A Renewable America

POWERING UP WASHINGTON

A REPORT ON THE ECONOMIC BENEFITS OF RENEWABLE ELECTRICITY DEVELOPMENT

A Renewable America
Wind Energy Foundation
1501 M Street NW, Suite 900
Washington, DC 20005
202-552-8105
http://arenewableamerica.org/
info@ARenewableAmerica.org

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EXECUTIVE SUMMARY

Economic growth, energy independence, and new job creation are just a few of the many reasons that a significant majority of Americans consistently support developing renewable electricity.[1] Technological innovations continue to lower costs, and in recent years several of the renewable electricity sectors have experienced significant growth, attracting billions in new private investment.

Solar, wind, hydropower, biomass, geothermal and waste-to-energy already provide more than 13 percent of the U.S. electricity, and renewables are capturing an increasing share of the power grid every year.[2] In 2013, the major renewable electricity technologies provided well over 527 million megawatts hours of electricity to the utility grid – enough to supply the equivalent of over 43 million average American homes.[3] The renewable electricity industries also represent an important source of American jobs, directly employing over half a million people.

This report examines the current and potential economic benefits from developing renewable electricity in Washington. The Evergreen State's existing deployment of renewable energy is already delivering significant economic benefits, as the sector has attracted at least $8.9 billion in new investment to bring projects online.[4]

The state also has considerable untapped renewable electricity potential, and this analysis finds that developing these resources can deliver significant economic gains.

Renewable electricity is **driving economic growth** and creating jobs in communities across Washington. The state is already home to more than an estimated 101,593 jobs in renewable power industries, energy efficiency and other conservation services.[5]

Renewable electricity offers an **affordable source of power**, as the cost of renewable electricity has declined dramatically in recent years. Renewable power purchase agreements are typically long-term, fixed cost agreements, helping protect ratepayers from price spikes associated with other energy sources. Wind power costs have fallen over 50 percent in the last five years.[6] Solar installation costs have fallen nearly 40 percent since 2010.[7]

A **reliable source of power**, renewable electricity can displace the most expensive, least efficient power sources on the utility grid.

While there are many examples of successful Washington renewable electricity projects, this report features four case studies that are representative of the current and future potential for the state's renewable power industries. Utility-scale projects including the Marengo wind farms, the Youngs Creek Hydroelectric project, and Boundary Dam, as well as projects by large institutions, including the Seattle Aquarium's solar array, are featured in greater detail below. The case studies demonstrate that renewable electricity is delivering low cost, reliable electricity, and creating jobs, while also saving businesses and other institutions money.

This report also builds on a scenario from the U.S. Department of Energy's (DOE) 2012 *Renewable Electricity Futures* study, which demonstrates that the U.S. is able to reliably and affordably meet 80 percent of its electricity use by 2050.

In a **"High Renewables" scenario**, Washington has the potential to deploy as much as 18,519 megawatts (MW) of additional installed renewable electricity capacity by 2030 (enough to supply nearly 98 percent of overall state electricity use). Our report finds that this deployment would:

- Create almost 212,000 additional local jobs and $13.6 billion more in wages and benefits during construction.
- After construction and during its operation, this new renewable energy would create more than 3,400 additional annual jobs, approximately $226 million in annual wages and benefits, and about $1.9 billion in annual tax revenue and $44 million in annual land leasing revenue.

Even in a **"Low Renewables" scenario**, characterized by low growth in electricity demand and 'Business-As-Usual' with no new policies, about 2,053 MW of additional renewable electricity capacity would be added by 2030. These additions would be driven by Washington's Renewable Portfolio Standard (RPS) and the increasing competitiveness of renewable energy technologies. Our report finds that this deployment would:

- Create over 27,000 jobs and $2.6 billion in wages and benefits during construction.
- After construction and during operation, these new renewable electricity facilities would create more than 700 annual jobs, approximately $48 million in annual wages and benefits, and over $150 million in annual tax revenue and over $2 million in annual land leasing revenue.

Finally, in June 2014, the U.S. Environmental Protection Agency (EPA) proposed a rule, known as the Clean Power Plan, to reduce carbon dioxide emissions from existing power plants. The rule aims to cut national emissions 30 percent from 2005 emissions by 2030, with an interim target of 25 percent on average between 2020 and 2029.[8] In developing emission reduction targets for each state, EPA assumed a certain level of renewable energy development, energy efficiency improvement, and increased natural gas use in each state.

EPA's proposed rule calls for Washington to reduce carbon dioxide emissions by 72 percent by 2030.[9] In our "High Renewables" case, renewable energy development would exceed the EPA assumption nearly three times over.[10] Even in the "Low Renewables" case, Washington would exceed the EPA assumption of renewable energy development thanks largely to the Washington RPS. As demonstrated in greater detail below, these results imply that Washington should be able to easily meet or exceed its emission reduction target.

WASHINGTON RENEWABLE ENERGY SUCCESS STORIES

Washington is home to hundreds of companies that either produce renewable electricity or supply the components to build and maintain new projects. These companies employ thousands of workers and contribute billions to the state's economy.

The Evergreen State's existing deployment of renewable energy is already delivering significant economic benefits, as the sector has attracted at least $8.9 billion in new investment to bring projects online.[11]

This section features an overview of current renewable electricity generation in Washington and includes four examples that illustrate the benefits of renewable power development. Utility-scale projects including the Marengo wind farms, the Youngs Creek Hydroelectric project, and Boundary Dam, as well as projects by large institutions, including the Seattle Aquarium's solar array, are featured in greater detail below.

Nearly 78 percent of Washington's electricity generation currently comes from renewable sources:[12]

- 2,808 MW of Wind Power
- 30 MW of Solar Power
- 20,902.5 MW of Hydropower
- 403.3 MW of Biomass Power
- 26 MW of Waste-to-Energy

DRIVING ECONOMIC GROWTH

Renewable electricity is helping fuel Washington's economy.

- The state is home to more than an estimated 101,593 jobs in renewable power industries, energy efficiency and other conservation services.[13]
- There are more than 110 in-state wind and solar companies and suppliers – varying from manufacturing and operations to construction and other support sectors.[14]
- Washington's wind industry has driven over $5.3 billion in new investments in the state.[15]

AFFORDABLE SOURCE OF POWER

The cost of renewable electricity has declined dramatically in recent years. Renewable power purchase agreements are typically long-term, fixed cost agreements, helping to protect ratepayers from price spikes associated with other energy sources. In many cases, renewable electricity is now cost competitive with traditional electricity sources. For example:

- Wind power costs have fallen over 50 percent in the last five years.[16]
- Solar installation costs have fallen nearly 40 percent since 2010.[17]

RELIABLE SOURCE OF POWER

Renewable electricity can displace the most expensive, least efficient power sources on the utility grid. Hydropower generates enough reliable renewable electricity in Washington to power over 6.9 million homes per year.[18]

WIND ENERGY HELPS PACIFICORP KEEP THE LIGHTS ON AND THE BILLS LOW

"We continue to look at ways that we can economically serve our customers by expanding our renewable resource portfolio, particularly as we continue our transition away from coal to a lower carbon future."

MARK TALLMAN
VICE PRESIDENT, RENEWABLE RESOURCES, PACIFICORP

EXECUTIVE SUMMARY:

The Marengo and Marengo II wind farms in Columbia County, Washington represent part of an over $2 billion investment that PacifiCorp has made to expand its wind resources in the Northwest and elsewhere in its system. The two projects required several hundred million dollars of investment, resulting in PacifiCorp becoming the county's largest taxpayer. Lease payments to landowners have helped revive many rural communities. It is estimated that this project created almost 200 jobs in direct, indirect, and induced spending.

BACKGROUND AND CONTEXT

The two wind farms, which went online in 2007 and 2008, encompass 117 turbines with an estimated 210 megawatts of generating capacity. The projects are owned and operated by PacifiCorp, one of the largest utilities in the western United States, serving Washington, Oregon, California, Utah, Wyoming, and Idaho. With a longstanding commitment to deploy renewable resources, PacifiCorp has 1,800 megawatts (MW) of wind, solar, and geothermal generating capacity, about 20 percent of its total generating portfolio.

The Marengo wind farms were sited in Columbia County due to their reliable and favorable wind resource. While the projects encompass more than 18,000 acres of privately held agricultural land, the footprint of each turbine is less than 0.25 acres, allowing farmers and ranchers in the area to continue using nearly all of their available acreage. Washington State has a goal of 15 percent renewable energy generation by 2020 and projects like the Marengo Wind farms are helping utilities reach that goal.

NEW INVESTMENT

PacifiCorp has invested $2 billion to expand its wind resources in the Northwest and elsewhere in its system.

JOB CREATION

The Marengo wind projects created an estimated 200 jobs in Columbia County.

The Marengo and Marengo II wind farms generate 210 MW of reliable power in Columbia County. Photo courtesy of PacifiCorp.

MAKING THE INVESTMENT

PacifiCorp has invested over $2 billion in wind energy projects. The Marengo wind farms utilize 117 Vestas wind turbine generators. Renewable Energy Systems Americas, Inc., under contract to PacifiCorp, completed the development of the Marengo wind projects creating an estimated 200 jobs in Columbia County through direct, indirect and induced spending. In addition, PacifiCorp pays yearly lease payments to landowners in Columbia County. By investing in wind energy as a cost effective and reliable technology, PacifiCorp has been able to provide some of the lowest cost electricity in the U.S. for its approximately 1.7 million customers.

TECHNOLOGY SPOTLIGHT: WIND POWER IN WASHINGTON STATE

Wind power is one of the fastest growing sources of electricity installation in the U.S. with more than 1,200 MW of new wind projects coming online in just the first 7 months of 2014.[19] Washington State ranks 9th in the nation for total installed wind generating capacity, with its approximately 2,800 MW of installed wind capacity, generating 6.2 percent of Washington's electricity.[20] The wind industry supports an estimated 2,000 in-state jobs, accounting for nearly $5.3 billion in capital investment.[21]

SEATTLE COMMUNITY SOLAR PROGRAM CREATES DEMAND FOR WASHINGTON SOLAR MANUFACTURERS

> "Solar energy has really taken off in Washington State due to state incentives, a growing interest by our customers in seeing more solar integration, and its affordability in the area. Almost 50 percent of Seattle's residents are renters. Community solar projects are a great way to allow them and others who cannot install solar themselves to encourage its deployment in Washington, at a price that works for them and sees a financial payback."
>
> ***SUZANNE DURARD***
> *COMMUNITY SOLAR PROGRAM MANAGER SEATTLE CITY LIGHT*

EXECUTIVE SUMMARY:

Seattle City Light brings solar power to residents who would otherwise not be able to install solar on their homes, completing its first community solar project in 2012. Residents can purchase a portion of a large solar array in their community and receive an incentive credit on their bill over time. This successful program has funded four projects totaling 175 kilowatts (kW). In addition, this program has helped spur investment in Washington's local solar manufacturing industry.

BACKGROUND AND CONTEXT

Seattle City Light, the public utility provider for Seattle, Washington, began its community solar program in 2009 after the state legislature adopted a renewable energy production incentive. Community solar is a resource that allows customers who cannot, or do not wish to, purchase an entire solar array but still want to invest in a solar system to do so.

Washington State provides incentives for community solar projects up to 75 kW, paying double the rate paid to non-community solar customers. For all solar incentives, a generous multiplier is added if the modules and inverters are made in the state, helping spur in-state solar manufacturing. Local residents can purchase units in the project for a cost of $150 each, and receive an estimated annual credit of $34 through 2020, resulting in a complete payback of the purchase price and a return on investment.

For community solar projects with made-in-Washington equipment, Washington State currently offers a $1.08 per kilowatt-hour (kWh) production incentive. City Light then adds an approximately $.08/kWh energy credit for the energy produced, for a total payment to participants of $1.16/kWh. Residents are credited based on the total number of kWh produced by their unit(s) in a given year. With four projects completed (the latest one is open for enrollment – all of the others have sold out), this program has been widely successful and popular among Seattle's residents. Units for the Seattle Aquarium community solar project sold out in less than six weeks. After the program expires in 2020, all solar systems will be gifted to the host sites, which lowers their operating costs for the remaining life of their systems. These well-publicized projects help educate Seattle residents on the benefits of solar, and help serve as catalysts for continued growth in the state's solar industry, which now employs an estimated 2,000 people.[22]

MAKING THE INVESTMENT

Seattle City Light carefully considers all potential locations for its community solar projects. The first project was completed in 2012 at Jefferson Park, located not far from downtown Seattle. The three solar picnic shelters generate approximately 26,000 kWh of clean and renewable electricity a year. When enrollment opened in September 2013 for the 44.4 kW solar array at the Seattle Aquarium, the 1850 shares sold out in just six weeks. It is estimated that each $150 investment in the Seattle Aquarium array will return $190 in electricity bill credits to customers by 2020.

Seattle City Light is adding more solar capacity each year and despite its cloudy reputation, Seattle is becoming a renewable energy leader through projects like City Light's community solar program. In the fall of 2014, Seattle City Light completed a 75 kW project at three sites in north Seattle, including two at the Woodland Park Zoo (the Phinney Ridge Project), and a 26 kW project on the roof of a low-income apartment building owned by Capitol Hill Housing, an affordable housing provider that helps those with limited means find affordable and secure housing. All projects use made-in-Washington State modules and inverters.

TECHNOLOGY SPOTLIGHT: SOLAR POWER

Not only does solar provide a clean and reliable power supply, it is also cost competitive with other renewable energy sources and in some cases, conventional fuels. The cost per kWh for solar power has fallen dramatically in the last decade. Nationally, the price for installing residential and business photovoltaic solar systems has dropped 39 percent compared to 2010 and in Washington State has seen nearly a 20 percent cost decline since 2012.[23] As a result, the state's solar industry has seen rapid growth, as in 2013 $44 million was invested in to install solar power for home, business, and utility use – an 88 percent increase over the previous year. There are more than 113 companies that work throughout the solar economy in Washington State.

RETURN ON INVESTMENT

It is estimated that each $150 share in the Seattle Aquarium array will return $190 in electricity bill credits to customers by 2020.

SPURRING IN-STATE MANUFACTURING

All Washington solar projects receive added incentives if the modules and inverters are manufactured in the state.

Seattle Aquarium's 44.4 kW solar array, part of the City Light Community Solar Program. Photo courtesy of Seattle City Light.

YOUNGS CREEK HYDROELECTRIC PROJECT PROVIDES RELIABLE AND AFFORDABLE POWER TO THOUSANDS

"We see small hydropower as a resource that's competitively priced, and often cheaper, compared to other green energy sources. These projects give us greater flexibility with our power supply as they're locally generated, reliable resources that provide energy at times of the year when it's needed the most."

SCOTT SPAHR
MANAGER OF GENERATION ENGINEERING, SNOHOMISH PUD

EXECUTIVE SUMMARY:

The Youngs Creek hydroelectric project in Snohomish County provides 7.5 megawatts (MW) of clean, reliable power to the local area. The project required a $29 million investment, creating dozens of construction jobs and eight permanent jobs. This small hydroelectric plant has a modest footprint of less than a quarter of an acre and is a vital energy resource for this rural community.

BACKGROUND AND CONTEXT

The Youngs Creek project represents the first hydroelectric power project built in the state in nearly 20 years, with operation starting in October of 2011. Snohomish County Public Utility District (PUD) anticipates its customer base will expand by up to 40 percent in coming years, and expects small hydroelectric projects to play a critical role in meeting growing power demand.

In line with the utility's 2007 climate change initiative, the PUD has decided to invest only in renewable energy sources. While hydroelectric power is not counted under the state's renewable energy portfolio standard, it does fit into the long-term renewable energy goals of the Snohomish County PUD.

NEW INVESTMENT, JOB CREATION

The project required a $29 million investment, creating dozens of construction jobs and eight permanent jobs

RELIABLE POWER

The 7.5 MW of power generated by the plant provides enough electricity for about 2,000 local homes.

The Youngs Creek 7.5 MW hydroelectric facility. Photo courtesy of Snohomish County PUD.

MAKING THE INVESTMENT

The Snohomish County PUD recognized the previously undeveloped dam as an opportunity to bring new investment to the county and help increase grid reliability. The land was purchased by the PUD in 2008 for $745,000, and the $29 million investment was financed through municipal bonds. The construction took 19 months and supported numerous engineering and construction jobs in the community. The project brought an additional $25,000 in sales tax revenue per year to the City of Sultan. The 7.5 MW of power generated by the plant provides enough electricity for about 2,000 local homes.

The Youngs Creek project has an incredibly small footprint of less than a quarter of an acre reservoir which feeds into a 14,300 foot long piping system with a vertical drop of almost 1000 feet. The water is then fed through two jet horizontal turbines which spin a generator and create power.

Newer hydroelectric plants, such as the Young Creek hydroelectric project, are often more affordable, reliable, and cost competitive than other renewable energy sources. Based on the economic success of the project, Snohomish County PUD is assessing several additional small hydropower sites for potential development over the next decade. These projects are expected to have generating capacity ranging between 2 to 30 MW. If fully developed, the collective energy output could serve tens of thousands of PUD customers. County officials expect that these projects could help reduce rates by reducing the utility's need to buy power from other sources.

BOUNDARY DAM POWERS ECONOMIC GROWTH IN PEND OREILLE COUNTY

"Hydroelectric power has always been an affordable resource here in Washington State. It is greenhouse gas neutral, highly reliable, and helps provide the perfect balance with wind and other renewable energy sources. Boundary Dam has been a strong and committed member of the local and state community for almost 50 years now. And we are always looking for new ways to invest in the community."

MIKE HAYNES
DIRECTOR OF POWER PRODUCTION, SEATTLE CITY LIGHT

EXECUTIVE SUMMARY:

Boundary Dam in Pend Oreille County has provided the urban Seattle area and rural Pend Oreille County with affordable, reliable energy since the 1960s. The project required a $93 million investment in 1967 and contributes an estimated $300,000 in annual taxes to Pend Oreille County. With 42 full-time employees, and clean, low-cost power supporting the local economy, Boundary Dam is a crucial economic driver in this community.

BACKGROUND AND CONTEXT

Hydroelectric power has a long history of providing reliable power in Washington State, and is currently meeting over 62 percent of the state's electricity needs. The Boundary Dam project has been operational since 1967, and in 1985, an additional 400 megawatts (MW) of generation capacity was added, bringing total generating capacity to 1,040 MW. The project is owned and operated by Seattle City Light, the 10th largest public electricity provider in the country, which is committed to generate all of its electricity from carbon neutral sources. The generated electricity is placed on the Bonneville Transmission system, helping to service the baseload requirements for the Northwest. In 2013 the Federal Energy Regulatory Commission approved a new 42-year license, allowing it to continue to provide up to 40 percent of Seattle's electricity needs.[24]

MAKING THE INVESTMENT

The Boundary Dam project required a total investment of $93 million in 1967. There are 42 full-time employees at the Boundary Dam and 10 seasonal employees that help manage the surrounding campgrounds and lake. In addition, the Dam generates an estimated $300,000 annually in sales and tax revenue for Pend Oreille County, and is one of the largest contributors to the county tax base. This revenue is used to support schools, nature preserves, and other municipal services in the area. Working alongside the Kalispel Tribe Career Center, Boundary Dam has helped create a training and apprenticeship program for those interested in the mechanical and electrical trades. Taking advantage of the nature trails and campsites around Boundary, nature enthusiasts represent an additional source of revenue for the local economy.

As part of the relicensing in 2013, City Light has committed to investing in new recreational trails along the dam's reservoir, improving and renovating boat launches, and building a new native fish conservation hatchery. According to Seattle City Light General Manager Jorge Carrasco, "final approval of the 42-year license is a critical economic benefit to City Light's customers and to Pend Oreille Public Utility District customers whose primary source of electricity is low-cost Boundary [Dam] power."[25]

TECHNOLOGY SPOTLIGHT: HYDROELECTRIC POWER

Nationwide, the hydroelectric power sector employs approximately 300,000 Americans, from project development to manufacturing to facilities operations and maintenance.[26] The U.S. currently has the world's second largest installed capacity of hydropower at approximately 100 gigawatts (GW), with significant potential for growth. A recent report from the U.S. Department of Energy estimates over 65 GW of potential new hydropower development across more than three million U.S. rivers and streams.[27]

ADDED TAX REVENUE

The Dam generates an estimated $300,000 annually in sales and tax revenue for Pend Oreille County, and is one of the largest contributors to the county tax base.

RELIABLE POWER

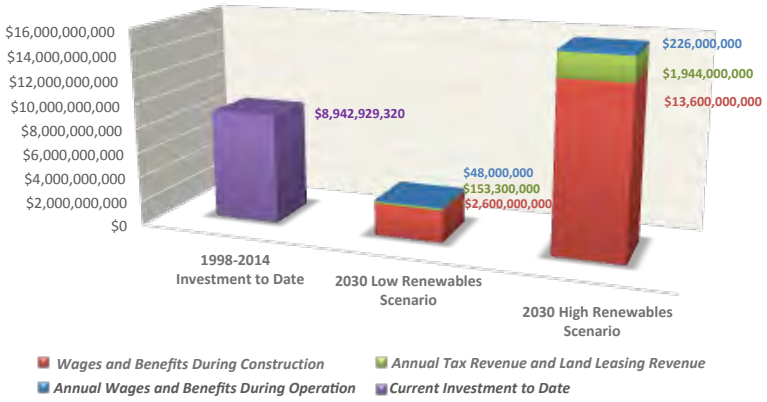
The project has a total generating capacity of 1,040 megawatts, enough to provide up to 40 percent of Seattle's electricity needs.

The 400 MW Boundary Dam has provided reliable power to Seattle for nearly 50 years. Photo courtesy of Seattle City Light.

WASHINGTON'S RENEWABLE FUTURE

Our key findings are listed in the summary table below (see Methodology section for data sources and methods used).

Current Investment and Potential Future Opportunities for Renewable Electricity in Washington

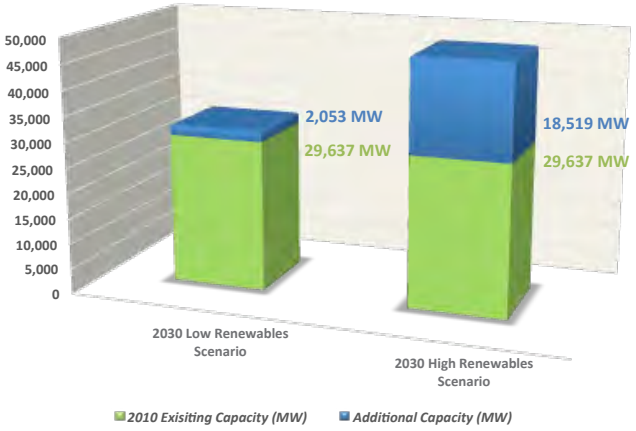


In a "High Renewables" scenario, Washington has the potential to attract over $15 billion more in wages and benefits during construction in addition to annual land leasing and tax revenue.

Jobs During Construction and Operation

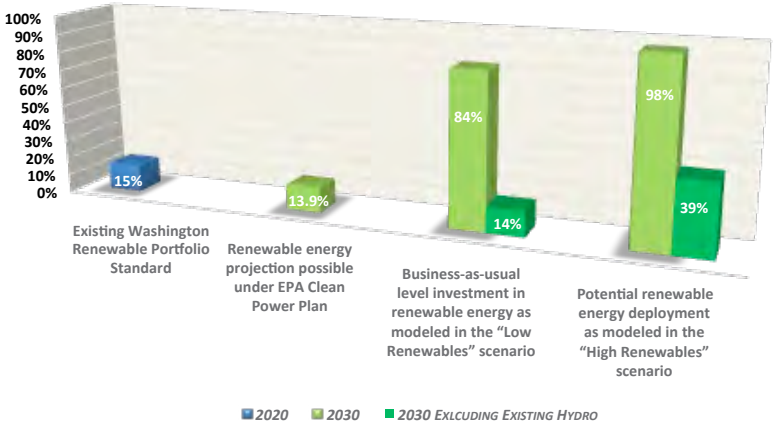
In a "High Renewables" scenario, Washington has the potential to create nearly 212,000 additional local jobs during construction and nearly 3,500 additional annual jobs committed to operations and maintenance.

Additional Installed Capacity (MW)



In a "High Renewables" scenario, Washington has the potential to supply over 98 percent of overall state electricity use from renewable electricity.

Potential Renewable Electricity Capacity



In our "High Renewables" case, renewable energy development (excluding existing hydroelectric power) would produce nearly three times as much renewable energy as EPA projected.

WASHINGTON'S RENEWABLE ELECTRICITY DEVELOPMENT POTENTIAL FAR EXCEEDS THE CLEAN POWER PLAN REQUIREMENTS

The EPA Clean Power Plan calls for Washington to reduce carbon dioxide emissions by 72 percent by 2030.[28] EPA based Washington's target on cuts through the following measures:

- A 3.7 percent reduction through increased efficiency of coal plants
- A 37.6 percent reduction through increased use of low-emitting natural gas combined cycle plants where excess capacity is available
- A 19.3 percent reduction through the use of more zero-emitting power sources such as renewable energy and nuclear power, and
- An 11.1 percent reduction through energy efficiency improvements to reduce electricity demand.[29]

Washington has a great deal of flexibility in developing its compliance plan, and may choose these or other carbon reduction strategies. A state could select a different balance among the approaches than EPA used to set the proposed emission reduction target.

Analysis from the Union of Concerned Scientists (UCS) demonstrates that even under a conservative growth scenario, states can achieve twice the renewable energy proposed by the EPA. According to UCS analysis, the Clean Power Plan does not sufficiently consider existing renewable energy deployment rates or the falling costs of renewable energy.[30]

Another recent analysis based on modeling by ICF International, a business management consulting firm, concludes that the EPA utilized outdated renewable energy cost considerations, including "levelized costs for both wind and solar energy that are 46 percent above current average costs".[31] The recent price drops in renewable energy will likely make the proposed rule less expensive to meet, and provide even greater opportunity for renewable energy development.

As demonstrated in the chart below, Washington also has the potential for significant renewable electricity development far beyond what is likely under the proposed standards. Developing those resources would attract substantial investment to the state and create thousands of new jobs.

Renewable energy projection possible under EPA Clean Power Plan[32]	**13.9% by 2030**
Existing Washington Renewable Portfolio Standard	**15% by 2020**
Business-as-usual level investment in renewable energy (excluding existing hydroelectric power) as modeled in the "Low Renewables" scenario	**14% by 2030**
Business-as-usual level investment in renewable energy as modeled in the "Low Renewables" scenario	**84% by 2030**
Potential renewable energy deployment (excluding existing hydroelectric power) as modeled in the "High Renewables" scenario	**39% by 2030**
Potential renewable energy deployment as modeled in the "High Renewables" scenario	**98% by 2030**

In the proposed Clean Power Plan, the EPA proposed a 2030 target emissions rate for each state. This target is based on EPA estimates of how each state could leverage a mix of measures, including adding new renewable electricity generation. States are not required to achieve EPA's renewable projections in order to comply with the proposed Clean Power Plan, or they may exceed them if cost-effective for the state. For Washington, EPA projects 13.9 percent renewable energy generation under the proposed rule by 2030.

Washington is well on its way to meet the EPA proposed target due to the state Renewable Portfolio Standard of 15 percent by 2020.

The "High Renewables" scenario modeled here and in the NREL *Renewable Electricity Futures* study would exceed the EPA proposed target nearly three-times over.[33]

RESEARCH METHODOLOGY

PURPOSE OF STUDY

David Gardiner and Associates (DGA) conducted this study for the Wind Energy Foundation and the A Renewable America campaign to assess the overall opportunity for renewable energy-based economic development in Washington.

METHODOLOGY

DGA modeled the economic effects of a renewable electricity future in 2030 for Washington based on two trajectories from the 2012 National Renewable Energy Laboratory (NREL) Renewable Electricity Futures (REF) study, the most comprehensive analysis of high-penetration renewable electricity in the United States to date.[34] That study involved a collaboration of more than 100 experts from 35 institutions representing national energy labs, academia, utilities, grid operators, industry, financial institutions, environmental groups and renewable energy businesses. It found that the United States could reliably meet at least 80 percent of its electricity needs from renewable energy resources by 2050, at a cost comparable with other scenarios for reducing harmful carbon dioxide (CO_2) and other power plant pollutants.

DGA features a "Low Renewables" and a "High Renewables" scenario based on updated 2014 results of the NREL Regional Energy Deployment System (ReEDS) model, completed by authors of the original REF study.[35]

- The "Low Renewables" scenario in this study is based on the "Low Demand Baseline" in the REF study. It assumes that electricity demand grows very slowly, and that no new renewable energy policies are enacted. Existing federal policies are assumed to expire as scheduled.
- The "High Renewables" scenario in this study is based on the REF "Core 80% RE scenario '80% RE-ITI'". It assumes that policies are enacted to achieve 49 percent of total contiguous U.S. electricity generation from renewable sources in 2030 and 80 percent in 2050, without specifying which of many policies could enable achieving that goal. It also assumes low electricity demand growth, and only incremental technology improvement (ITI) that reflects partial achievement of the future technical advancements that may be possible for each technology.

DGA did not utilize the scenario from REF that assumed a higher rate of "Evolutionary Technology Improvement", or scenarios that assumed "No Technology Improvement" or that assumed various potential constraints on renewable energy development, such as inadequate available renewable resources, inadequate transmission, or inadequate flexibility technologies, such as energy storage, needed to balance electricity demand with supply.[36] DGA also did not utilize REF scenarios with high energy demand, which would have produced higher levels of renewable energy development.

ReEDS calculates the mix of renewable energy and other technologies in each state that could meet the national renewable energy goals at the lowest total system cost.

DGA then calculated the economic development impacts of the five major renewable electricity technologies (biomass, geothermal, hydroelectric power, solar, and wind) using the NREL Jobs and Economic Development Impact (JEDI) model, with its generic default cost assumptions. JEDI was initially designed to estimate economic impacts of renewable energy to state economies, and later refined to focus on specific renewable energy projects. It includes both direct employment in the projects and their supply chains, and indirect and induced employment including wages and benefits spent in the state or local region.

The JEDI model is not a macroeconomic model, and does not calculate any offsetting reduction in employment in other parts of the economy, such as extracting fossil fuels. Many previous studies have found, however, that renewable energy technologies yield more employment per dollar or per megawatt than fossil fuel technologies, and thus lead to net increases in employment.[37]

DGA has also not calculated the economic benefits of other investments needed to enable the "High Renewables" scenario, such as upgrades to transmission and distribution systems, or the development of energy storage or other flexibility resources. ReEDS calculates that the "High Renewables" scenario would also be accompanied by 2,165 MW of electricity storage technologies by 2030.

While distributed generation solar photovoltaics are exogenous to the ReEDS model, which focuses primarily on utility-scale solar opportunities, the REF study utilized a separate model to represent rooftop solar PV deployment.

The REF study and JEDI model do not include specific estimates for waste-to-energy technology. We include an estimate of the technical potential for waste-to-energy expansion in the key findings section of the report, based on a recent study from Columbia University.[38] The growth assumptions for waste-to-energy in this report are based on the percent of municipal solid waste (MSW) used at waste-to-energy facilities in Europe (which process 25 percent of MSW using waste-to-energy facilities, as opposed to 7.6 percent in the United States). Unlike the ReEDS modeling for other technologies, that estimate is not based on any assessment of the economic competitiveness of waste-to-energy relative to other electricity generation technologies. Other studies, such as the U.S. Energy Information Administration Annual Energy Outlook, have found that significant expansion of waste to energy is unlikely under business-as-usual or with modest renewable energy or greenhouse gas reduction policies. Expanded use of waste-to-energy is possible under policies favorable to that technology, however.

APPENDIX

Total Renewable Electricity (Biomass, Hydroelectric, Solar, and Wind)	2030 High Renewables Scenario	2030 Low Renewables Scenario
Additional Installed Capacity	18,519 MW	2,053 MW
Local Jobs During Construction	211,893	27,266
Wages and Benefits During Construction	$13.6 billion	$2.6 billion
Annual Jobs During Operation	3,418	707
Annual Wages and Benefits During Operation	$226 million	$48 million
Annual Tax Revenue	$1.9 billion	$151 million
Annual Land Leasing Revenue	$44 million	$2.3 million
Wind (2,152 MW in 2010)	2030 High Renewables Scenario	2030 Low Renewables Scenario
Additional Installed Capacity	14,595 MW	753 MW
Local Jobs During Construction	55,189	2,848
Wages and Benefits During Construction	$3.7 billion	$193 million
Annual Jobs During Operation	1,693	87
Annual Wages and Benefits During Operation	$115 million	$6 million
Annual Tax Revenue	$1.8 billion	$97 million
Annual Land Leasing Revenue	$44 million	$2.3 million
Biomass (451 MW in 2010)	2030 High Renewables Scenario	2030 Low Renewables Scenario
Additional Installed Capacity	27 MW	27 MW
Local Jobs During Construction	47	47
Wages and Benefits During Construction	$4 million	$4 million
Annual Jobs During Operation	36	36
Annual Wages and Benefits During Operation	$2.29 million	$2.29 million
Hydroelectric Power (27,024 MW in 2010)	2030 High Renewables Scenario	2030 Low Renewables Scenario
Additional Installed Capacity	1,737 MW	1,273 MW
Local Jobs During Construction	46,918	34,370
Wages and Benefits During Construction	$3.2 billion	$2.4 billion
Annual Jobs During Operation	798	584
Annual Wages and Benefits During Operation	$54 million	$40 million
Annual Tax Revenue	$74 million	$54 million
Solar (10.1 MW in 2010)	2030 High Renewables Scenario	2030 Low Renewables Scenario
Additional Installed Capacity	2,160 MW	N/A*
Local Jobs During Construction	109,738	N/A*
Wages and Benefits During Construction	$6.7 billion	N/A*
Annual Jobs During Operation	892	N/A*
Annual Wages and Benefits During Operation	$55 million	N/A*

Both scenarios estimate an extremely limited deployment of geothermal in Washington.

*** NREL assumed no growth for distributed generation solar PV in the Low Renewables scenario.**

Separately, this report also reviewed the technical potential for waste-to-energy in Washington.

Waste-to-Energy (26 MW in 2014)	2030 Additional Capacity Potential
	150 MW

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LEAD AUTHORS:

David Gardiner and Associates – David Gardiner, Michael Grubert, Ryan Hodum, and Stefan Koester

LEAD CONTRIBUTORS:

David Gardiner and Associates – Alan Nogee

Wind Energy Foundation – John Kostyack, Robin Pressman, Todd Keller, Kevin O'Rourke

REPORT DESIGN:

Cater Communications, Inc. – Sarah Golden and Cristen Farley

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ABOUT THE ORGANIZATIONS

A RENEWABLE AMERICA

A project of the Wind Energy Foundation, a 501c3 nonprofit organization, *A Renewable America* provides education about the many benefits of American-made renewable electricity. A Renewable America raises public awareness of how each of the six major U.S. renewable electric technologies – biomass, geothermal, hydro, solar, waste-to-energy, and wind power – are already providing a substantial amount of clean, affordable, and reliable electricity. For more information, visit www.arenewableamerica.org.

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The Wind Energy Foundation is a 501c3 nonprofit organization dedicated to raising public awareness of wind as a clean, domestic energy source through communication, research, and education. The Foundation is also committed to supporting ongoing research that furthers the continued growth of wind energy. For more information, visit www.windenergyfoundation.org.

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