EVERGREEN ECONOMICS

# Community Renewable Energy Association (CREA) Oregon Wind and Solar Economic Impact Analysis

Final Report

October 4, 2018

# Table of Contents

# Executive Summary

In 2017, PacifiCorp completed its recent integrated resource plan (IRP) that outlines its proposed plans for investing in new renewable energy resources. As outlined in this plan, PacifiCorp proposes to develop the vast majority of the new renewable energy resources outside of Oregon, including adding wind resources in Wyoming (1,100 MW) and solar resources in Utah (1,040 MW). The IRP acknowledges that the addition of these new wind and solar resources will provide "extraordinary economic benefits" to the states where these projects are located.

One of PacifiCorp's main reasons for building these resources in Wyoming and Utah is that they are expected to provide lower cost electricity to Oregon ratepayers, compared to the scenario where they are built in Oregon. However, focusing only on the benefit of lower electricity costs ignores the additional potential benefits to Oregonians from constructing, operating, and maintaining these renewable resources within the state.

To address this issue, the Community Renewable Energy Association (CREA) contracted with Evergreen Economics to estimate the potential economic benefits of building and operating the wind and solar resources in Oregon rather than in Wyoming and Utah. Evergreen used the IMPLAN economic impact model to estimate the economic benefits of locating the wind and solar projects in Oregon, both during the Construction Phase and the ongoing Operations and Maintenance Phase. The IMPLAN model is widely used and has the advantage of providing detailed estimates across 440 different industry sectors. IMPLAN also relies on historical Oregon spending data to develop estimates of direct, indirect, and induced economic impacts that will result from this project.

Based on the IMPLAN model results, the economic benefits to Oregon for building and operating the proposed wind and solar resources within Oregon include the following:

- The creation of almost 4,000 jobs in Oregon and adding over $600 million in economic output to Oregon's economy during the Construction Phase.
- The creation and sustaining of over 120 jobs and almost $16 million in economic output to Oregon annually from the operations and maintenance of the wind and solar resources throughout the lifetime of these projects.

According to the IRP, building these resources in Oregon will increase costs to Oregon ratepayers by more than $141 million through high electricity rates. The economic impact analysis takes these increased costs into account and incorporates them into the total economic benefit estimate. Even with the additional costs, the project will still be a net gain to Oregon ratepayers when the expected benefits from the Construction Phase and the Operations and Maintenance Phase are both considered together.

# 1 Introduction

In 2017, PacifiCorp completed its recent integrated resource plan (IRP) that outlined its proposed plans for near-term investments in existing and new renewable resources. The IRP outlined PacifiCorp's plans to develop a vast majority of the new resources outside the state of Oregon, including adding wind resources in Wyoming and solar resources in Utah. Specifically, the plan discussed adding "1,100 MW of new Wyoming wind resources by the end of 2020" and "new solar resource additions totaling 1,040 MW," 77 percent of which will be located in Utah.[1] The IRP also acknowledges that the addition of these new wind and solar resources will provide "extraordinary economic benefits" to the states receiving the projects.

One of the primary reasons the IRP proposes the majority of new renewable production outside of Oregon is because of the lower cost per MWh of energy production. The IRP—and organizations such as the Oregon Public Utility Commission (OPUC) and the Oregon Citizens' Utility Board—have outlined how the increased capacity factor for new wind in Wyoming and the greater solar resources in Utah provide cost production benefits over Oregon. However, the benefits of the lower MWh production costs do not inherently account for the potential loss in economic benefits Oregonians may incur as a result of the generation projects being completed out of state.

To address these issues, the Community Renewable Energy Association (CREA) contracted with Evergreen Economics to evaluate the comparable economic impacts of PacifiCorp's proposed out-of-state resource procurement plan with an alternative plan that allocates approximately 25 percent of the resource acquisition to Oregon.[2] This report looks at the construction and ongoing operational cost inputs for both wind and solar projects being completed in Oregon and estimates the resulting economic impacts. These estimates also incorporate the effects of higher electricity rates for Oregon households and businesses that will result from constructing these renewable resources in Oregon.

[1] PacifiCorp, *2017 Integrated Resource Plan Volume I*, April 4, 2017.
[2] The allocation of 25.742 percent is based on PacifiCorp's allocation of resources to Oregon.

# 2 Impact Analysis Methodology

## 2.1 Input-Output Model Framework

Evergreen used the IMPLAN economic model to estimate short-term impacts of the wind and solar projects, both during the Construction Phase and the ongoing Operations and Maintenance Phase. The IMPLAN input-output model has several features that make it particularly well suited for estimating these short-term impacts.

- The IMPLAN model is widely used and well respected. IMPLAN is constructed with data assembled for national income accounting purposes, thereby providing a tool that has a robust link to widely accepted data development efforts.[3]
- The IMPLAN model's input-output framework and descriptive capabilities allow for the construction of economic models with region-specific data for 440 different industry sectors, as well as for households and government institutions. These details permit accurate mapping of project spending to industry and household sectors in the IMPLAN model.
- The IMPLAN model is constructed using historical economic data for the state of Oregon and therefore reflects the unique nature of its economy.

The IMPLAN model takes user-specified inputs (described below) and generates outputs of economic impact using multipliers based on actual historical economic data. The outputs include three types of economic effects:

- *Direct effects* are perhaps the most intuitive type of economic impact. They are driven by project spending and represent production changes brought by increases in final demand. For example, turbine construction expenditures increase final demand for concrete, rebar, and electrical engineering services.
- *Indirect effects* result from changes in the demand for "factor inputs" caused by project activities. Factor inputs are the main goods and services necessary for installation and operation of the turbines and photovoltaic (PV) generation, such as hand tools used during construction and regular maintenance. For instance, indirect effects account for any additional materials purchased or rented by the contractors

[3] The United States Department of Agriculture (USDA) recognized the IMPLAN modeling framework as "one of the most credible regional impact models used for regional economic impact analysis" and, following a review by experts from seven USDA agencies, selected IMPLAN as its analysis framework for monitoring job creation associated with the American Recovery and Reinvestment Act of 2009. See excerpts from an April 9, 2009 letter to MIG, Inc., from John Kort, Acting Administrator of the USDA Economic Research Service, on behalf of Secretary Vilsack, at www.implan.com.

hired to install the turbines. IMPLAN's input-output matrices capture these changes in demand and model the effects on all related industries.

- *Induced effects* result from the ways households and workers spend newfound money, from labor income, on general consumer goods and services. The term "induced" refers to the fact that these effects reflect impacts on industries that were not directly involved with the program or in supplying a program's factor inputs. For example, a wheat farmer may spend his or her new land lease income on a concert ticket. In this case, dollars flow to a completely unrelated industry (the entertainment industry), but are still attributed as an effect of the wind and solar projects.

## 2.2 Model Input Assumptions

Table 1 and Table 2 show the input assumptions for both the wind and solar resources that would be built in Oregon. The analysis assumes the Oregon wind resources will be built in counties traditionally utilized for wind resources (e.g., Morrow, Sherman, Gillam) and the solar resources will be built where current solar infrastructure is located (Eastern and Southeastern Oregon). A statewide IMPLAN model was used to estimate the economic impacts throughout Oregon, as workers will likely travel from outside the presumed wind and solar installation counties to complete construction and ongoing maintenance. The values for the wind projects were entered into IMPLAN using the same industry distribution as Evergreen Economics used in its wind turbine analysis completed as part of the Sherman County Wind Farm Economic Analysis project. For the solar projects, the inputs were allocated across industry sectors using the distribution found in the National Renewable Energy Laboratory's (NREL's) JEDI input-output model for concentrated solar power, modified as needed to better account for PV solar installations.

**Table 1: Oregon Wind Model Inputs**

| Parameter | Value | Sources |
|---|---|---|
| Original WY Project Size (MW) | 283 | Calculations based on 2017 IRP data |
| Equivalent Oregon Project Size (MW) | 348 | 2017 IRP, Table 6-2, Page 111 |
| Construction Costs ($/MW) | $1,692,091 | PacifiCorp Utility-Scale Wind Generation Study For The 2017 IRP, Table 7-1, Page 7-4 |
| Annual O&M Costs ($/MW) | $51,450 | PacifiCorp Utility-Scale Wind Generation Study For The 2017 IRP, Table 6-1, Page 6-2 |

| Parameter | Value | Sources |
|---|---|---|
| Total Construction Costs ($) | $588,847,636 | PacifiCorp Utility-Scale Wind Generation Study For The 2017 IRP, Table 7-1, Page 7-4 / 2017 PacifiCorp IRP calculations |
| Total Annual O&M Costs ($) | $17,904,600 | PacifiCorp Utility-Scale Wind Generation Study For The 2017 IRP, Table 6-1, Page 6-2 / 2017 PacifiCorp IRP calculations |
| nnual Payments to Landowners ($/MW) | $6,250 | PacifiCorp Utility-Scale Wind Generation Study For The 2017 IRP, Table 6-1, Page 6-2 |

**Table 2: Oregon Solar Model Inputs**

| Parameter | Value | Sources |
|---|---|---|
| Original UT Project Size (MW) | 268 | Calculations based on 2017 IRP data |
| Equivalent Oregon Project Size (MW) | 289 | 2017 IRP, Table 6-2, Page 111 |
| Construction Costs ($/MW) | $1,762,000 | 2017 PacifiCorp IRP |
| Annual O&M Costs ($/MW) | $16,520 | Literature review of NewEnergyUpdate, NREL and EPRI solar reports[4] |
| Total Construction Costs ($) | $509,993,280 | 2017 PacifiCorp IRP |
| Total Annual O&M Costs ($) | $4,774,280 | Literature review of NewEnergyUpdate, NREL and EPRI solar reports |

### 2.2.1 Construction Costs

The "installed construction costs" of a turbine or PV system include the purchase price of the equipment as well as all construction and installation costs. The following sections provide an overview of the assumed construction costs for the wind and solar projects.

[4] NewEnergyUpdate: PV, 2016 / NREL PV O&M Cost Model and Cost Reduction, 2017, Page 3 / EPRI Addressing Solar Photovoltaic Operations and Maintenance Challenges, 2010, Table 5, Page 8 / NREL Best Practices in PV System Operations and Maintenance, 2015, Page 25 / NREL Distributed Generation Renewable Energy Estimate of Costs, 2016, Table 1 / 2017 PacifiCorp IRP calculations

## Oregon Wind Construction Costs

To estimate the construction costs for the Oregon wind project, Evergreen Economics used cost estimates derived from NREL's 2015 Cost of Wind Energy Review, Evergreen's Sherman County Wind Farm Economic Analysis report and PacifiCorp's Utility-Scale Wind Generation Study for the 2017 IRP Report.[5,6] Table 3 shows how these cost estimates were split between the turbine equipment and construction portions of the "construction" inputs based on a per MW basis, and then extrapolated per turbine (2 MW) for the entire project capacity of 348 MW.

**Table 3: Assumed Construction Costs By Activity**

| Phase | Activity | Per MW | Per Turbine (2 MW) | All Turbines (348 MW) |
|---|---|---|---|---|
| Construction | Turbine Equipment | $1,222,091 | $2,444,182 | $425,287,636 |
| | Construction | $470,000 | $940,000 | $163,560,000 |
| | **Total** | **$1,692,091** | **$3,384,182** | **$588,847,636** |

The analysis for wind turbine equipment costs used NREL's JEDI wind model to estimate the relative proportion of costs across the different equipment categories that go into the finished turbine. These allocations are factored into the relative sectors in IMPLAN and help generate more industry-specific inputs and subsequent outputs. These categories include the turbines themselves, towers, transportation, blades, and controllers. The categories for the construction costs include the materials (concrete, steel and rebar, cranes, etc.) and the labor required for the installations.

## Oregon Solar Construction Costs

Construction cost estimates for the Oregon solar project were derived from cost assumptions provided in PacifiCorp's 2017 IRP. Evergreen Economics compared these cost estimates to other solar construction estimates completed by NREL and New Energy

[5] Christopher Mone and Maureen Hand, *2015 Cost of Wind Energy Review,* NREL, 2015.
[6] Black & Veatch, *Utility-Scale Wind Generation Study for the 2017 IRP: Wind Energy Design Basis and Cost Estimate Report,* July 2016.

Update and found similar results.[7,8] The assumed construction costs are outlined in Table 4 by activity.

**Table 4: Assumed Solar Construction Costs by Activity**

| Phase | Activity | Per MW | All PV (289 MW) |
|---|---|---|---|
| Construction | PV Equipment | $1,233,400 | $356,452,600 |
| | Construction | $299,540 | $86,567,060 |
| | Other (Project management, permitting, etc.) | $229,060 | $66,198,340 |
| | **Total** | **$1,762,000** | **$509,993,280** |

## 2.2.2 Operating and Maintenance Costs

### *Oregon Wind Operating and Maintenance Costs*

Similar to the construction costs, the operating and maintenance cost analysis based the per MW cost assumptions on the previous Sherman County research, NREL's 2015 Cost of Wind Energy Report and PacifiCorp's Wind Generation Study. Table 5 below shows the total operations and maintenance costs by activity. These activities include:

- *Land Lease Payments.* The annual average value paid out to landowners where the turbines are located.
- *Taxes & Fees*. Property tax estimates for the property where the wind turbines would be installed.
- *Resident Incentives.* Though residents do not receive all the revenue from the wind turbines, counties with large wind production, such as Sherman County, sometimes issue payments to all households as a dispersal of revenue. These payments come from increased county revenue from fees paid by turbine owners in lieu of property taxes and are intended to help offset any negative impacts the turbines might have on residents (obstructed views, added noise, etc.). Previous examples of these

[7] NREL, *Distributed Generation Renewable Energy Estimate of Costs.* 2016. www.nrel.gov/analysis/tech-lcoe-re-cost-est.html

[8] New Energy Update, *Innovations in solar plant assembly drive costs towards $1 per watt in 2017*. 2017. http://analysis.newenergyupdate.com/pv-insider/innovations-solar-plant-assembly-drive-costs-towards-1-watt-2017

incentive payments have included checks distributed directly to households through the mail.

- *Other O&M.* Costs related to labor (salaries, administrative, project management) and materials and services (site maintenance, fees, utilities, insurance, etc.)

**Table 5: Assumed Operations and Maintenance Costs by Activity**

| Phase | Activity | Per MW | Per Turbine (2 MW) | All Turbines (348 MW) |
|---|---|---|---|---|
| Operations | Land Lease | $6,250 | $12,500 | $2,175,000 |
| | Taxes & Fees | $9,529 | $19,058 | $3,316,092 |
| | Resident Incentives | $405 | $810 | $140,940 |
| | Other O&M | $35,266 | $70,532 | $12,272,568 |
| | **Total** | **$51,450** | **$102,900** | **$17,904,600** |

### *Oregon Solar Operating and Maintenance Costs*

The operating and maintenance costs were estimated using a variety of sources including NREL, New Energy Update, and the Electric Power Research Institute (EPRI).[9] Based on the average of these sources, the analysis estimated annual maintenance costs of $16,520 per MW. Using the assumed project size of approximately 289 MW, the total annual operating and maintenance costs were estimated to be $4,774,280.

## 2.2.3 Summary of Model Inputs

**Based on the cost assumptions outlined above, Table 6 and**

[9] A complete list of sources used for cost estimates can be found in Appendix A.

Table 7 provide the final assumed total costs for each category of expenditure for both the wind and solar projects.

**Table 6: Assumed Total Wind Costs by Phase and Activity**

| Phase | Activity | Per MW | Per Turbine (2 MW) | All Turbines (348 MW) |
|---|---|---|---|---|
| Construction | Turbine Equipment | $1,222,091 | $2,444,182 | $425,287,636 |
| | Construction | $470,000 | $940,000 | $163,560,000 |
| Operations and Maintenance | Land Lease | $6,250 | $12,500 | $2,175,000 |
| | Taxes & Fees | $9,529 | $19,058 | $3,316,092 |
| | Resident Incentives | $405 | $810 | $140,940 |
| | Other O&M | $35,266 | $70,532 | $12,272,568 |
| | **Total** | **$1,743,541** | **$3,487,082** | **$606,752,236** |

Table 7: Assumed Total Solar Costs by Phase and Activity

| Phase | Activity | Per MW | All PV (289 MW) |
|---|---|---|---|
| Construction | PV Equipment | $1,233,400 | $356,452,600 |
| | Construction | $299,540 | $86,567,060 |
| | Other (Project management, permitting, etc.) | $229,060 | $66,198,340 |
| Operations and Maintenance | Total O&M | $6,250 | $2,175,000 |
| | **Total** | **$1,768,250** | **$511,393,000** |

# 3 Economic Impact Results

The model inputs outlined in Section 2 were entered into the IMPLAN model to estimate the economic impacts that would occur in Oregon. Note that this analysis uses the 2012 IMPLAN model for Oregon. Impacts are estimated for both the one-time Construction Phase and the annual Operations and Maintenance (O&M) Phase for both resources.

Based on these inputs, the estimated economic impacts are shown below for the Construction Phase and for the Operations and Maintenance Phase. The economic impacts are categorized into the following metrics:

- ***Jobs.*** A job-year in IMPLAN is equivalent to the annual full-time-equivalent (FTE) jobs in a given industry. In other words, one job-year is equivalent to one person being employed for a full year or two people being employed for half a year each.
- ***Economic output.*** The value of production for a specified period of time, output is the broadest measure of economic activity, and includes intermediate goods and services and the components of value added (personal income, other income, and indirect business taxes).
- ***Personal income.*** This represents the total payroll cost of the employee paid by the employer, and includes wages and salary, all benefits (e.g., health, retirement) and payroll taxes (Social Security, unemployment taxes, etc.).
- ***Business income.*** Also called proprietary income (or small business income), business income represents the payments received by small-business owners or self-employed workers.
- ***Other property type income.*** Income derived from dividends, royalties, corporate profits, payments for rent, and interest income. This other property type income provides a source of income for households, businesses, and governments.
- ***Tax revenue.*** A summary of the state and local taxes. The state and local taxes are corporate dividends, social insurance tax on employee compensation, taxes on production (sales, property, licensing, other), corporate profits tax, and household taxes (income tax, fines/fees, vehicle licensing, fishing/hunting, etc.).[10]

## 3.1 Construction Phase Impacts

The Construction Phase consists of the initial equipment purchase, siting, permitting, legal services, administrative activities, and actual construction and installation of the wind turbines and PV equipment. These are one-time benefits that occur only during the

[10] The impacts do not account for an increase in property tax revenue resulting from the wind and solar installations.

construction period. Below, Table 8 outlines the wind construction economic benefits, Table 9 the solar wind construction economic benefits, and Table 10 the combined construction economic benefits from both wind and solar projects (Sum of Table 8 and Table 9).

**Table 8: Wind Construction Economic Benefits**

| Economic Impact Metric | Direct | Indirect | Induced | Total |
|---|---|---|---|---|
| Jobs | 793 | 335 | 381 | 1,509 |
| Economic Output | $128,094,047 | $51,225,499 | $49,887,522 | $229,207,068 |
| Personal Income | $38,127,641 | $16,203,723 | $14,944,736 | $69,276,101 |
| Business Income | $8,802,074 | $2,919,308 | $2,244,516 | $13,965,898 |
| Other Property Type Income | $8,531,511 | $7,508,321 | $9,916,185 | $25,956,018 |
| Tax Revenue | | | | $12,410,577 |

**Table 9: Solar Construction Economic Benefits**

| Economic Impact Metric | Direct | Indirect | Induced | Total |
|---|---|---|---|---|
| Jobs | 1,307 | 533 | 649 | 2,488 |
| Economic Output | $216,791,945 | $87,314,282 | $85,031,511 | $389,137,738 |
| Personal Income | $68,394,233 | $25,774,232 | $25,472,524 | $119,640,989 |
| Business Income | $13,501,436 | $5,068,048 | $3,825,784 | $22,395,268 |
| Other Property Type Income | $14,068,407 | $13,635,388 | $16,902,722 | $44,606,518 |
| Tax Revenue | | | | $15,424,213 |

Table 10: Wind and Solar Combined Construction Economic Benefits

| Economic Impact Metric | Direct | Indirect | Induced | Total |
|---|---|---|---|---|
| Jobs | 2,100 | 868 | 1,030 | 3,998 |
| Economic Output | $344,885,992 | $138,539,781 | $134,919,033 | $618,344,806 |
| Personal Income | $106,521,874 | $41,977,955 | $40,417,260 | $188,917,089 |
| Business Income | $22,303,510 | $7,987,356 | $6,070,300 | $36,361,166 |
| Other Property Type Income | $22,599,918 | $21,143,709 | $26,818,907 | $70,562,534 |
| Indirect Business Taxes (IBTs) | $3,574,708 | $4,976,650 | $8,086,417 | $16,637,775 |
| Tax Revenue | | | | $27,834,790 |

## 3.2 Operating and Maintenance Phase Impacts

Once the Construction Phase is completed, the Operations and Maintenance Phase begins and consists of all activities needed to operate and maintain the wind turbines and PV equipment. This phase includes land lease payments, operations and maintenance expenditures (administrative activities, turbine maintenance, and electricity transmission), and resident incentive payments.[11] These impacts will be experienced every year that all of the turbines and PV systems are operational, but are estimated below in Table 11 (wind only), Table 12 (solar only), and Table 13 (combined wind and solar) as one-time annual economic benefits.

[11] Land lease payments and resident incentive payments estimated only for the proposed wind turbine project.

### Table 11: Wind Annual O&M Economic Benefits

| Economic Impact Metric | Direct | Indirect | Induced | Total |
|---|---|---|---|---|
| Jobs | 34 | 11 | 33 | 78 |
| Economic Output | $3,933,928 | $1,401,128 | $4,317,586 | $9,652,641 |
| Personal Income | $1,676,854 | $488,069 | $1,292,310 | $3,457,233 |
| Business Income | $221,832 | $74,655 | $194,767 | $491,253 |
| Other Property Type Income | $309,731 | $202,914 | $863,462 | $1,376,107 |
| Tax Revenue | | | | $524,614 |

### Table 12: Solar Annual O&M Economic Benefits

| Economic Impact Metric | Direct | Indirect | Induced | Total |
|---|---|---|---|---|
| Jobs | 27 | 8 | 11 | 46 |
| Economic Output | $3,748,355 | $1,110,779 | $1,468,387 | $6,327,520 |
| Personal Income | $1,234,067 | $372,247 | $439,883 | $2,046,197 |
| Business Income | $279,677 | $61,897 | $66,065 | $407,639 |
| Other Property Type Income | $878,372 | $185,977 | $291,872 | $1,356,221 |
| Tax Revenue | | | | $334,166 |

### Table 13: Combined Wind and Solar O&M Economic Benefits

| Economic Impact Metric | Direct | Indirect | Induced | Total |
|---|---|---|---|---|
| Jobs | 61 | 19 | 44 | 124 |
| Economic Output | $7,682,283 | $2,511,907 | $5,785,973 | $15,980,161 |
| Personal Income | $2,910,921 | $860,316 | $1,732,193 | $5,503,430 |
| Business Income | $501,509 | $136,552 | $260,832 | $898,892 |
| Other Property Type Income | $1,188,103 | $388,891 | $1,155,334 | $2,732,328 |
| Tax Revenue | | | | $858,780 |

# 4 Incremental Cost Calculations

## 4.1 Differences in Capital Costs Across States

Based on PacifiCorp's 2017 IRP, Oregon's wind and solar capacity factors are lower than the comparable Wyoming and Utah capacity factors. As a result, the Oregon wind and solar projects require a higher amount of MW capacity for the equivalent amount of MWh production. These higher MW capacity requirements, along with higher capital cost rates, make the total capital costs for comparable wind and solar projects in Oregon greater than the capital costs in Wyoming or Utah.

Table 14 shows the difference in capital costs between Oregon and Wyoming/Utah for both resources, assuming the projects are sized so that generating capacity is equivalent between states (see Table 1 and Table 2). The combined effect will be an increase in costs of $145,237,916, which will eventually be borne by Oregon ratepayers through higher electricity rates.

**Table 14: Differences in Capital Costs Across States**

| Project | Oregon Capital Costs | Wyoming Capital Costs (wind) | Utah Capital Costs (solar) | Difference |
|---|---|---|---|---|
| Wind | $588,847,636 | $491,571,000 | - | $97,276,636 |
| Solar | $509,993,280 | - | $462,032,000 | $47,961,280 |
| **Total** | | | | **$145,237,916** |

To estimate the potential impacts of these incremental capital costs passed down to Oregon ratepayers, we completed a second IMPLAN model using the incremental cost difference as the model input. The impacts from this incremental cost model provide an estimate of the negative economic impacts that would result from these higher construction costs. These impacts, combined with the positive economic benefits from the Construction and Operations and Maintenance Phases, provide a more comprehensive picture of the potential impacts that may result from the wind and solar projects being completed in Oregon.

## 4.2 Incremental Cost Model Inputs

The incremental cost differences outlined above served as the primary inputs for the incremental cost model. The costs were allocated across the residential, commercial, and industrial ratepayer markets with individual input/output models completed for each

market. The analysis used load forecast sales data from PacifiCorp's IRP to estimate the relative percentage of the incremental costs that would be passed along to different customer segments. Table 15 shows the costs by ratepayer segment.

**Table 15: Incremental Costs by Ratepayer Market**

| | Residential | Commercial | Industrial | Total |
|---|---|---|---|---|
| Percentage of incremental costs | 42.3% | 40.9% | 14.1% | |
| Incremental costs for wind | $41,148,017 | $39,766,689 | $13,716,006 | $94,630,712 |
| Incremental costs for solar | $20,287,621 | $19,606,571 | $6,762,540 | $46,656,733 |
| **Total** | **$61,435,638** | **$59,373,260** | **$20,478,546** | **$141,287,445** |

### 4.2.1 Residential Market Inputs

Using IMPLAN, the residential market inputs were categorized across the varying Census income brackets. The percentage of households per income bracket, as shown in Table 16, was estimated based on Census data for Sherman, Gillam, and Morrow counties in Oregon (the counties with the highest concentration of current wind generation). The estimated $61,435,638 of incremental costs passed down to residential ratepayers was distributed based on the percentage of households in each income bracket.

Table 16: Household Income Brackets and Allocated Costs

| Income Bracket | Percentage of Households | Allocated Costs |
|---|---|---|
| Less than $10,000 | 5% | $2,958,848.76 |
| $10,000 to $14,999 | 5% | $3,376,701.45 |
| $15,000 to $24,999 | 11% | $7,058,322.43 |
| $25,000 to $34,999 | 14% | $8,560,333.45 |
| $35,000 to $49,999 | 12% | $7,385,828.60 |
| $50,000 to $74,999 | 23% | $14,432,857.71 |
| $75,000 to $99,999 | 13% | $8,063,427.55 |
| $100,000 to $149,999 | 12% | $7,476,175.12 |
| $150,000 to $199,999 | 2% | $1,050,278.38 |
| $200,000 or more | 2% | $1,072,865.01 |
| **Total** | **100%** | **$61,435,638.47** |

### 4.2.2 Commercial Market Inputs

For the commercial market inputs, the allocated incremental costs were distributed across the IMPLAN 440 sector codes that represented commercial industries. To distinguish between commercial and industrial sectors, Evergreen Economics used the NAICS code-description data, which segment industries into "goods-producing" (such as manufacturing and construction) and "service-providing" (such as trade and information industries). For the analysis, the commercial market included all NAICS industries that were categorized as "service-providing," while the goods-producing industries were used in the industrial model (outlined below). The NAICS industry codes were then mapped to the IMPLAN 440 sector codes using the IMPLAN sectoring tool.[12]

The $59,373,260 in incremental costs allocated to the commercial market were distributed to the various commercial industries based on their relative output (measured in US dollars) within the commercial market. For example, IMPLAN Sector 329 – "Retail –

[12] https://implanhelp.zendesk.com/hc/en-us/articles/115009674428-IMPLAN-Sectoring-NAICS-Correspondences

General Merchandise" – accounted for approximately 1.2 percent of the total output generated from the commercial market and thus received 1.2 percent of the incremental costs.

### 4.2.3 Industrial Market Inputs

Similar to the commercial market inputs, the industrial market inputs distributed the allocated incremental costs for the industrial market across the corresponding IMPLAN 440 sector codes based on relative industry output. These sectors included all goods-producing sectors as defined by the NAICS coding system. The incremental costs for the industrial market were significantly smaller than for the residential and commercial markets, with a total of $29,478,546.

## 4.3 Incremental Cost Model Impacts

Using the incremental cost inputs outlined above, Evergreen Economics estimated the negative economic impacts from the increased capital costs associated with completing the wind and solar generation projects in Oregon versus Wyoming or Utah. Table 17 shows the combined "negative" economic impacts across the residential, commercial, and industrial ratepayer segments. While the negative economic impacts from the increased capital costs would most likely be passed down to Oregonians through increased rates over the course of multiple years, the combined impacts presented below are summarized as a one-time total impact, similar to the O&M benefits outlined in Table 13.

**Table 17: Combined Incremental Cost Model Impacts**

| Economic Impact Metric | Direct | Indirect | Induced | Total |
|---|---|---|---|---|
| Jobs | 464 | 152 | 712 | 1,329 |
| Economic Output | $72,645,508 | $22,788,035 | $93,509,287 | $188,942,830 |
| Personal Income | $22,066,827 | $6,821,099 | $27,957,971 | $56,845,897 |
| Business Income | $2,741,647 | $1,220,627 | $4,232,910 | $ 8,195,184 |
| Other Property Type Income | $12,530,240 | $3,950,750 | $18,747,836 | $35,228,826 |
| Indirect Business Taxes (IBTs) | $1,962,305 | $922,098 | $5,622,176 | $8,506,579 |
| Tax Revenue | | | | $10,407,974 |

# 5 Combined Economic Impact Results

The combined economic impact results are generated using the impact results outlined in the previous chapters, and are intended to more accurately reflect the true economic impacts of the Oregon wind and solar projects with consideration for the increased customer rates. The combined economic impacts are estimated using the following formula:

Combined Economic Impacts = (Construction Impacts + O&M Impacts) – Incremental Cost Model Impacts

Table 18 below outlines the estimated combined economic impacts for the combined wind and solar projects using the above formula. The combined economic impacts represent the combined construction impacts (Table 10) and the combined O&M impacts (Table 13) subtracting out the incremental cost impacts (Table 17). Despite the additional $141,287,445 in incremental costs, the overall impacts are still positive and reflect an overall economic gain as a result of the wind and solar installations.

**Table 18: Combined Economic Impacts for Wind and Solar Generation Projects**

| Economic Impact Metric | Direct | Indirect | Induced | Total |
|---|---|---|---|---|
| Jobs | 1,697 | 735 | 362 | 2,793 |
| Economic Output | $279,922,767 | $118,263,653 | $47,195,719 | $445,382,137 |
| Personal Income | $87,365,968 | $36,017,172 | $14,191,482 | $137,574,622 |
| Business Income | $20,063,372 | $6,903,281 | $2,098,222 | $29,064,874 |
| Other Property Type Income | $11,257,781 | $17,581,850 | $9,226,405 | $38,066,036 |
| Indirect Business Taxes (IBTs) | $1,612,403 | $4,054,552 | $2,464,241 | $8,131,196 |
| Tax Revenue | - | - | - | $18,285,596 |

# 6 Conclusion

As outlined in Table 18, the economic analysis for the proposed wind and solar projects estimated a positive economic impact for the state of Oregon including job creation, personal income, business income, other tax revenue, and overall economic output. The analysis accounted for the positive economic gains that would come from the construction of the wind and solar resources (Table 10), along with the positive economic gains of ongoing operations and maintenance for the resources (Table 13), while taking into account the increased costs passed down to Oregonians through increased rates (Table 17).

Based on the IMPLAN model results, the economic benefits to Oregon for building and operating the proposed wind and solar resources within Oregon include the following:

- The creation of almost 4,000 jobs in Oregon and adding over $600 million in economic output to Oregon's economy during the Construction Phase.
- The creation and sustaining of over 120 jobs and almost $16 million in economic output to Oregon annually from the operations and maintenance of the wind and solar resources throughout the lifetime of these projects.

According to the IRP, building these resources in Oregon will increase costs to Oregon ratepayers by more than $141 million through high electricity rates. The economic impact analysis takes these increased costs into account and incorporates them into the total economic benefit estimate. Even with the additional costs, the project will still be a net gain to Oregon ratepayers when the expected benefits from the Construction Phase and the Operations and Maintenance Phase are both considered together.

# Appendix A: References


Black & Veatch, prepared for PacifiCorp. 2016. *Utility-Scale Wind Generation Study for the 2017 IRP: Wind Energy Design Basis and Cost Estimate Report.* https://www.pacificpower.net/content/dam/pacific_power/doc/About_Us/Rates_Regulation/Oregon/Regulatory_Filings/Docket_No_UM_1794/10-14-16_Opening_Testimony_and_Exhibits/Brian_S_Dickman/exhibits/Exhibit_PAC_102.pdf

Electric Power Research Institute (EPRI). 2010. *Addressing Solar Voltaic Operations and Maintenance Challenges: A Survey of Current Knowledge and Practice*. http://assets.fiercemarkets.net/public/smartgridnews/1021496AddressingPVOaMChallenges7-2010_1_.pdf

Mone, Christopher, M. Hand, M. Bolinger, J. Rand, D. Heimiller, and J. Ho. 2015. *2015 Cost of Wind Energy Review*. National Renewable Energy Laboratory (NREL).

National Renewable Energy Laboratory (NREL). 2016. "Distributed Generation Renewable Energy Estimate of Costs." https://www.nrel.gov/analysis/tech-lcoe-re-cost-est.html

New Energy Update: PV. 2016. "US solar market boom cuts O&M costs years ahead of forecast." http://analysis.newenergyupdate.com/pv-insider/us-solar-market-boom-cuts-om-costs-years-ahead-forecast

PacifiCorp. *2017 Integrated Resource Plan Volume 1*. 2017. https://www.pacificorp.com/content/dam/pacificorp/doc/Energy_Sources/Integrated_Resource_Plan/2017_IRP/2017_IRP_VolumeI_IRP_Final.pdf

Walker, Andy. 2017. *PV O&M Cost Model and Cost Reduction*. National Renewable Energy Laboratory (NREL). Presented at the 2017 Photovoltaic Module Reliability Workshop, 2017. https://www.nrel.gov/docs/fy17osti/68023.pdf

Wiser, Ryan and M. Bolinger (NREL). 2017. *2016 Wind Technologies Market Report*. US Department of Energy Office of Energy Efficiency & Renewable Energy.