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MADE IN OREGON: A CASE STUDY EXAMINING THE IMPACTS IN OREGON OF LOCAL PURCHASING AND MANUFACTURING OF SOLAR PHOTOVOLTAICS

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prepared for:

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Summary of Findings

This case study is being conducted in response to a question posed at a State of Oregon Legislative Joint Tax Credit Committee Hearing on May 17, 2011, as well as a Governor of Oregon request, to examine the effects of in-state versus out-of-state sourcing of solar photovoltaic projects (solar PV). Specifically, this analysis examines the regional economic impacts of a large, multi-facility solar PV project using standard modeling assumptions about in-state sourcing, and compares it to a scenario with 100 percent in-state sourcing of materials (solar panels, inverters, etc.).

Case Study

As a case study, this analysis focuses on the Oregon University System (OUS) multi-facility solar project. This project specifically targets locally sourced materials and labor. The total certified costs of project are $27.1 million. This analysis uses the Jobs and Economic Development Impact Solar Model (JEDI)[1] as its central tool, and compares results to outputs from the standard IMPLAN (Input-Output for PLANning) model. JEDI allows for more detailed input assumptions related to solar PV projects than exist in the standard IMPLAN model, while drawing on IMPLAN multipliers (i.e., assumptions about the ripple effects of expenditures within and outside of the State).

Findings

Overall, this analysis supports the hypothesis that increased local sourcing increases the economic impacts of a project on the Oregon economy. Key findings are as follows:

- As discussed above, the key variables that change between the Low Scenario and the High Scenario are assumptions about whether the materials, which together comprise approximately 60 percent of total project installation and construction costs of the OUS project, are purchased or manufactured locally.
- This analysis finds that local sourcing would produce an increase in local employment demand from 238 to 400 worker-years over the life of the OUS project.
- Thus, local sourcing would increase employment demand in Oregon by six worker-years (from 8.8 to 14.8 worker-years) per million dollars of expenditures on the OUS project, which represents an increase of 72 percent over a scenario where little manufacturing or purchasing occurs locally (Low Scenario).
- Similar trends can be observed related to labor income, which increases from $11.1 million to $21.6 million with local sourcing.
- Thus, local sourcing would increase local labor income by $331,000 per million dollars of project expenditures (a 75 percent increase over the Low Scenario).
- Under any scenario, the majority of employment effects are related to the installation and construction phase of the project. JEDI and IMPLAN model results are similar for labor demand impacts.

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[1] U.S. Department of Energy, National Renewable Energy Laboratory, JEDI Solar Model PV Model rel NG1.11.01, available at: http://www.nrel.gov/analysis/jedi/download.html , accessed February 2012.

Recommendations

For future study, consideration of local sourcing, and the extent to which government investment encourages development of local industries over time, represent metrics that should continue to be evaluated. As adoption of alternative energy sources and implementation of more efficient systems continues, the long-term success of government investments may be measured better by a program impact evaluation framework that considers both the net changes in energy use and production, and the extent to which new systems provide long-term production and job benefits for the State.

Purpose of Case Study

This analysis is a follow up to a previous study we conducted for the State of Oregon, in which we found that while Business Energy Tax Credits (BETCs) played a significant role in enabling the solar photovoltaic (solar PV) projects we analyzed, solar PV projects resulted in relatively small regional economic benefits overall.[2] We generally attributed this result to the assumption that most project materials (modules, inverters, etc.) were purchased and manufactured outside of Oregon. We noted that the regional economic impact would be greater if installations relied more heavily on the use of materials manufactured in-state. This study is being conducted in response to a question posed at a State of Oregon Legislative Joint Tax Credit Committee Hearing on May 17, 2011, as well as a Governor of Oregon request to more closely examine the effects of in-state versus out-of-state sourcing of solar PV projects.

Specifically, the intent of this analysis is to examine the regional economic impacts of a large, multi-facility solar PV project using standard modeling assumptions about in-state sourcing, and to compare it to a scenario with 100 percent in-state sourcing of materials (solar panels, inverters, etc.). As a case study, this analysis focuses on the Oregon University System (OUS) multi-facility solar project, which received seven BETCs in 2010. **This project specifically targets locally sourced materials and labor**.

Case Study in Context: Brief Overview of Solar Projects in Oregon

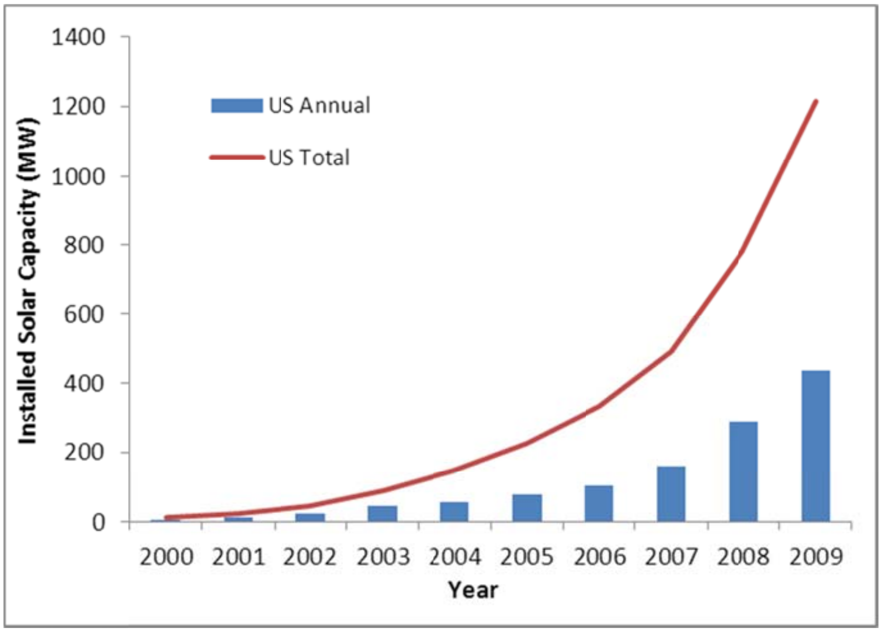
Energy conservation and the development of renewable energy resources has been a policy priority in Oregon for more than 30 years. In 1979, Oregon established the BETC program as part of Oregon's specific policy responses. The program, under the direction of the Oregon Department of Energy (ODOE), intends to provide Oregon businesses with an incentive to invest in energy conservation measures and renewable energy projects.

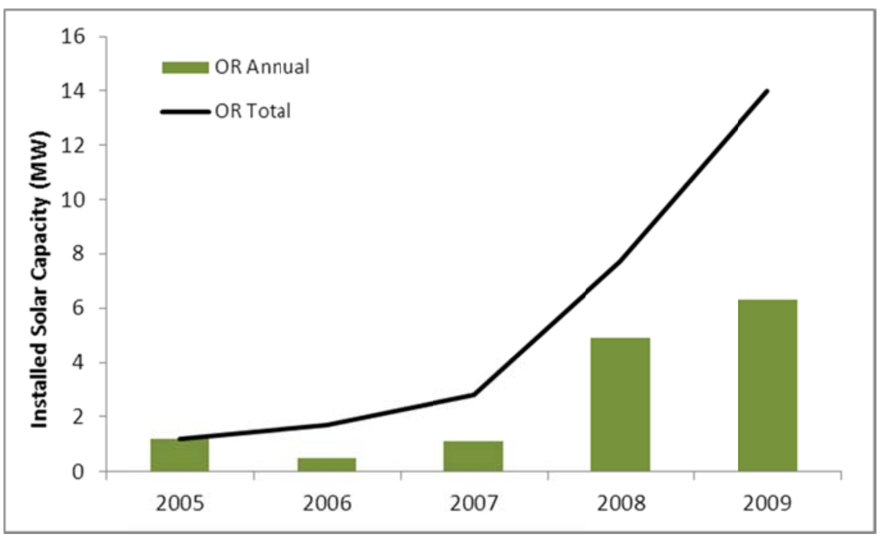
Solar PV capacity in Oregon is growing at a fairly significant rate that mirrors the national trend (Exhibit 1). At 4.99 MW, the OUS project that is the focus of this case study would increase Oregon's installed capacity for solar energy projects by approximately 20 percent over 2010 levels. Because of its large capital requirements, the solar PV industry is inherently risky, and has been somewhat volatile. However, the nature and degree of volatility depends on the market sector. The risk in the manufacturing segment is driven by foreign as well as domestic competition, while installation and financing operations face uncertainties and risk regarding manufacturing as well as government policies.

[2] Industrial Economics, Inc. "Financial and Economic Impact of the Oregon Business Energy Tax Credit: An Analysis of Representative Projects Certified During the Period 2002 to 2009: Final Report." Under contract to the Oregon Department of Energy, May 26, 2011.

Exhibit 2 shows that the national average cost to produce solar energy has been decreasing over time on a per-watt basis. At a cost of approximately $5.42 per watt, the OUS project costs appear to be consistent, and on the low end, of costs per watt on a nationwide level. However, according to Portland General Electric, the current expected range of residential costs per watt in Oregon is $3.50 to $5.00 in 2012.[3] This would suggest that the OUS project may be at the higher end of costs on a per-watt basis in Oregon.

EXHIBIT 1. ANNUAL AND CUMULATIVE GRID-TIED SOLAR PV CAPACITY, US AND OREGON

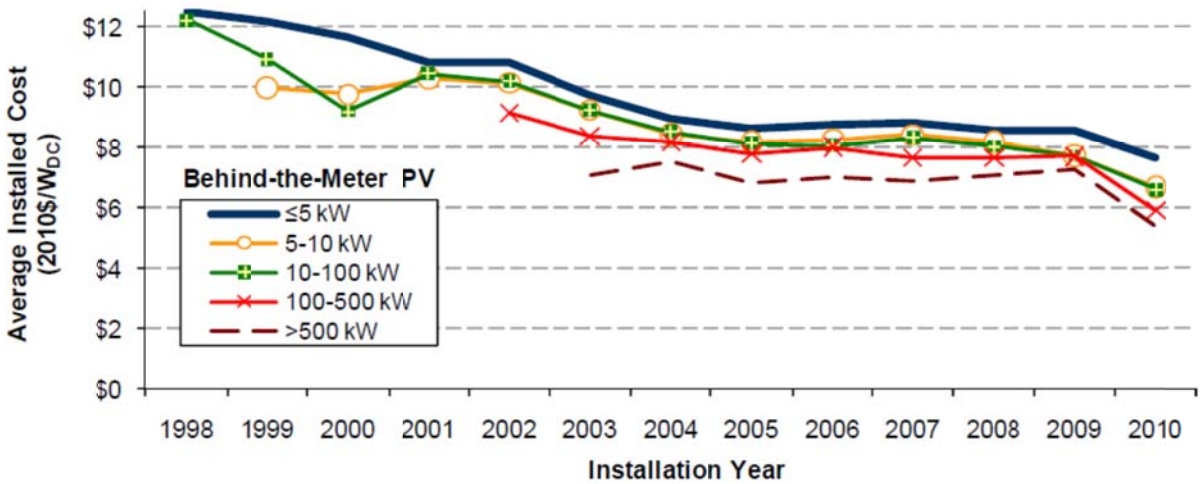




Sources: Solar Energy Industries Association, U.S. Solar Market Insight, 2010 Year in Review; Interstate Renewable Energy Council, U.S. Solar Market Trends reports (2007, 2008, and 2009).

[3] Energy Trust Oregon/PGE Webinar, April 3, 2012.

EXHIBIT 2. NATIONWIDE SOLAR PV INSTALLED COST TREND FOR BEHIND-THE-METER PV



Source: Cost Trends over Time for Behind-the-Meter PV, by PV System Size. Barbose, G., N. Darghouth, R. Wiser, J. Seel. 2011. Tracking the Sun IV: An Historical Summary of the Installed Cost of Photovoltaics in the United States from 1998 to 2010. Lawrence Berkeley National Laboratory. September.

Case Study: Oregon University System "Solar By Degrees" Project

The OUS applied and received pre-certifications for seven BETCs in 2010 for 14 solar PV initiatives throughout the OUS system. OUS refers to these projects holistically as the "Solar By Degrees" project. At 4.9 MWs, OUS states that this project would constitute the State's largest solar project to date.[4] The solar project is part of a broader set of OUS renewable energy demonstration projects that include geothermal, wave energy, and biofuels projects.[5] OUS hopes that by adding the Solar By Degrees project to an ongoing geothermal project at Oregon Institute of Technology (OIT), OIT will generate 100 percent of its electricity and heating needs from renewable energy.[6] OUS states that OIT's Klamath Falls campus is currently the only university in the world that is completely heated by geothermal water, and has the

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[4] "University System launches state's largest solar project, Governor Kitzhaber breaks ground in Klamath Falls," Oregon University System, August 18, 2011 http://www.ous.edu/news/081811; "OUS to break ground on Oregon's largest solar project.," Sustainable Business Oregon, March 9, 2012. http://www.sustainablebusinessoregon.com/articles/2011/08/ous-to-break-ground-on-oregons.html

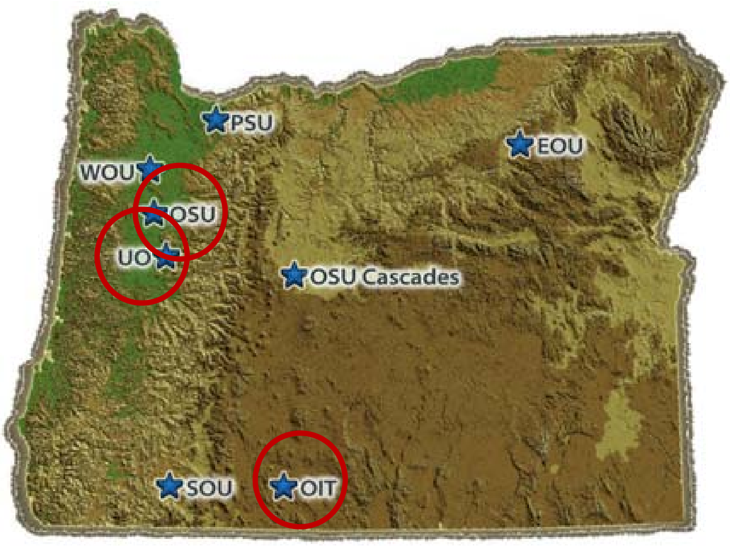
[5] Personal communication with Bob Simonton, OUS, March 2, 2012. A wind demonstration project had originally been included as part of the demonstration projects, but has since been cancelled.

[6] "University System launches state's largest solar project, Governor Kitzhaber breaks ground in Klamath Falls," Oregon University System, August 18, 2011 http://www.ous.edu/news/081811.

first university-based geothermal combined heat and power plant in the world.[7] Other demonstration projects are in various stages of development at this time.[8]

Since its 2010 BETC approval, OUS has consolidated the plans for the Solar By Degrees project from 14 "subprojects" to five, which are distributed across three OUS campuses (the University of Oregon (U of O), OIT, and Oregon State University (OSU)). OUS states that the current plans are to develop only ground-mounted PV systems, which require enough land and a favorable location for siting. Subprojects that require rooftop installation will be held off until Phase 2.[9] **The total certified costs of the Solar By Degrees project are projected to be $27.1 million**.[10] Exhibit 4 summarizes the estimated current distribution of costs by subproject.

EXHIBIT 3. SOLAR-BY-DESIGN PROJECT LOCATIONS



Source: Oregon University System, www.ous.edu

When the BETCs were approved, the plan was that OUS would **host** the project, while the project developer, or a **solar services provider**, would be responsible for project finance, engineering, permitting, procurement, construction and project management.[11] The solar services provider would build the solar arrays on leased university property and then sell the electricity it produced back to the universities at or below the current electrical utility rates for the campuses. OUS estimated that the project would save $6.6 million dollars in utility rates over a 25-year period, at which point the panels would

[7] "University System launches state's largest solar project, Governor Kitzhaber breaks ground in Klamath Falls," Oregon University System, August 18, 2011 http://www.ous.edu/news/081811.

[8] Personal communication with Bob Simonton, OUS, March 2, 2012.

[9] Projects at four other campuses have been temporarily shelved, and moved to Phase 2 of this project. These are projects at Eastern Oregon University, Western Oregon University, and Southern Oregon University. OUS states that projects at these campuses require rooftop installation. Personal communication with Bob Simonton, OUS, March 2, 2012.

[10] Written communication with Martin Shain, consultant to Oregon University System, March 23, 2012.

[11] Written communication with Martin Shain, consultant to Oregon University System, March 23, 2012.

revert to campus ownership.[12] The OUS would also have the option to purchase the system after six years.[13] The solar services provider would oversee an **installer** of the project, as well as a team of **investors** willing to use the tax incentives, including the BETCs. A diagram of the general relationships between these entities in what is known as a Solar Power Purchase Agreement is presented in Attachment A to this report.

Unfortunately, the solar services provider for this project, Utah-based Renewable Energy Development Corp (REDCo), filed for bankruptcy in December 2011, prior to commencing development of the OUS project. As of March 2012, OUS has been evaluating proposals from a new developer, SolarCity.[14] SolarCity is a national solar services provider with an office in Portland, Oregon.[15] While details of the new agreement are not yet available, it appears that SolarCity has agreed to an electricity sales agreement that is similar to the REDCo agreement.[16]

EXHIBIT 4. SUMMARY OF OUS PROJECT COMPONENTS

UNIVERSITY	PROJECT NAME	COST	PERCENT TO TOTAL COSTS
Oregon Institute of Technology	OIT –The Hill	$10,834,072	40.0%
Oregon State University	OSU-Vegetable Farm/VetMed/Rabbit Research	$10,743,029	39.7%
	U of O-Sports Center	$2,585,610	9.6%
	U of O-Tennis Center	$2,622,027	9.7%
University of Oregon	U of O -Building 130	$273,128	1.0%
Total	n/a	$27,057,867	100.0%
Written communication with Martin Shain, consultant to Oregon University System, March 23, 2012. Nine projects at four other campuses have been temporarily shelved, and moved to Phase 2 of this project.			

OUS refers to the Solar By Degrees project as an "all-Oregon" project, and has indicated that it intends to use locally manufactured materials, if technically and economically possible.[17] OUS plans to source solar panels from SolarWorld, which has its U.S. headquarters in Hillsboro, Oregon. OUS reports that solar inverters will be sourced from PV Powered (now Advanced Energy) of Bend, Oregon, but caveats that

[12] "University System launches state's largest solar project, Governor Kitzhaber breaks ground in Klamath Falls," Oregon University System, August 18, 2011.
[13] Eastern Oregon University, "EOU will play role in State's largest solar power program," August 18, 2011, http://www.eou.edu/news-press/ous-launches-solar-by-degrees/
[14] Sustainable Business Oregon, "OUS solar project hits bump with REDCO bankruptcy." March 9, 2012. http://www.sustainablebusinessoregon.com/articles/2012/03/ous-solar-project-hits-bump-with-redco.html ; "OSU Solar Partner Goes Bankrupt", Natural Resources Report, March 28, 2012, http://naturalresourcereport.com/2012/03/osu-solar-partner-goes-bankrupt/
[15] SolarCity, http://www.solarcity.com/media-center/company-profile.aspx accessed April 2, 2012.
[16] Personal communication with Bob Simonton, OUS, March 2, 2012.
[17] Written communication with Martin Shain, consultant to Oregon University System, March 23, 2012; "University System launches state's largest solar project, Governor Kitzhaber breaks ground in Klamath Falls," Oregon University System, August 18, 2011.

these inverters will be used "where system design allows and assuming PV Powered has a solid financial position that will not place their warranty and service at risk."[18]

Methodology

We use an input-output model to estimate economic impacts of the OUS project. Economic input-output models estimate the distribution of money (i.e., project costs, or "inputs") throughout the economy when a project is undertaken. These models calculate both direct distributions for purchases of project equipment and labor for installation, and also "ripple effects" such as expenditure of wages on household goods.

Model Selection

IMPLAN (IMpact Analysis for PLANning) is an input-output model designed by the U.S. Forest Service that is commonly used by State and Federal agencies for policy planning and evaluation purposes.[19] The current IMPLAN model divides the economy into 440 industry sectors. IMPLAN sectors include, for example, a sector for "electric power generation, transmission, and distribution," but do not include a separate sector for "solar power generation." To account for this lack of specificity, the U.S. Department of Energy's National Renewable Energy Laboratory developed a modified IMPLAN model specifically to examine the regional economic impacts of solar PV energy development at the State level. This model, the Jobs and Economic Development Impact Solar Model (JEDI),[20] allows for more detailed input assumptions related to solar PV projects than exist in the standard IMPLAN model, while drawing on IMPLAN multipliers (i.e., assumptions about the ripple effects of expenditures within and outside of the State). For example, JEDI modelers created specific sectors for mounting, modules, and inverters for solar projects, while the standard IMPLAN model only includes commodities such as "bare printed circuit board manufacturing" and "wiring devices" which may include other commodities not related to solar projects. A brief comparison of the IMPLAN and JEDI models is presented in Exhibit 5.

Because the JEDI model is tailored to the solar industry, but relies on essentially the same foundational data as IMPLAN, this analysis uses JEDI model as its central tool. For comparison purposes, we also generate results in this analysis using IMPLAN. As presented in the Results section, results for the two model runs are similar when examined at the aggregate level (i.e., total impacts on demand for labor), though results may differ at the sector-specific level.

[18] PV Powered was acquired by Advanced Energy in March 2010, but continues to be headquartered in Bend, Oregon. "University System launches state's largest solar project, Governor Kitzhaber breaks ground in Klamath Falls," Oregon University System, August 18, 2011 http://www.ous.edu/news/081811.Written communication with Martin Shain, consultant to Oregon University System, March 23, 2012.
[19] IMPLAN is produced by the Minnesota IMPLAN Group. The IMPLAN model draws upon available data from several federal and state agencies, including the Bureau of Economic Analysis and the Bureau of Labor Statistics, and groups economic activity data into sectors using the North American Industry Classification System (NAICS).
[20] U.S. Department of Energy, National Renewable Energy Laboratory, JEDI Solar Model PV Model rel NG1.11.01, available at: http://www.nrel.gov/analysis/jedi/download.html , accessed February 2012.

EXHIBIT 5. BRIEF COMPARISON OF IMPLAN AND JEDI MODELS

METRIC	JEDI SOLAR MODEL	IMPLAN VERSION 3.0
Level of detail (State/County)	State level, can be fitted to county level with additional data	State or County level
Model Developer	U.S. Department of Energy's National Renewable Energy Laboratory (NREL). State-level multipliers for employment, wage and salary income, output, and personal expenditure patterns are derived from 2008 IMPLAN data.	Minnesota IMPLAN Group
Industry sectors identified for solar industry	• Mounting • Modules • Electrical • Inverter • Labor installation Relies on 440 Sector IMPLAN multipliers for indirect and induced effects.	None specifically, but industries can be created within the model with extensive data inputs. In the standard model, solar energy production would be captured under "Electric power generation." Standard modeled commodities include bare-printed circuit boards, wiring, etc. Construction labor and engineering sectors exist. 440 Industry sectors
Year of data	2008	2009 (updated annually)
Impacts measured	Project development and onsite labor impacts, module and supply chain impacts, induced effects	Direct, indirect, induced
Outputs	Jobs, earnings, output	Employment, labor income, value added, output, taxes

Modeled Impacts and Outputs

IMPLAN and JEDI both translate initial changes in expenditures (i.e., project costs) into changes in demand for goods and services from affected industries. The JEDI model considers three types of economic effects:

- **Project Development and Onsite Labor Impacts (similar to Direct Effects in IMPLAN)**[21] are production changes or expenditures that result from an activity or policy.[22] In this analysis, these effects include the number of FTE's supported, on-site and related worker earnings, and output related to costs of the OUS project.

[21] Together, "Project Development and Onsite Labor Impacts" and "Module and Supply Chain Impacts" are comparable to IMPLAN's direct and indirect effects measures. JEDI's Project Development and Onsite Labor Impacts category is identical to IMPLAN's measure of Direct Effects except that it only includes labor-related expenditures for the construction/installation of a system and does not include additional impacts of initial expenditures. Those additional expenditures are captured in JEDI's Module and Supply Chain impacts category (which is otherwise identical to IMPLAN's Indirect Effects measure). Written communication with Marshall Goldberg, MRG Associates, developers of JEDI, on March 5, 2012.
[22] Output is the value of all goods and services produced.

- **Project Development and Onsite Labor Impacts (similar to Indirect Effects in IMPLAN)** are the "ripple" impact of local industries buying goods and services from other local industries as a result of the project within Oregon (e.g., PV module producers purchase more raw materials). Additional impacts that occur outside of Oregon are not included in these effects.
- **Induced Impacts** are changes in household consumption arising from changes in employment and associated income (which in turn results from direct and indirect effects) in Oregon. For example, these may include additional expenditure of wages by the workers who installed the OUS project, as well as additional expenditures by inverter manufacturers with income received from sales to OUS.

Regional economic flows related to solar PV projects are shown graphically in Exhibit 6. JEDI calculates the sum of the Project Development and Onsite Labor Impacts, Project Development and Onsite Labor Impacts, and Induced Impacts that specifically occur in Oregon for the OUS project to determine the total regional economic contribution, in terms of additional employment demand, labor income, and output.

- **Employment Demand**, in this context, measures the number of additional employees necessary for the Construction/Installation and Operations Phases of projects, and is measured in "worker-years" (full time equivalents for a year). Employment demand may reflect new permanent jobs (e.g., if a new facility requires employees for operations), but much of the demand in this analysis is related to additional short-term construction labor and other services.[23]
- **Output** represents the value of industry production. In retail sectors, output is equal to sales. For manufacturers, output is sales plus or minus the change in inventory.[24]
- **Labor Income** is a measure of the employment income received in Oregon as part of the employment demand, and includes wages, benefits, and proprietor income.

JEDI separately estimates employment, output and income effects for the construction and installation period ("one-time" effects) and for a representative year during the project's operational period. We multiply the operational period impacts by the expected lifetime of the project to determine the Lifetime Operation Effects. Finally, we sum the impacts of the two phases to provide an estimate of the total regional economic impacts of these projects over their lifetimes.[25] We note that our analysis focuses on identifying "economic impacts," as measured by changes in economic activity, or expenditure patterns, in Oregon. **This is not a cost-benefit analysis that examines total changes to social welfare**.

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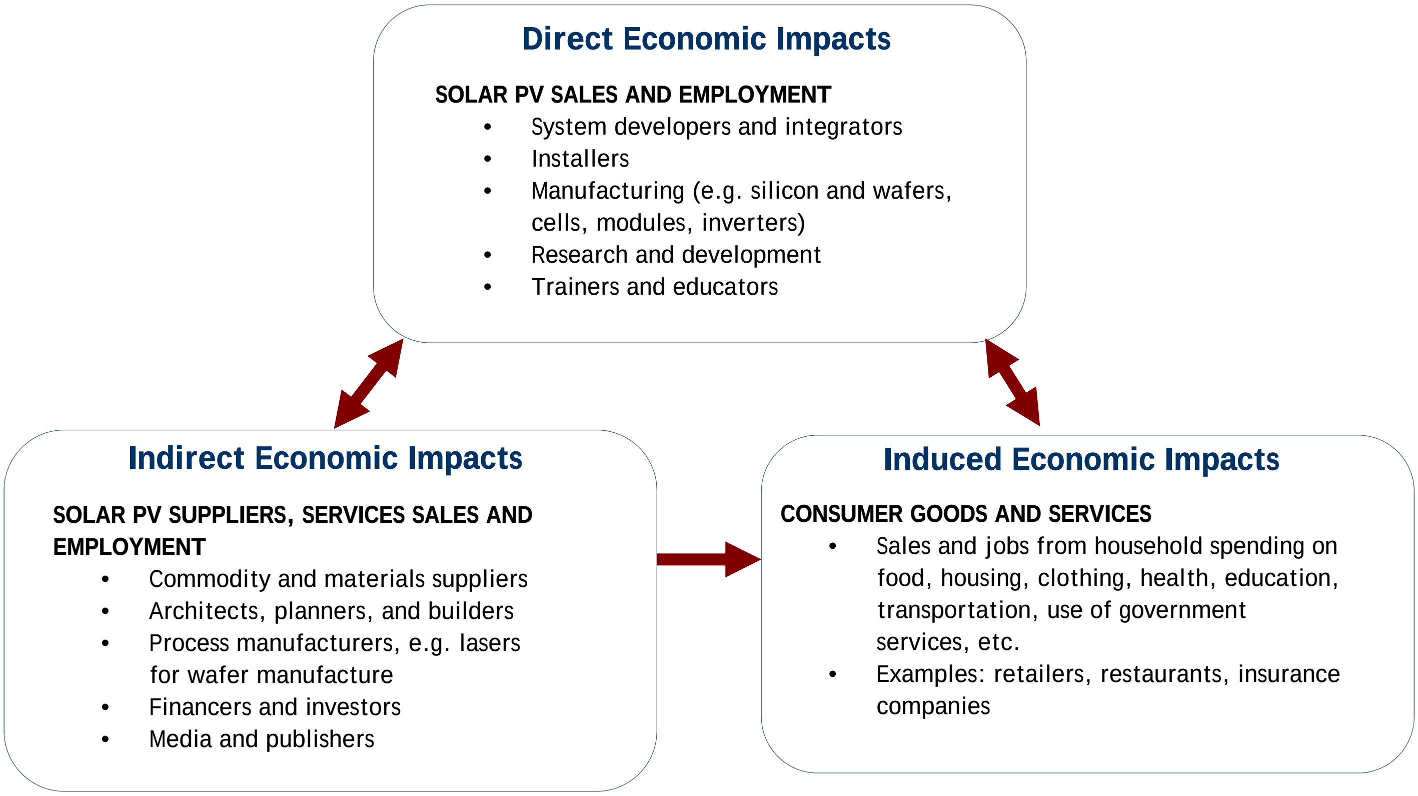
[23] We note that it is not uncommon for employment demand to be interpreted or reported as "job creation." However, in fact, IMPLAN describes annual (i.e., single-year) impacts, and thus the "created" jobs technically have a one-year duration. Thus, we believe it is more accurate and appropriate to describe an increase in employment demand rather than the "creation of jobs," which may not be new or permanent.

[24] Note that JEDI results do not report value added (net additional dollars into the economy). Our other report focuses on value added because it nets out double counting of activity that occurs across sectors in the reporting of output measures. Based on the relationship between output and value added in IMPLAN results from other categories of impacts we analyzed, the value added estimates would be approximately 50 to 80 percent of output values reported. Source: IMPLAN Glossary, 2012, accessed at www.IMPLAN.com.

[25] The lifetime project impacts are not discounted, and involve a number of simplifying assumptions. Thus, these represent only an order-of-magnitude level estimate of these effects.

EXHIBIT 6. FLOW OF REGIONAL ECONOMIC IMPACTS OF SOLAR PROJECTS



SOURCE: Adapted from NREL PV jobs/intensity project presentation, November 2009

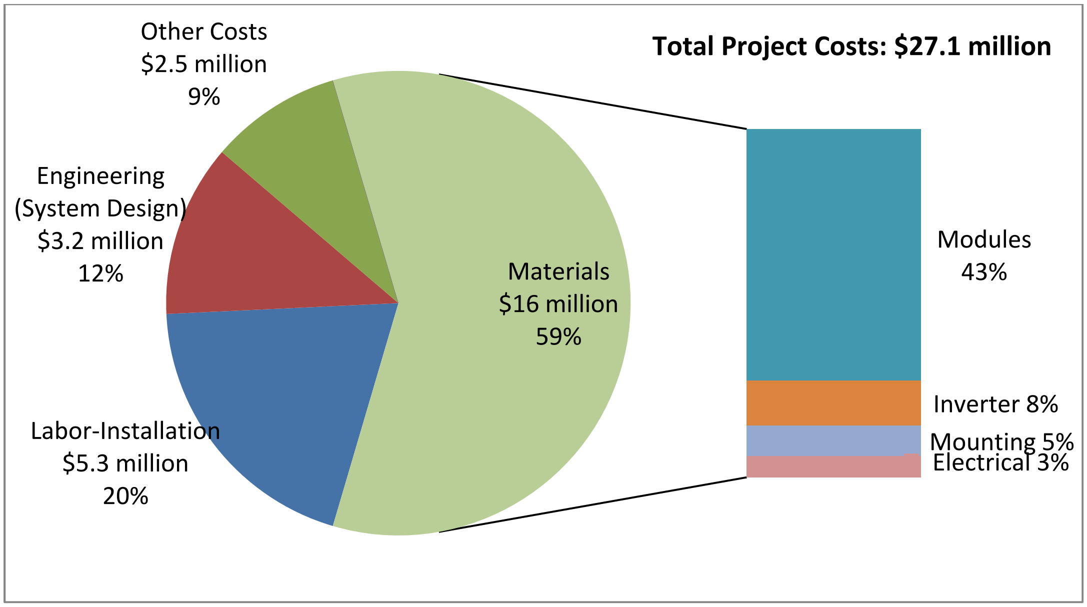
Cost Assumptions

As stated in the JEDI documentation, "the benefits that are ultimately generated by expenditures…depend upon the extent to which those expenditures are spent locally and the structure of the local economy.[26]" We use JEDI to compare the effects on the local economy that could be observed from a solar PV project that was sourced locally, i.e., one which uses materials and labor that are purchased and produced in Oregon, with one that does not exploit local resources. To establish what the regional economic impacts of the OUS project would be under high versus low local sourcing scenarios, we must understand the components of the expenditures for the project, by type and by scope.

We incorporated the total materials, labor, engineering, and other costs for the OUS project (including all subprojects) from BETC files. Exhibit 7 presents these costs. In general, upfront costs of solar PV projects are dominated by materials costs, but also include substantial engineering, installation and other permitting costs. As shown, materials costs of the OUS project comprise 59 percent of total certified project costs.

[26] JEDI Manual, 2006.

EXHIBIT 7. COST COMPONENTS OF OUS SOLAR BY DESIGN PROJECT



Sources: BETC applications for OUS project, 2010; JEDI Model assumptions about materials costs.

In general, materials costs for a solar PV project ($16 million in the Solar By Design project) are dominated by two primary components: one or more solar modules, and an inverter. Materials costs also include mounting materials and electrical wiring and meters. Because detailed materials costs were not included in the BETC application and are not yet available from OUS, Exhibit 7 incorporates JEDI assumptions about the modules, inverter, mounting, and electrical cost components of the materials costs. The $2.5 million spent on "other costs" as identified in the BETC application are distributed into overhead costs (6 percent of total costs), permitting costs (2 percent of total costs), and miscellaneous other costs (1 percent of total costs), following JEDI assumptions.

The distribution of OUS project costs are comparable to average costs developed by a United Kingdom-based consulting firm, Green Rhino, that specializes in providing strategic advice to organizations involved in photovoltaics. Green Rhino reports that 70 percent of project costs are materials contributing to modules, with 15 percent for other components and 15 percent for installation.[27]

Local Purchasing and Manufacturing of PV Components

From a brief review of the market conditions for components of the solar PV projects, it appears that some components are less likely to be manufactured in Oregon, even with additional investment. However, SolarWorld states that its Hillsboro, Oregon plant, currently undergoing a major $400 million renovation, is now completely vertically integrated, and includes crystal growing and processing, wafering, and cell development, in addition to module production.[28] Of $300 million that the company

[27] "The Solar Value Chain: Value Chain Segments and Activities." Accessed at www.greenrhinoenergy.com.
[28] Solarworld, "Hillsboro Oregon: America's largest and most advanced solar PV production facility." Accessed at http://www.solarworld-usa.com/about-solarworld/locations/hillsboro-oregon.aspx , on April 5, 2012; Personal communication with Devin Cichoski, SolarWorld America, May 4, 2012.

spends on manufacturing inputs in the U.S., SolarWorld reports that approximately $83 million is spent in Oregon.[29] The **four major components of solar PV manufacturing, including polysilicon development, solar wafer manufacturing, crystalline cell manufacturing, and module manufacturing**, are described below:

- The **polysilicon development** stage of the process includes the process of metallurgical-grade silicon into electronics-grade or solar-grade silicon used for silicon wafers. This market is currently dominated by seven international firms, and barriers to entry for this sector are high.[30] Capital investments for building a polysilicon plant are estimated at $500 million to $1 billion, and many customers have long-term contracts with existing suppliers, making it difficult for new entrants.[31] SolarWorld reports using Joint Solar Silicon GmbH and Company together with the chemical company, Degussa, for polysilicon development, which are both based in Germany. However, as noted above, SolarWorld states that the Hillsboro, Oregon plant includes crystal growing and processing.[32]
- The manufacturing of **solar wafers** includes melting polysilicon into ingots and then cutting them into wafers. This process can be conducted by upstream or downstream processors, but can also be conducted by specialized companies. Most of these producers are integrated with polysilicon suppliers. Currently, the top five companies share 93 percent of the wafer market. In North America, the regional leader is SUMCO in Japan.[33] SolarWorld reports using Deuche Solar in Germany for this process. However, SolarWorld also claims that the Hillsboro, Oregon plant includes wafering.[34]
- The manufacturing of **crystalline cells** involves producing materials with the required characteristics to generate electricity from sunlight. This industry is not currently dominated by a few big players. The top 10 producers produce just over 50 percent of the total.[35] SolarWorld AG produces the cells for their modules via its subsidiaries Deutche Cell GmbH and SolarWorld Industries America LP. However, SolarWorld states that the Hillsboro, Oregon plant includes cell production.[36]
- In general, **module manufacturing**, where cells are put onto glass and merged into larger units or panels, is the last stage in the manufacturing process. Module manufacturers comprise the

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[29] Personal communication with Devin Cichoski, SolarWorld America, May 4, 2012.
[30] Green Rhino, 2012.
[31] Green Rhino, Value Chain Activity: Producing Polysilicon, 2012. Accessed at: www.greenrhinoenergy.com
[32] Solarworld, "Hillsboro Oregon: America's largest and most advanced solar PV production facility." Accessed at http://www.solarworld-usa.com/about-solarworld/locations/hillsboro-oregon.aspx , on April 5, 2012; Personal communication with Devin Cichoski, SolarWorld America, May 4, 2012.
[33] Green Rhino, Value Chain Activity: Manufacturing Wafers, 2012. Accessed at: www.greenrhinoenergy.com on March 14, 2012.
[34] Solarworld, "Hillsboro Oregon: America's largest and most advanced solar PV production facility." Accessed at http://www.solarworld-usa.com/about-solarworld/locations/hillsboro-oregon.aspx , on April 5, 2012.
[35] Green Rhino, Value Chain Activity: Manufacturing Crystalline Cells, 2012. Accessed at: www.greenrhinoenergy.com on March 14, 2012.
[36] Solarworld, "Hillsboro Oregon: America's largest and most advanced solar PV production facility." Accessed at http://www.solarworld-usa.com/about-solarworld/locations/hillsboro-oregon.aspx , on April 5, 2012; Personal communication with Devin Cichoski, SolarWorld America, May 4, 2012.

largest group of manufacturers of solar components.[37] This process is most feasible to manufacture locally, as shown by SolarWorld's investment in Hillsboro, Oregon.[38]

Scenario Development

To compare the regional economic benefits associated with local versus non-local purchasing and manufacturing of solar PV components and labor, we create two scenarios for modeling purposes using basic OUS data. The Low Scenario examines the project as a "typical" project that does not specifically target local purchasing, while the High Scenario represents the project as one that maximizes use of local spending and manufacturing. More specifically:

- **Low Scenario**. This scenario is intended to reflect a project that does not purposely locally source materials. It assumes that a minimal percent of PV components are purchased locally, and that manufacturing occurs outside of Oregon. We derived assumptions about the "minimal percent" of local purchasing from another study that estimated the local content of solar component purchases.[39] The amount of local purchasing for the OUS project is likely to be higher than these assumptions convey. Most labor is assumed to be local (90 percent) under this scenario.
- **High Scenario**: Assumes 100 percent of materials are purchased locally, labor is local, and manufacturing occurs in Oregon.

To understand the implications of local versus non-local purchasing, and local versus nonlocal manufacturing, it is helpful to look at the project components individually. Exhibit 8 presents the key components of a PV project, the relative percent of installation costs that each comprises, and the expected location of manufacture in the OUS project. This information suggests that the high end assumptions that 100 percent of labor and components will be purchased and manufactured in Oregon is not completely unrealistic. We note that JEDI assumes that local manufacturing will maximize local potential for utilizing local resources, but will not assume that an industry exists within the region if it does not currently exist (e.g., silica manufacturing).[40] The actual local purchasing and manufacturing content of the OUS project is uncertain because (1) the project is not yet built, (2) the contractor who will conduct the work is yet to be determined and (3) because the primary supplier of materials, SolarWorld, may or may not be sourcing its materials locally. The key assumptions for the Low and High Scenarios, as translated into the JEDI input format, are summarized in Exhibit 9.

[37] Green Rhino, Value Chain Activity: Manufacturing Crystalline Modules, 2012. Accessed at: www.greenrhinoenergy.com on March 14, 2012.
[38] Solarworld, "Hillsboro Oregon: America's largest and most advanced solar PV production facility." Accessed at http://www.solarworld-usa.com/about-solarworld/locations/hillsboro-oregon.aspx , on April 5, 2012.
[39] Low scenario assumptions related to Local Purchase percentage are derived from Peter Olmstead, "Jobs and Economic Impacts: An analysis of Delaware's Solar Market," Delaware Renewable Energy Taskforce, April 2011.
[40] Written communication with Marshall Goldberg, MRG Associates, developers of JEDI, on March 5, 2012.

EXHIBIT 8. COMPONENTS OF OUS PV PROJECT COSTS AND LOCATION OF MANUFACTURER

PROJECT COMPONENT		PERCENT OF TOTAL INSTALLATION COST	OUS MANUFACTURER	LOCATION OF MANUFACTURE	LOCATION OF PURCHASE
Materials	Polysilicon	21 percent	Joint Solar Silicon GmbH and Co/Degrussa (SolarWorld)	OR (& Germany)	OR/U.S.
	Solar wafers (silicon wafers) and ingots	15 percent	Deutsche Solar (SolarWorld)	OR (& Germany)	OR/U.S.
	Crystalline cell (PV cell)	19 percent	SolarWorld Industries America LP (U.S.-CA) and Deutche Cell GmbH(SolarWorld)	OR (& Germany)	OR/U.S.
	Crystalline module (panel)	15 Percent	SolarWorld	OR	OR/U.S.
	Solar Glass/Protective cover	Other components: 15 percent	Same as cell	OR (& Germany)	OR/U.S.
Mounting and Tracking			(unknown)	(unknown)	OR/U.S.
Electrical Components, including inverter			Advanced Electronics, other	U.S.	OR/U.S.
Install ation	Wholesale distribution	15 percent	SolarCity	OR	OR/CA
	Project Development			OR	OR/WA
	Design Engineering Construction			OR	OR/CA
Operations and Maintenance		N/A	SolarCity	OR	OR

Sources: "The Solar Value Chain: Value Chain Segments and Activities." Accessed at www.greenrhinoenergy.com; SolarWorld Value Chain information, http://www.solarworld-usa.com, accessed on January 27, 2012; Written communication with Martin Shain, consultant to Oregon University System, March 23, 2012; Personal communication with Bob Simonton, OUS, March 2, 2012; Personal communication with Devin Cichoski, SolarWorld America, May 4, 2012.

EXHIBIT 9. SUMMARY OF INPUT ASSUMPTIONS FOR JEDI MODEL

	TOTAL PROJECT COST	COST	PURCHASED LOCALLY		MANUFACTURED LOCALLY	
		Per KW	Low Scenario[1]	High Scenario	Low Scenario	High Scenario
Installation						
Mounting	$1,390,367	$278	30%	100%	N	Y
Modules	$11,545,159	$2,309	20%	100%	N	Y
Electrical	$974,983	$195	20%	100%	N	Y
Inverter	$2,083,760	$417	10%	100%	N	Y
Labor	$8,580,806	$1,716	90%	100%		
Permitting	$667,523	$1	100%	100%		
Overhead	$1,542,811	$309	50%	100%		
Other	$272,458	$55	30%	100%[2]		
TOTAL	**$27,057,868**	**$5,280**	-	-		
Operations and Maintenance						
Materials and Equipment (annual)	JEDI default: $60,000 labor; $38,800 materials and services, $3.1 million annual payment		80%	100%		
Financial Parameters						
Debt Financing	JEDI default, 80 percent financed at 10 percent interest rate		0%	100%		

[1] Low scenario assumptions related to Local Purchase percentage are derived from Peter Olmstead, "Jobs and Economic Impacts: An analysis of Delaware's Solar Market," Delaware Renewable Energy Taskforce, April 2011.

[2] Some portion of the 15 percent of costs that comprise "other components" are tracking and mounting costs. While we are not certain where these devices are manufactured, we assumed that they have the potential to be manufactured in Oregon in the High End scenario.

Economic Impact Analysis Summary

Exhibits 10 through 12 present the impacts of local versus non-local sourcing of the OUS project per million dollars of project expenditures. As shown in Exhibit 10A, local sourcing would produce an increase in local employment demand from 238 to 400 worker-years over the life of the project, which represents an increase of 72 percent over a scenario where little manufacturing or purchasing occurs locally (Low Scenario). As shown in Exhibit 10B, **local sourcing would increase labor demand in Oregon by six worker-years (from 8.8 to 14.8 worker-years) per million dollars of expenditures on the OUS project**. Similar trends can be observed related to labor income (Exhibit 11), which increases from $11.1 million to $21.6 million (a 75 percent increase over the Low Scenario). This represents an **increase of $331,000 in labor income per million dollars of project expenditures**. Impacts on output are more pronounced (Exhibit 12), with impacts on output increasing from $21.6 million to $54.5 million (a 160 percent increase over the Low Scenario). This represents an **increase due to local sourcing of**

$1.2 million in output per million dollars of project expenditures. Under any scenario, the majority of employment effects are related to the installation and construction phase of the project. JEDI and IMPLAN model results are similar for labor demand impacts.

In order to provide some context for understanding the differences between IMPLAN and JEDI results, Exhibit 14 compares the labor demand impacts of the low scenario using both IMPLAN and JEDI models. For the IMPLAN modeling efforts, inputs were distributed as follows:

- Materials costs:
    - "bare printed circuit boards" (panels and other materials costs of OUS project: $14.4 million); SAM model value (default) used for local purchase percentage (47.48%)
    - "wiring devices" ($4.4 million); SAM model value (default) used for local purchase percentage (0.05%)
- Labor Costs:
    - Engineering: $3.2 million
    - Construction: $5.3 million
    - O&M (from JEDI default): $59,766

As shown, JEDI and IMPLAN model results are similar for labor demand impacts under the low scenario.

EXHIBIT 10A. OUS PROJECT IMPACTS ON EMPLOYMENT DEMAND IN OREGON, 2011 (WORKER-YEARS)[1]

	LOW LOCAL CONTENT SCENARIO[2]	HIGH LOCAL CONTENT SCENARIO[3]	NET BENEFIT OF IN-STATE SOURCING	PERCENT INCREASE
Construction/Installation Phase (One-time)				
Project Development and Onsite Labor Impacts	129.6	147.3	17.7	14%
Module and Supply Chain Impacts	34.3	125.2	90.9	265%
Induced Impacts	44.9	95.9	50.9	113%
Total C/I Phase Effect	**208.9**	**368.4**	**159.6**	**76%**
Operations/Maintenance Phase				
Onsite Labor Impacts	0.9	0.9	-	0%
Local Revenue and Supply Chain Impacts	0.3	0.4	0.1	26%
Induced Impacts	0.2	0.3	0.0	8%
Total O&M Phase Effect (Annual) [3]	1.5	1.6	**0.1**	**7%**
Lifetime O&M Phase Effect (20 years) [3]	**29.3**	**31.2**	**1.9**	**7%**
Total Project Effect (All Phases) [3]	**238.1**	**399.6**	**161.5**	**72%**

Source: IEC Analysis using JEDI Solar model, March 2012.

[1]The total certified costs of the modeled projects were $27.1 million, with an installed capacity of 5 MW.

[1] Low scenario is defined as "low in-state sourcing", which means low percent of materials and labor purchased and manufactured in Oregon.

[1] High scenario is defined as "high in-state sourcing", which means high percent of materials and labor purchased and manufactured in Oregon.

[3] These costs are not discounted. While regional economic analyses using JEDI typically do not attempt to sum impacts over time, we provide these estimates here to get a sense for the scale of the lifetime impacts of the operational phase, and for the project as a whole.

EXHIBIT 10B. OUS PROJECT IMPACTS ON EMPLOYMENT DEMAND IN OREGON, 2011 (WORKER-YEARS), PER MILLION DOLLARS OF EXPENDITURES[1]

	LOW LOCAL CONTENT SCENARIO[2]	HIGH LOCAL CONTENT SCENARIO[3]	NET BENEFIT OF IN-STATE SOURCING	PERCENT INCREASE
Construction/Installation Phase (One-time)				
Project Development and Onsite Labor Impacts	4.8	5.4	0.7	14%
Module and Supply Chain Impacts	1.3	4.6	3.4	265%
Induced Impacts	1.7	3.5	1.9	113%
Total C/I Phase Effect	**7.7**	**13.6**	**5.9**	**76%**
Operations/Maintenance Phase				
Onsite Labor Impacts	-	-	-	0%
Local Revenue and Supply Chain Impacts	0.011	0.014	0.003	26%
Induced Impacts	0.009	0.010	0.001	8%
Total O&M Phase Effect (Annual) [4]	0.054	0.058	0.004	7%
Lifetime O&M Phase Effect (20 years) [5]	**1.1**	**1.2**	**0.1**	**7%**
Total Project Effect (All Phases) [5]	**8.8**	**14.8**	**6.0**	**72%**

Source: IEC Analysis using JEDI Solar model, March 2012.

[1]The total certified costs of the modeled projects were $27.1 million, with an installed capacity of 5 MW.

[2] Low local content scenario is defined as "low in-state sourcing", which means low percent of materials and labor purchased and manufactured in Oregon.

[3] High local content scenario is defined as "high in-state sourcing", which means all materials and labor purchased and manufactured in Oregon.

[4] Does not include impacts associated with reinvestment of utility expenditures resulting from energy savings. As a result, O&M phase impacts are underestimated.

[5] These costs are not discounted. While regional economic analyses using JEDI typically do not attempt to sum impacts over time, we provide these estimates here to get a sense for the scale of the lifetime impacts of the operational phase, and for the project as a whole.

EXHIBIT 11A. OUS PROJECT IMPACTS ON LABOR INCOME IN OREGON, THOUSANDS OF 2011 DOLLARS[1]

	LOW LOCAL CONTENT SCENARIO[2]	HIGH LOCAL CONTENT SCENARIO[3]	NET BENEFIT OF IN-STATE SOURCING	PERCENT
Construction/Installation Phase (One-time)				
Project Development and Onsite Labor Impacts	$8,097	$9,092	$995	12%
Module and Supply Chain Impacts	$1,455	$7,548	$6,093	419%
Induced Impacts	$1,555	$3,316	$1,761	113%
Total C/I Phase Effect	**$11,107**	**$19,956**	**$8,849**	**80%**
Operations/Maintenance Phase				
Onsite Labor Impacts	$56	$56	$0	0%
Local Revenue and Supply Chain Impacts	$15	$19	$4	30%
Induced Impacts	$8	$9	$1	8%
Total O&M Phase Effect (Annual) [3]	$79	$84	**$5**	**6%**
Lifetime O&M Phase Effect (20 years) [3]	**$1,571**	**$1,673**	**$101**	**6%**
Total Project Effect (All Phases) [3]	**$12,678**	**$21,629**	**$8,951**	**75%**

Source: IEC Analysis using JEDI Solar model, March 2012.

[1]The total certified costs of the modeled projects were $27.1 million, with an installed capacity of 5 MW.

[1] Low scenario is defined as "low in-state sourcing", which means low percent of materials and labor purchased and manufactured in Oregon.

[1] High scenario is defined as "high in-state sourcing", which means high percent of materials and labor purchased and manufactured in Oregon.

[3] These costs are not discounted. While regional economic analyses using JEDI typically do not attempt to sum impacts over time, we provide these estimates here to get a sense for the scale of the lifetime impacts of the operational phase, and for the project as a whole.

EXHIBIT 11B. OUS PROJECT IMPACTS ON LABOR INCOME IN OREGON, PER MILLION DOLLARS OF EXPENDITURES [1]

	LOW LOCAL CONTENT SCENARIO[2]	HIGH LOCAL CONTENT SCENARIO[3]	NET BENEFIT OF IN-STATE SOURCING	PERCENT
Construction/Installation Phase (One-time)				
Project Development and Onsite Labor Impacts	$299,000	$336,000	$36,800	12%
Module and Supply Chain Impacts	$53,800	$279,000	$225,000	419%
Induced Impacts	$57,500	$123,000	$65,100	113%
Total C/I Phase Effect	**$410,000**	**$738,000**	**$327,000**	**80%**
Operations/Maintenance Phase				
Onsite Labor Impacts	$2,050	$2,050	$0	0%
Local Revenue and Supply Chain Impacts	$544	$707	$164	30%
Induced Impacts	$309	$332	$24	8%
Total O&M Phase Effect (Annual) [4]	$2,900	$3,090	$187	6%
Lifetime O&M Phase Effect (20 years) [5]	**$58,100**	**$61,800**	**$3,740**	**6%**
Total Project Effect (All Phases) [5]	**$469,000**	**$799,000**	**$331,000**	**75%**

Source: IEC Analysis using JEDI Solar model, March 2012.

[1] The total certified costs of the modeled projects were $27.1 million, with an installed capacity of 5 MW.

[2] Low local content scenario is defined as "low in-state sourcing", which means low percent of materials and labor purchased and manufactured in Oregon.

[3] High local content scenario is defined as "high in-state sourcing", which means all materials and labor purchased and manufactured in Oregon.

[4] Does not include impacts associated with reinvestment of utility expenditures resulting from energy savings. As a result, O&M phase impacts are underestimated.

[5] These costs are not discounted. While regional economic analyses using JEDI typically do not attempt to sum impacts over time, we provide these estimates here to get a sense for the scale of the lifetime impacts of the operational phase, and for the project as a whole.

EXHIBIT 12A. OUS PROJECT IMPACTS ON OREGON REGIONAL ECONOMIC OUTPUT, THOUSANDS OF 2011 DOLLARS[1]

	LOW LOCAL CONTENT SCENARIO[2]	HIGH LOCAL CONTENT SCENARIO[3]	NET BENEFIT OF IN-STATE SOURCING	PERCENT
Construction/Installation Phase (One-time)				
Project Development and Onsite Labor Impacts	$8,777	$10,020	$1,244	14%
Module and Supply Chain Impacts	$4,726	$29,621	$24,895	527%
Induced Impacts	$5,427	$11,577	$6,150	113%
Total C/I Phase Effect	**$18,930**	**$51,218**	**$32,288**	**171%**
Operations/Maintenance Phase				
Onsite Labor Impacts	$56	$56	$0	0%
Local Revenue and Supply Chain Impacts	$48	$76	$28	58%
Induced Impacts	$29	$31	$2	8%
Total O&M Phase Effect (Annual) [3]	$133	$163	**$30**	**23%**
Lifetime O&M Phase Effect (20 years) [3]	**$2,659**	**$3,265**	**$606**	**23%**
Total Project Effect (All Phases) [3]	**$21,589**	**$54,483**	**$32,894**	**161%**

Source: IEC Analysis using JEDI Solar model, March 2012.

[1] The total certified costs of the modeled projects were $27.1 million, with an installed capacity of 5 MW.

[1] Low scenario is defined as "low in-state sourcing", which means low percent of materials and labor purchased and manufactured in Oregon.

[1] High scenario is defined as "high in-state sourcing", which means high percent of materials and labor purchased and manufactured in Oregon.

[3] These costs are not discounted. While regional economic analyses using JEDI typically do not attempt to sum impacts over time, we provide these estimates here to get a sense for the scale of the lifetime impacts of the operational phase, and for the project as a whole.

EXHIBIT 12B. OUS PROJECT IMPACTS ON OREGON REGIONAL ECONOMIC OUTPUT, PER MILLION DOLLARS OF EXPENDITURES[1]

	LOW LOCAL CONTENT SCENARIO[2]	HIGH LOCAL CONTENT SCENARIO[3]	NET BENEFIT OF IN-STATE SOURCING	PERCENT
Construction/Installation Phase (One-time)				
Project Development and Onsite Labor Impacts	$324,000	$370,000	$46,000	14%
Module and Supply Chain Impacts	$175,000	$1,090,000	$920,000	527%
Induced Impacts	$201,000	$428,000	$227,000	113%
Total C/I Phase Effect	**$700,000**	**$1,890,000**	**$1,190,000**	**171%**
Operations/Maintenance Phase				
Onsite Labor Impacts	$2,050	$2,050	$0	0%
Local Revenue and Supply Chain Impacts	$1,780	$2,820	$1,040	58%
Induced Impacts	$1,080	$1,160	$82	8%
Total O&M Phase Effect (Annual) [4]	$4,910	$6,030	$1,120	23%
Lifetime O&M Phase Effect (20 years) [5]	**$98,300**	**$121,000**	**$22,400**	**23%**
Total Project Effect (All Phases) [5]	**$798,000**	**$2,010,000**	**$1,220,000**	**161%**

Source: IEC Analysis using JEDI Solar model, March 2012.

[1] The total certified costs of the modeled projects were $27.1 million, with an installed capacity of 5 MW.

[2] Low local content scenario is defined as "low in-state sourcing", which means low percent of materials and labor purchased and manufactured in Oregon.

[3] High local content scenario is defined as "high in-state sourcing", which means all materials and labor purchased and manufactured in Oregon.

[4] Does not include impacts associated with reinvestment of utility expenditures resulting from energy savings. As a result, O&M phase impacts are underestimated.

[5] These costs are not discounted. While regional economic analyses using JEDI typically do not attempt to sum impacts over time, we provide these estimates here to get a sense for the scale of the lifetime impacts of the operational phase, and for the project as a whole.

EXHIBIT 13. COMPARISON OF JEDI VERSUS IMPLAN OUTPUTS, OUS PROJECT IMPACTS ON OREGON LABOR DEMAND, PER MILLION DOLLARS OF EXPENDITURES

	IMPLAN	JEDI	DIFFERENCE
Construction/Installation Phase (One-time)			
Direct	3.7	4.8	1.1
Indirect	1.7	1.3	-0.5
Induced Impacts	2.1	1.7	-0.4
Total C/I Phase Effect	**7.5**	**7.7**	**0.2**
Operations/Maintenance Phase			
Direct	0.0	0.0	0.0
Indirect	0.0	0.0	0.0
Induced Impacts	0.0	0.0	0.0
Total C/I Phase Effect	**0.1**	**0.1**	**0.0**
Lifetime O&M Phase Effect (20 years)	**1.0**	**1.1**	**0.0**
Total Project Effect (All Phases)	**8.5**	**8.8**	**0.3**
IEC analysis using JEDI Solar model and IMPLAN version 9.0 (2009 data).			

EXHIBIT 14. IMPACTS OF OUS PROJECT ON LABOR DEMAND, ASSUMING MODULES ARE MANUFACTURED IN OREGON

	LOW LOCAL CONTENT SCENARIO[2]
Construction/Installation Phase (One-time)	
Project Development and Onsite Labor Impacts	4.8
Module and Supply Chain Impacts	3.4
Induced Impacts	2.9
Total C/I Phase Effect	**11.1**
Operations/Maintenance Phase	
Onsite Labor Impacts	0.0
Local Revenue and Supply Chain Impacts	0.0
Induced Impacts	0.0
Total O&M Phase Effect (Annual) [3]	0.1
Lifetime O&M Phase Effect (20 years) [3]	**1.1**
Total Project Effect (All Phases) [3]	**12.2**
IEc analysis using JEDI PV model.	

Discussion

Overall, this analysis supports the hypothesis that increased local sourcing increases the economic impacts of a project on the Oregon economy. **As discussed above, the key variables that change between the Low Scenario and the High Scenario are assumptions about whether the materials, which together comprise approximately 60 percent of total project installation and construction costs of the OUS project, are purchased or manufactured locally.** Because some of the OUS project components are expected to be purchased and manufactured locally, actual impacts of the Solar By Degrees project are expected to fall in between the High Scenario and the Low Scenario presented in this analysis.

The purchase of a project component in Oregon will result in increased value added, essentially revenues and profits, to the seller of the component. If the seller is based in Oregon, then increased corporate profits should result in increased in-state expenditures as well. The increase in-state revenues to sellers have ripple effects within the state. However, if the component purchased within Oregon is *manufactured outside* of Oregon, the impacts of purchasing that component within the state are largely limited to the marginal gains of the seller (i.e., the markup).

On the other hand, if a component of a PV project is *purchased and manufactured* within Oregon, the marginal gains to the component seller comprise only one part of the Oregon impacts. Locally manufactured components also require local labor demand, materials, and utilities. Increasing sales of locally manufactured components also increases demands for goods and services that contribute to the components, i.e., to the extent that those suppliers are located in Oregon, purchase of a locally manufactured component increases local demand.

For example, the assembly of the PV modules, which comprises approximately 15 percent of the costs of project construction and installation, are likely to be sourced from SolarWorld's Hillsboro, Oregon plant. By assuming that these modules are *purchased and manufactured* locally, while other components are manufactured outside of Oregon, the expected impacts on labor demand related to the Installation/Construction Phase from the OUS project increase from 7.7 worker-years to 11.1 worker-years per million dollars of expenditures on the project (Exhibit 14). This represents an increase of 44 percent over the Low Scenario, where all materials are assumed to be manufactured outside of Oregon, and most are purchased outside of Oregon. **The more components are assumed to be purchased and manufactured in Oregon, the closer to the High Scenario are the results**.

Under any scenario, the majority of employment effects are related to the installation and construction phase of the project, as opposed to the operations and maintenance (O&M) phase (which comprises approximately 12 percent of labor effects). Using the method presented above, O&M phase employment demands are assumed to be constant from year to year, and, as such, the percent of O&M Phase impacts as a percent of total project impacts will increase if the project lifetime is increased. As noted above, this analysis assumes the project lifetime is 20 years to be consistent with our previous study. In fact, the target lifetime for the OUS project is 25 years.[41] In addition, this study does not capture the regional economic impacts of any reinvestment of utility expenditures by OUS. Thus, O&M Phase effects may be somewhat underestimated here. In addition, the long-term financial viability of the project

[41] Personal communication with Bob Simonton, OUS, March 2, 2012.

increases with the lifetime of the project, because the project is more attractive from a payback period return-on-investment perspective.

In terms of the JEDI model results, a caveat is that, like IMPLAN, JEDI is a static model that, as stated above, does not in itself capture changes in demand, market capacity, or sector growth over time. It should be noted that, to the extent that facilities that would have been built elsewhere are built in Oregon, these effects represent transfers of income and output to the Oregon economy from other local economies.

We also note that investments in solar PV projects may also have important benefits that are not captured in a regional economic impact analysis, such as air quality improvements and reductions in greenhouse gas emissions associated with avoided emissions from fossil fuel-based power generation.

Recommendations

Our analysis to date relies primarily on the project information provided by OUS in its BETC applications. If this application process continues as it has in the past, or if there is a different application process to undergo in the future, we would recommend that some additional data be collected from applicants in order to enable better future assessment of economic impacts, particularly in regard to the impacts on the Oregon economy. These recommendations are:

- **Create local procurement or sourcing mechanism**. To the extent that Oregon wishes to emphasize to applicants the desirability of utilizing locally sourced materials, a question could be added to the application inquiring as to whether local labor sources, local purchases, and/or locally manufactured materials will be used. While determining what portion would be considered adequate could be challenging, *Oregon could consider providing a credit or preference for applicants who propose to use local sourcing.*

Collect additional details related to materials, "other" costs, and O&M costs. More specific information in applications about the materials to be purchased (for example, in this case, costs of modules, racking, inverters, etc.), including specific models and brands, and the location of purchase if available, would help to more accurately assess impacts of local sourcing. In the applications, we would also recommend acquiring more detailed information about costs currently called "other costs." Breaking out the permitting costs from other costs, at a minimum, could be useful. Finally, *we would recommend collecting information about the operational labor and maintenance costs of projec* We will develop a forward-looking assessment using the following methodology:

Building upon the survey results we collect describing recent and forecast employment in each EE/RE sector, we will perform a sector-specific trends analysis to quantitatively estimate future growth behavior. Statistical analysis of the estimates calculated for each sector will facilitate comparisons among sectors and between future and past. Careful analysis of (a) predicted net growth, (b) predicted growth relative to the past and (c) the perceived rate of growth within each sector will inform a qualitative discussion of expectations for future employment.

A central component of the qualitative discussion will be a comparison of the overall trends in employment in major EE/RE sectors relative to the percent employment in these sectors estimated by survey respondents. This will be supplemented by an analytical statement about the prospects in each industry based on current and expected trends as well as external factors that may contribute to changes in employment over time—i.e. state energy tax incentives.

- *ts, in order to be able to better assess the longer-term economic impacts of projects.*
- **Collect post-certification performance and cost information**. We recommend that ODOE collect information in a manner that assists in the assessment of payback and return on investment of BETC projects. For example, recording observed project performance in the applications database would help in assessing at a broad scale whether assumptions in the applications about payback periods and return on investment are accurate. In some cases, collecting follow-up information on project construction costs would be also be helpful in understanding a project's regional economic impacts. This is particularly true when a project is delayed or modified prior to implementation.

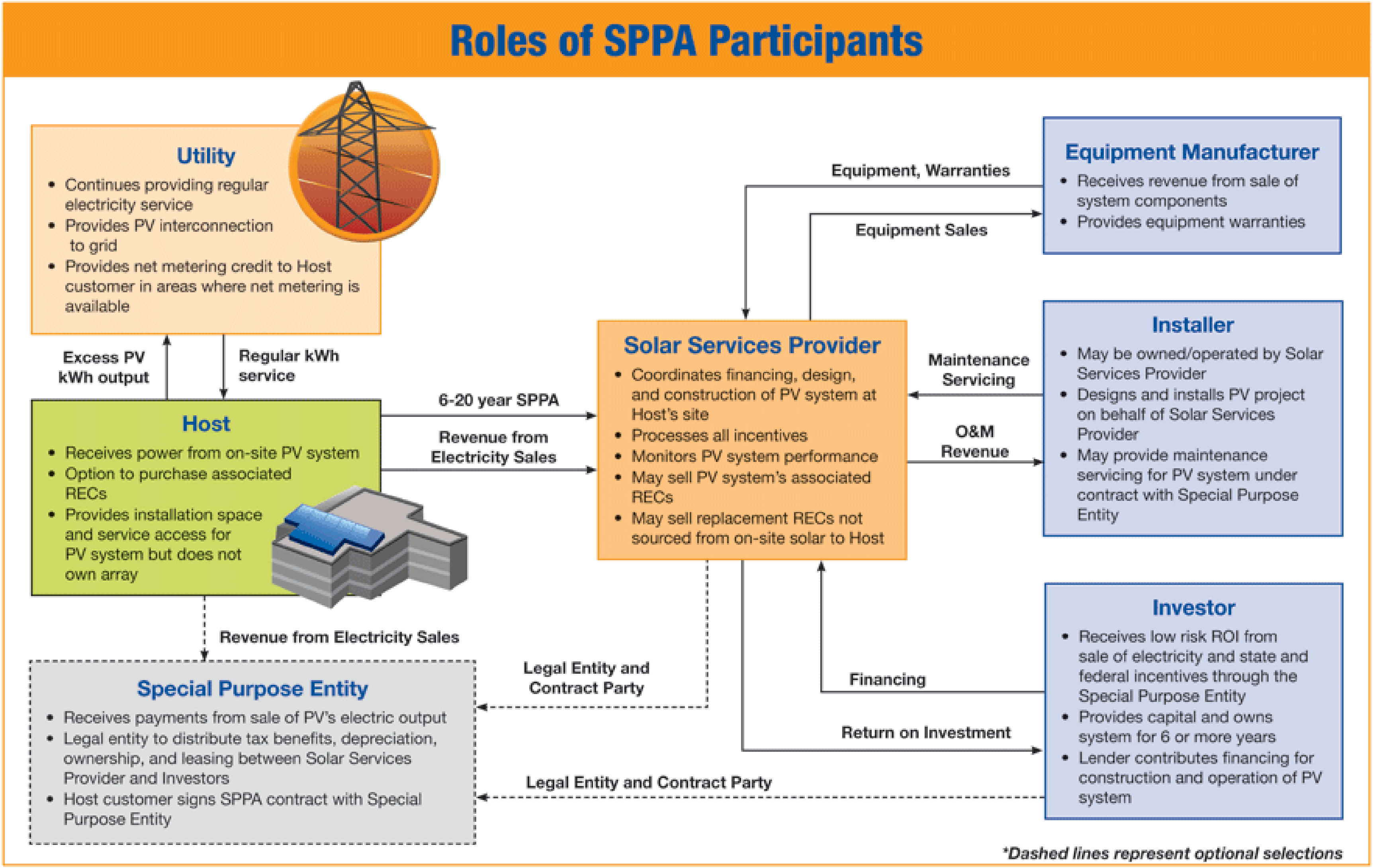
In summary, consideration of local sourcing, and the extent to which government investment encourages development of local industries over time, represent metrics that should be evaluated. As adoption of alternative energy sources and implementation of more efficient systems continues, *the long-term success of government investments may be measured better by a program impact evaluation framework that considers both the net changes in energy use and production, and the extent to which new systems provide long-term production and job benefits for the State*.

Questions for further inquiry

This short analysis supports our hypothesis that, for the solar project examined, all else being equal, increasing the amount of local purchase and manufacturing of project materials should result in significant increases in regional economic impacts in the construction and installation phase of a project. However, the long-term impacts of an installed project appear to themselves have only modest effects on regional employment. Potential future studies could examine the following:

- **Local sourcing of other renewable energy/conservation projects**. Renewable energy and efficiency projects other than solar PV, such as conservation projects and biofuels projects, may utilize a different mix of materials and labor types. *A future study that examined the potential regional economic impacts of other renewable energy technologies could provide information about which technologies are most responsive to local sourcing strategies and/or policies.*
- **Displacement effects of local sourcing.** It may be the case that some local sourcing of energy may ultimately displace some need for out of state energy purchases by the State of Oregon. A future study could investigate whether this is likely to occur in Oregon from increased use of renewable energy.
- **Tax effects of local sourcing.** A future study could include an assessment of benefits to local tax collection of local sourcing.
- **Impacts of Oregon Department of Transportation (ODOT) procurement process that targets local sourcing**. An example of an additional study that could be conducted would be to investigate the benefits to the Oregon economy of ODOT's policy/procurement process that is designed to encourage local sourcing of materials and labor.

- **Impacts of installed projects**. Because the Solar by Degrees project has not yet been installed, specific information about actual purchases, labor hours, and energy produced are not available. A backward look at some existing projects could illuminate more precisely what labor sectors are benefiting from local purchases, and what purchases are not being made locally. *A study of already-built projects that received BETCs could provide insights into potential niches for market development locally*. If not already being conducted, an assessment of the trends and capacities of local renewable energy suppliers could inform discussions about whether investments in local manufacturing may bear fruit.
- **Further examination of markets and barriers to entry for solar PV, solar thermal, as well as other renewable project types in Oregon**. Although we conducted a brief assessment of the markets for solar PV components, a more thorough assessment that included a detailed look at Oregon's market conditions could inform decisionmakers about the feasibility of establishing new markets for renewables in Oregon.



Source: "Roles of Solar Power Purchase Agreement Participants," Solar Photovoltaic Panels, accessed at http://www.solarphotovoltaicpanels.com/ on April 5, 2012.