individual, business or community that installs a solar energy system to earn fair compensation for the electricity they produce.

- **Establishing a feed-in tariff program for large solar energy systems** — Feed-in tariffs encourage development of commercial-scale and utility-scale solar installations by requiring utilities to purchase electricity at a fixed rate from producers, which helps eliminate financial uncertainty caused by fluctuations in electricity prices and guarantees producers a reasonable return on their investments.

- **Strengthening the state's renewable electricity standard** — To drive development of solar power in Washington, the state should strengthen its renewable electricity standard (RES) to get 25 percent of its total electricity use from renewable sources by 2030.

- **Eliminating siting restrictions for community solar projects** — Community solar projects allow citizens and neighborhoods to pool their resources to establish solar arrays. However, siting restrictions currently limit community solar projects to local government-owned buildings, preventing private schools, churches or other non-profit organizations from using their own facilities to house solar arrays. The state should remove these restrictions.

- **Create a net-zero energy building code** — Washington should require all new homes to generate the equivalent of their entire energy use annually by 2020 and all new commercial buildings to do the same by 2030.

Methodology

This analysis focuses on the potential for solar power and water heating on the rooftops of Washington buildings and on vacant land. Electricity and hot water generated on top of buildings can be used locally, reducing the need for cross-country power lines and increasing grid efficiency and reliability. Utility-scale solar power installations on vacant land offer substantial additional potential.

Solar PV Potential

Technical

To estimate the total technical potential for rooftop solar PV in Washington, we relied upon *Rooftop Photovoltaics Market Penetration Scenarios*, a report carried out by Navigant Consulting for the National Renewable Energy Laboratory.[85] Taking into account factors such as tree and other shading, roof tilt and orientation, and the room needed on roofs between solar panels and taken up by other objects such as chimneys and fan systems, Navigant estimated that 22 percent of residential roof space and 65 percent of commercial roof space in states with cool climates (such as Washington) could be used for solar panels, on average.[86]

Navigant found that installing solar panels on all suitable residential and commercial rooftop space in Washington in 2008 would result in 9,646 MW of solar power. Navigant also estimated total rooftop solar potential through 2015, based on a forecast for increasing rooftop space as new buildings are constructed.[87] Navigant also assumed that solar PV technology would increase in average efficiency from 13.5 percent in 2007 to 18.5 percent in 2015—meaning that the same amount of rooftop area could host solar panels capable of producing more electricity.

To estimate total solar PV potential in 2025, we used Navigant's value for Washington's technical potential for 2015, ignoring any further improvements in solar technology or new construction. These assumptions are very conservative, as improvements in PV technology are likely to shrink the amount of rooftop space needed for solar energy systems, and population

growth is likely to increase total rooftop space available for those systems. To the extent that solar PV technology moves beyond 18.5 percent efficiency and new buildings are constructed, Washington rooftops might be able to hold additional solar capacity.[106]

We calculated that at 18.5 percent conversion efficiency, installing the full 14,828 MW of Washington's technical PV potential in 2025 would require approximately 762 million square feet of rooftop area.[88] Subtracting out the area required by solar hot water systems at full penetration (see below) would reduce area available for PV by 15 percent, yielding a total technical potential in 2025 of 12,588 MW.

We did not attempt to make an estimate of the technical potential for non-rooftop solar installations, which would be limited only by the availability of acceptable open land area with adequate sun exposure.

Table A-1: Potential Rooftop Solar PV Market Growth in Washington, Based on Actual and Forecast Growth in California and New Jersey[91]

Year	Growth Rate	Cumulative Capacity (MW)
2012	70%	16
2013	96%	28
2014	96%	54
2015	64%	106
2016	45%	174
2017	42%	253
2018	45%	360
2019	44%	522
2020	37%	751
2021	39%	1,028
2022	33%	1,432
2023	36%	1,903
2024	27%	2,587
2025	24%	3,286

Achievable Vision

To lay out a vision for a future course of rooftop solar PV development for Washington to pursue, we looked toward established rates of solar PV market growth that the states of New Jersey and California have demonstrated are possible. Using actual and forecast growth curves for solar in these states, presented visually in Figure 2 on page 11, we estimated that Washington could achieve market growth as described in Table A-1.[89] In Washington, 3,286 MW of solar PV will generate about 3.3 million MWh of electricity per year.[90]

We assume that non-rooftop, utility-scale solar development can generate another 1.7 million MWh annually by 2025, bringing solar energy generation to 4.7 percent of Washington's electricity supply. (See "Estimating Washington's Future Electricity and Hot Water Energy Needs" below.) If the utility-scale solar took the form of ground-mounted photovoltaic panels, and were placed in areas with sun exposure comparable to the rooftop panels as described below, Washington would need to install about 1,700 megawatts (MW) by 2025 to achieve this target. (See Figure 3 on page 12.)

Energy Output

We calculated the energy output of solar PV panels in Washington using a population-weighted state average annual electricity generation estimate of 1,018 kWh per kW, per the National Renewable Energy Laboratory's *PVWatts* tool.[92]

Solar Water Heating Potential

Technical

To calculate the maximum market penetration for solar hot water systems, we

first needed an estimate of the number of residential and commercial buildings that will exist in Washington in 2025.

We estimated the number of housing units in Washington in 2025 using data from the U.S. Census Bureau. Using 2008 estimates of population and housing units, we calculated a ratio of residents per housing unit.[93] Holding this ratio constant, we then applied population projections to obtain an estimate of total housing units in 2025.[94]

We calculated the current number of commercial buildings in Washington using estimates of the number of commercial buildings and the number of establishments per building in the Pacific census region, per the U.S. Department of Energy's *Commercial Building Energy Consumption Survey*.[95] Given that the Census reports that there are 175,914 commercial establishments in Washington, we calculated that there are 143,496 commercial buildings in the state.[96] (The number of establishments per commercial building was listed as ranges in the Commercial Buildings Energy Consumption Survey—for example, two to five establishments per building. In order to be conservative in estimating the number of buildings, the highest number in the range was assumed when converting number of establishments to number of buildings.)

To project the number of commercial buildings in Washington in 2025, we first calculated growth in commercial building space. We began with a 2004 Brookings Institution Metropolitan Policy Program report called *Toward a New Metropolis: The Opportunity to Rebuild America*. This report estimates and projects the number of commercial workers by state in 2000 and 2030, and the building space that they require.[97] To interpolate those figures for intervening years, we assumed that the percentage of the population engaged in commercial work (determined using the Brookings Institution commercial workers data and population projections from the State of Washington Office of Financial Management) would change at a steady rate between 2000 and 2030.[98] Then, we calculated the total square footage of building space that those commercial workers would require using the Brookings Institution estimates of space requirements per worker. We found that Washington commercial building area is likely to increase 37 percent by 2025 relative to 2003.[99] Assuming that average space per commercial building remains constant, in 2025, Washington is likely to have 128,000 commercial buildings.

We assumed that 55 percent of residential buildings and 65 percent of commercial buildings in the Pacific region could install solar hot water systems, per the National Renewable Energy Laboratory.[100]

This yielded a maximum of nearly 1.8 million residential solar hot water systems and 128,000 commercial-scale solar hot water systems in 2025.[107] We calculated that at an average efficiency of heat capture of a solar hot water system of 55 percent (very conservative), and Washington's average solar resources per our population-weighted *PVWatts* estimate described above, the state would require 115 million square feet of rooftop area to deliver the energy savings described.

Achievable Vision

We assumed that solar water heating systems could be installed in Washington such that the state would achieve 22 percent of total technical potential for solar water heating by 2025—achieving the same percentage of technical potential achieved by solar PV, as described above.

Energy Output

We calculated the amount of energy that could be saved by solar hot water systems by assuming that a typical solar hot water system in Washington could replace 50 percent of the energy used to heat water

in a typical Washington building, per the National Renewable Energy Laboratory.[101] We broke down energy saved into electricity and natural gas fractions by using the percent of residential and commercial buildings in the Pacific census region that use electricity and natural gas to heat water, respectively, per the *Residential Energy Consumption Survey* and *Commercial Building Energy Consumption Survey*.[102] We then multiplied the number of systems by the average Pacific Region electricity or gas consumption per building for water heating, for residential and commercial buildings respectively, yielding savings in terms of kWh of electricity or cubic feet of natural gas. We calculated that solar water heating systems would save about 930,000 MWh of electricity in 2025.

Together, the electricity saved by solar water heating and the electricity generated by rooftop solar PV and utility scale solar power in 2025 (see above) represent more than 6 million MWh—about 5.5 percent of Washington's projected electricity use in 2025.

Estimating Washington's Future Electricity and Hot Water Energy Needs

Calculations for the equivalent percent of Washington's future energy needs that solar output would represent were based on the following.

We derived an estimated value for 2025 electricity consumption in Washington from the Northwest Power and Conservation Council, *Sixth Northwest Conservation and Electric Power Plan*, Chapter 3, February 2010. We scaled the percent change in regional power demand to Washington using Washington's 2010 electricity consumption, per U.S. Department of Energy, Energy Information Administration, *2010 State Electricity Profiles: Washington*, January 2012.

Washington's anticipated water heating energy needs in 2025 were derived by multiplying the housing and commercial space increase forecast described above by the average electricity and natural gas consumption for water heating per residence or square foot of commercial building space, per the U.S. Census Bureau's *Residential Energy Consumption Survey* and *Commercial Building Energy Consumption Survey*.[103] This calculation assumes that there are no improvements in the energy efficiency of residential and commercial buildings in Washington before 2025.

Preventing Global Warming Pollution

We translated energy generation figures into global warming pollution as follows.

We assumed that the electricity generated by solar PV and the electricity saved by solar water heating systems would not necessarily be timed to coincide with peak electricity demand, and therefore assumed that it would displace electricity at the total WECC Northwest pollution rate of 819 lbs of carbon dioxide per MWh.[104]

For natural gas, we assumed that every million British thermal units (BTU) would prevent 53 kilograms of carbon dioxide pollution, per emission coefficients from the U.S. Department of Energy.[105]

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107 In an earlier version of this report, we wrote that achieving the full technical potential for solar water heating would yield a maximum of 396,000 residential systems and 28,000 commercial-scale systems. However, those numbers reflect what would be accomplished under our policy scenario (achieving 22 percent of technical potential), not under full technical potential.