



VISOR

VISION TO INTEGRATE SOLAR IN OREGON

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PRODUCED BY



CHRIS ROBERTSON & ASSOCIATES, LLC

VISION TO INTEGRATE SOLAR IN OREGON

Forward

People have used technology to harness the power of the sun for nearly 3,000 years when the first magnifying glass was invented to ignite fires. If this time span were reduced to a 24-hour day, the first commercial solar hot water system would have been installed at roughly 11PM, and a photovoltaic, or PV-powered home just 22 minutes before midnight. Only in recent years has solar energy gained prominence in the U.S., and though one hour of the sun's energy could power the entire planet for a year, today it represents less than 0.5% of our country's energy mix.

Contrary to popular belief, the solar resource of the rainy state of Oregon is quite strong. In the Willamette Valley, for example, there are thousands of rooftop solar installations, and several large utility-scale projects are now online in this region.

Widespread adoption and development of solar energy in Oregon is constrained, not by the resource or its economics, but by other substantial market barriers. These are addressed in this report.

OSEIA's Board of Directors conceived of the *Vision to Integrate Solar in Oregon* in August 2011. Since that time, months of research, analyses, interviews, and dialogue among experts of various disciplines have gone into the production of this report with an intended purpose to present a bold vision and a reasoned case for solar energy development in Oregon.

Commissioned by OSEIA, a trade association that represents the interests of the solar industry, the *VISOR* makes no claim of achieving consensus. The diversity of perspectives and analyses vary widely among thought leaders in energy, utility operations, regulatory environments, economic development, and other disciplines. For example, the implications for energy and land use policy have elicited praise as well as scorn among peer reviewers; and though the report should not be construed as OSEIA's policy position, it is its provocative nature that we hope will prompt collaborative conversation and meaningful engagement among Oregon's business community, citizens, and policy makers.

I am deeply thankful to all who participated in this monumental effort, both those publicly acknowledged, as well as the behind-the-scenes contributors. It is from this broad base of support that OSEIA hopes to achieve its goal to harness the potential of solar energy for the benefit of all in this great State of Oregon.

With gratitude,

Glenn Montgomery
Executive Director

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Disclaimer

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EXECUTIVE SUMMARY

VISOR is the Oregon Solar Energy Industries Association's *Vision to Integrate Solar in Oregon*. It answers these key questions. How can solar energy become a significant part of Oregon's energy supply? What are the barriers to widespread development of the solar resource?

VISOR reports on two market sectors: small-scale distributed generation ("DG"), mainly on buildings, and larger utility-scale solar power plants. Its scope is photovoltaic ("PV") solar energy conversion, the electronics industry technology that turns sunlight ("photo") directly into electricity ("voltaic").

As the *VISOR* analysis makes clear, Oregon's energy future could include a substantial and cost-effective solar resource. Oregon's energy policy makers and stakeholders should consider implementing the activities and goals necessary to produce 20 percent of Oregon's electricity using solar resources by the year 2030.

Utility-Scale Solar Energy is Now Cost-Effective in Oregon, But Significant Market Barriers Inhibit its Development

For six decades since PV's invention the high cost of the technology made it unattractive as a major energy resource. Rapid worldwide growth caused PV technology prices to fall and fall and keep falling. In 2011 solar energy economics changed. Energy from best-practice large-scale solar power plants became cheaper than Oregon's electric utilities' avoided costs of fossil-fuel electricity generation.

A new Oregon market for PV power plants can be opened by the new low prices for solar technology. Oregon could now be on the verge of a long boom in solar power plant construction, worth perhaps \$10 billion in capital investment. A large solar resource will help to stabilize electricity prices, improve energy security, reduce risks, improve environmental quality, and provide benefits for Oregon's economy and its energy consumers.

However, this future is not guaranteed. Formidable market barriers including availability of suitable land, transmission and distribution system constraints, lack of cost-effective financing and others inhibit building out the solar resource.

Solar energy needs access to sufficient land that is close enough to the electric transmission and distribution system. The T&D system must have available capacity to move the energy to market. It is now highly constrained and very difficult to expand, particularly from sunny Oregon to the Willamette Valley. And the distribution system in the Valley will need to be upgraded to accommodate the new solar capacity.

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Oregon's land use planning system began in 1899. Managing Oregon's valued natural resources requires balancing numerous social, environmental and economic interests. The large-scale solar resource is market ready. Can Oregon allocate sufficient land in the necessary places to build out the solar resource? This will require thoughtful conversations among Oregonians.

The amount of land needed depends on Oregonians' goals and values. If utility-scale solar power plants produce 20 percent of Oregon's electricity it would take about 6,000 MW of installed PV capacity on about 65 square miles of land. For comparison, that solar land is equal to 0.07 percent of Oregon's land area, and is slightly more than ¼ of 1 percent of Oregon's agricultural lands.

If utility-scale solar power plants produce 20 percent of Oregon's electricity, it would take about 6,000 MW of installed PV capacity on about 65 square miles of land.

Because of east-west transmission constraints, solar resource lands would need to be available in the Willamette Valley, as well as in sunny Oregon. Solar power plants could then be built to serve the electric utility systems close to the electric loads in various parts of the state. The *VISOR* analysis assumes a bit more than half of the solar energy production capacity would be in the Valley and the balance in sunny rural Oregon.

Governor Kitzhaber's Ten Year Energy Action Plan explicitly addresses these barriers. In his letter that released the draft plan, the Governor highlighted these action priorities.

“Enhancing clean energy infrastructure development by removing finance and regulatory barriers. Since 2007, renewable energy development has resulted in more than \$5 billion investment in Oregon. However, the state's ability to attract new investment and pursue promising new technologies is hampered by three things: outdated and inadequate energy transmission and infrastructure; inefficient and disjointed local, state and federal regulatory processes; and limited public resources. The plan calls for landscape level planning and streamlined permitting to give clean energy developers more certainty and predictability and to ensure the State's natural resources are protected...”¹

¹ http://www.oregon.gov/energy/AnalyticsReports/Ten_Year_Energy_Action_Plan.pdf

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Distributed Solar Generation on Buildings

The building-scale PV market has grown rapidly in the past few years, though it started from a small base. Financial incentives from the utilities, the Energy Trust of Oregon and Oregon Department of Energy Residential Energy Tax Credits have supported the market as it has grown. In 2009, the Oregon legislature created a pilot program to test a production-based incentive mechanism, known as a Volumetric Incentive Rate, more commonly called a Feed-in-Tariff. The Oregon Public Utility Commission will provide the 2013 legislature with a progress report. From the perspective of the Oregon solar industry, the pilot program experienced turbulence in design and upon launch and continues to operate with fundamental challenges.

PV contractors pass along falling technology prices to their customers. However, since Oregon's building-level PV market is small, fragmented and risky they have not achieved economies of scale. High costs for installation, transaction and customer acquisition make PV on buildings not yet cost-effective.

Two keys to make DG solar cost effective are to reduce installed cost and to recognize its value to the electric utility system. The relatively high cost of PV on buildings can be attributed to market design and transaction friction, including delayed permits, costly and uncertain financing for potential customers, and fragmented incentives. These can be resolved through concerted effort by government, the non-profit sector and industry working together.

Market design can be improved by increasing the size of the market, and making financing easier for customers. In Germany, a Feed-in-Tariff (FIT) supports a large, robust and highly competitive solar market. In this market design PV systems feed their energy into the grid, the utility buys it, and the PV owners earn bond-like returns on their investments. A nearly identical residential solar energy system in Germany costs less than half of a system here.

Feed-in-Tariffs are now known in the US as "Clean Energy Contracts." Clean Contracts operate much like the FIT in Germany, but with accommodation of the policy and tax differences between the two countries. Oregon could develop a Clean Contracts program with annual goals and budgets sufficient to enable contractors to get to economies of scale. A larger, smoother and more predictable market can allow contractors to ramp up production and ramp down costs.

Policy makers may wish to consider a Clean Contracts program for all solar development, both utility scale and distributed on buildings. This could be used to achieve balanced and orderly growth in the two sectors. A useful policy design goal would be to blend the utility-scale and the DG resources to achieve a reasonable average total cost of the solar resource, both in the near term and in the long term.

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Value to the Electric Utility System

In addition to energy, solar also produces “non-energy” benefits for the electric utility system. These positive economic values should be accounted for. Developers should be paid for the value their plants create, and should pay for the extra costs they impose.

For example, solar energy reduces greenhouse gas emissions and mitigates financial risk to the utility system of anticipated future carbon regulation. Solar energy is also a hedge against higher electric rates driven by volatile natural gas prices and low water years in the hydro system. Solar reduces the cost of expensive peak power generators running on hot days, can reduce congestion on the transmission and distribution system, improves grid reliability and efficiency through power factor correction and other technical services, and reduces transmission costs.

A large expansion of solar energy will impose costs that must also be accounted for. Electric utility operations and investments will be affected. Transmission and distribution system upgrades, grid integration and generation balancing services will add costs in utility operations.

Regulators will need to assure the careful integration of the new energy sources with the grid and traditional energy generation.

The Bigger Picture

Oregon’s energy system is embedded in the much larger regional and Western US systems. The change in solar economics will have impacts beyond the state. OSEIA hopes this report will stimulate broader discussions of renewable energy economic development, transmission adequacy, utility operations, resource locations, land use, carbon emissions abatement and related matters in the Northwest.

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INTRODUCTION

The scope of the *VISOR* is limited to photovoltaic (“PV”) solar energy conversion. This is the electronics industry technology that turns sunlight (“photo”) directly into electricity (“voltaic”).

Oregon recently surpassed the 50MW threshold of cumulative installed solar capacity, nearly all of which has come on line in the last 5 years. Distributed generation on and near buildings represents more than 30 MW of this capacity. The majority of these systems have been installed in the investor-owned utility territories due to favorable incentives and rebates.

By contrast, only a handful of utility-scale projects exceeding 1MW in size have been completed, and all in the last 18 months. Though few in number, these projects already comprise more than one-fifth of the state’s grid-tied solar. As the cost of solar energy technology has fallen precipitously, Oregon is at the point where utility-scale projects can begin to play a major role in the state’s energy future.

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In the bigger picture, the Pacific Northwest currently enjoys a surplus of electricity generation, and it may seem unnecessary to consider increasing the amount of solar in Oregon’s energy mix. That said, there are significant and immediate benefits that solar energy can deliver *today*. Solar energy development can:

- Build Oregon businesses and jobs in the green economy
- Help to stabilize the total cost of the electric utility system
- Mitigate price volatility from natural gas and hydroelectric generation
- Reduce greenhouse gas emissions from fossil fuels
- Reduce risk and cost of eventual carbon regulation
- Improve electric grid operations

Additionally, the new solar energy is exportable to other western US markets. And, it will help to replace energy generation lost due to the closure of the Boardman coal-fired power plant, which is scheduled to close in 2020.

Though both distributed and utility-scale generation produce significant benefits, there are formidable market barriers that inhibit solar resource development. *VISOR* details these market barriers and suggests possible solutions.

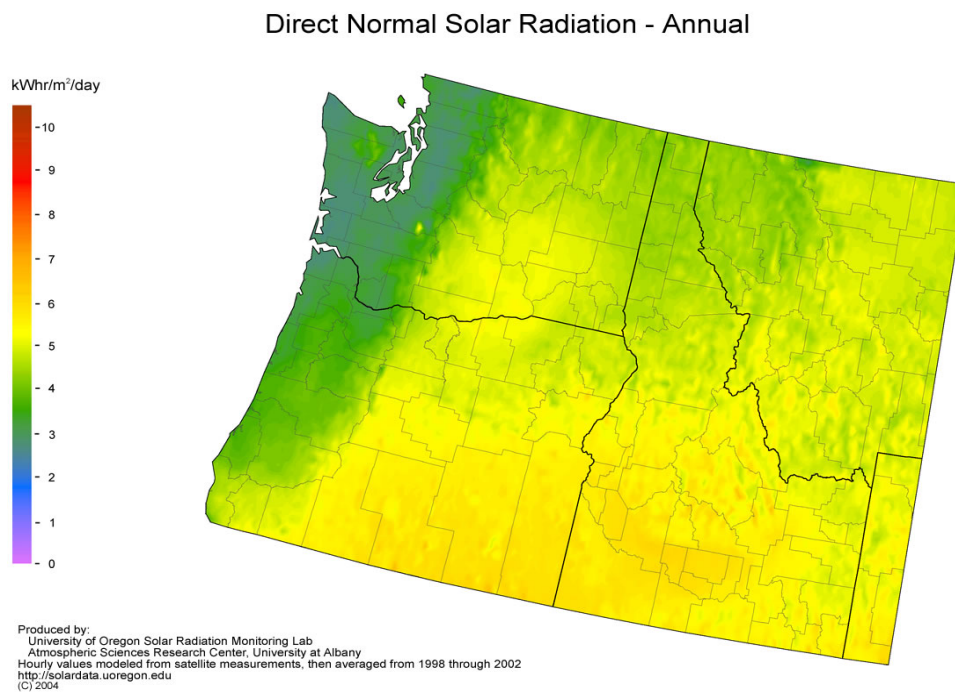
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The Oregon Solar Resource Base

In response to the energy crises of the late 1970s, the Oregon Department of Energy asked Oregon State University and the University of Oregon to assess the potential for solar energy in the state.² In the chapter on solar electricity the authors reported a very large land base where solar energy systems could be built.

Since that study, substantial data on the quality of the solar energy resource has been accumulated across the state. The National Renewable Energy Laboratory (“NREL”) now offers on-line tools that can be used to calculate the amount of energy that can be produced from solar energy systems for nearly any location in the state and around the world.³ The University of Oregon maintains an extensive solar radiation monitoring capability. Figure 1 illustrates the solar resource across the entire Pacific Northwest.⁴

Figure 1: The Pacific Northwest Solar Resource Map



In Oregon, the solar resource is different from east to west, with the Cascades the dividing line. The quality of the solar resource is excellent in Oregon, and is good even in the Willamette Valley, where cost-effective solar power plants can be sited.

² Frank Vignola, et al., *The Oregon Solar Planning Study*, University of Oregon and Oregon State University, March 1, 1978

³ See, for example, <http://www.nrel.gov/rredc/pvwatts/>

⁴ <http://solardat.uoregon.edu/Assets/ayrdn.jpg>

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Oregon’s solar resource exceeds that of Germany, the world’s leader in solar energy installations.

Location, Scale and Technology Affect Energy Production and Cost

The difference in sunshine affects energy produced by a solar PV electric system from location to location around the state. Table 1 illustrates this for a PV system that would typically be mounted as a fixed array on a rooftop. Built in each of these cities, energy production can vary significantly. Similar results can also be seen in the energy performance of utility scale solar energy plants.

Table 1: Annual energy production comparison by location for a 1 kW⁵ fixed tilt array. Source: PV Watts, VISOR analysis

Location	Energy produced (kWh per kW)
Portland	1100
Medford	1355
Pendleton	1335
Redmond	1465

On buildings, most solar systems are mounted on unmoving “fixed tilt” racks. By contrast, a utility-scale solar power plant will often use a racking design that moves with the sun from east to west, known as single-axis tracking, to maximize exposure to the solar radiation.

Energy production is different for these two types of systems. In Redmond, for example, a fixed tilt array will produce approximately 1465 kWh per year per kW of capacity, while a single-axis-tracking array will produce 1773 kWh per kW. This 21 percent difference in energy production improves economic performance, in spite of some additional capital and maintenance cost of the tracking system itself.

⁵ Watt is measure of the plant’s capacity to produce energy, or Watt-hours. A kilowatt (kW) is 1000 Watts and, and a megawatt (MW) is 1,000,000 Watts. W, kW and MW are the rated maximum capacity to produce energy. Kilowatt-hours, or kWh and megawatt hours, MWh, are energy units. They are production capacity operating over time. Electric rates are stated in cents per kWh or \$/MWh.

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Oregon's Utility Scale Plant Experience

Energy Trust of Oregon provided financial incentives to some 15 projects labeled utility-scale during the period 2008 – 2011. These plants were relatively small.

Table 2: Energy Trust Funded Utility Scale Solar Power Plants
Source: Energy Trust of Oregon

Energy Trust Funded Utility Scale Solar Plants			
Year	Number	MW-dc	\$/Watt
2008	1	0.85	\$7.69
2009	5	1.22	\$7.94
2010	7	2.40	\$5.84
2011	2	2.84	\$6.14
Total	15	7.31	

In 2009, the Oregon Legislature passed HB 3039, which requires the electric utilities to procure 20 MW of PV power plant capacity by the year 2020. The capacity increments must be in the range of 0.5 – 5.0 MW-ac.⁶

This has led to recent and historically important solar power plant developments in several parts of Oregon. Projects that are part of this procurement include the Lake County plants Outback, at 5.77 MW-dc and Black Cap at 2.57 MW-dc. Willamette Valley plants include the Baldock Solar Highway project at 1.75 MW. In Yamhill County the Yamhill and Bellevue projects combined capacity is 2.84 MW. The costs for these projects were not available to include in this report.

Larger scale plants, on the order of 10 MW, if ordered today, will be much cheaper to build per MW than the small plants that were initiated in previous years and only recently completed. This is because development costs can be spread across a larger investment, technology costs have fallen rapidly, and economies of scale come into play.

⁶ PV systems generate direct current energy (DC), which must be converted by an inverter to alternating current (AC) before it is used in the electric utility system. The conversion from DC to AC incurs electrical losses. A one MW-dc system capacity in the VISOR analysis is assumed to be 0.83 MW of AC generating capacity.

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Utility Scale Solar Power Plants Can Be Cost-Effective in Oregon

A potentially large market for solar energy has become possible in Oregon. In 2011 the cost of energy from best practice large-scale PV power plants, in the range of 10 MW and above, fell below Oregon electric utilities' avoided cost of energy from the next fossil fuel power plant. Solar power plants ordered for delivery in 2014 and beyond (accounting for normal time lag in the development process) can now be considered economically cost effective for utility-scale development.⁷

However, best practice power plant economics cannot be achieved in Oregon until crucial market barriers are addressed and resolved. Land use rules, transmission constraints, lack of cost-effective finance, property tax rates, labor rules, aging and inadequate distribution system infrastructure, lack of transparency on where interconnection can be difficult or easy, and other barriers act as deterrents to low cost solar development.

As these barriers are mitigated Oregon could see a long boom in PV power plant construction in sunny Oregon as well as the Willamette Valley. Over the next ten to fifteen years Oregon's solar electric generating capacity could conceivably grow to produce about 20 percent of the State's annual electricity requirements. This is more than 120 times Oregon's present installed solar capacity.

... Solar energy can be cost-effective for large-scale plants ordered today and entering service in 2014 and beyond.

Utility Scale Solar Energy Economic Analysis

The *VISOR* economic analysis compares the cost of energy from a solar power plant with the electric utilities' regulated avoided cost rates. If solar energy production cost is less than the avoided cost rates the plants are considered cost-effective.

The result of the analysis is that solar energy can be cost-effective for large scale plants ordered today and entering service in 2014 and beyond. The economic assumptions are based on a replicable 10 MW scale plant design on an ideal flat site with an easy interconnection to the electric utility grid.

This section describes the information used in the economic analysis.

⁷ Oregon has not yet had the experience of someone building a 10 MW power plant at present day low costs. The economic analysis presented below is only appropriate for larger scale plants, in the range of 10 MW or above.

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- Electric utility avoided cost rates are the basis for revenue a solar power plant owner would earn from a contract to sell energy to a utility.
- Several additional economic benefits of solar power plants are also presented. These are not included in the economic analysis, but if they were the value of the solar resource would increase.
- Solar energy capital costs, which have declined rapidly.

Results of the analysis are then presented as Levelized Cost of Energy (LCOE) in 2012 \$/MWh for both solar production cost and electric utility avoided cost. Appendix A provides additional detail on the *VISOR* LCOE model.

LCOE is a detailed economic comparison, but is not an investment grade pro forma that can be used to finance a plant. It omits consideration of annual cash flows, debt coverage ratios, Internal Rate of Return and similar business metrics.

The economic analysis assumes that the plant owner can make full use of the federal tax benefits that accrue to solar energy systems. This assumption is only appropriate for owners that have large federal tax exposure, or if Congress extends the so-called Section 1603 grant-in-lieu-of-tax-credits program. Other owners will have costs that are greater because of the cost of financial engineering required to access the federal tax benefits. This issue is discussed further in the section on Federal Tax Credit Policy at page 38.

Electric Utility Avoided Costs

The 1978 federal Public Utilities Regulatory Policy Act (PURPA) defines electric utility Avoided Cost Rates. These rates are what a utility plans to pay for energy from the next power plant in future years.

Power plants that are “Qualifying Facilities” (“QF”) may sign long term Power Purchase Agreements (“PPA”) with utilities. QF power plants’ revenues are the utility’s PURPA Avoided Cost Rates.

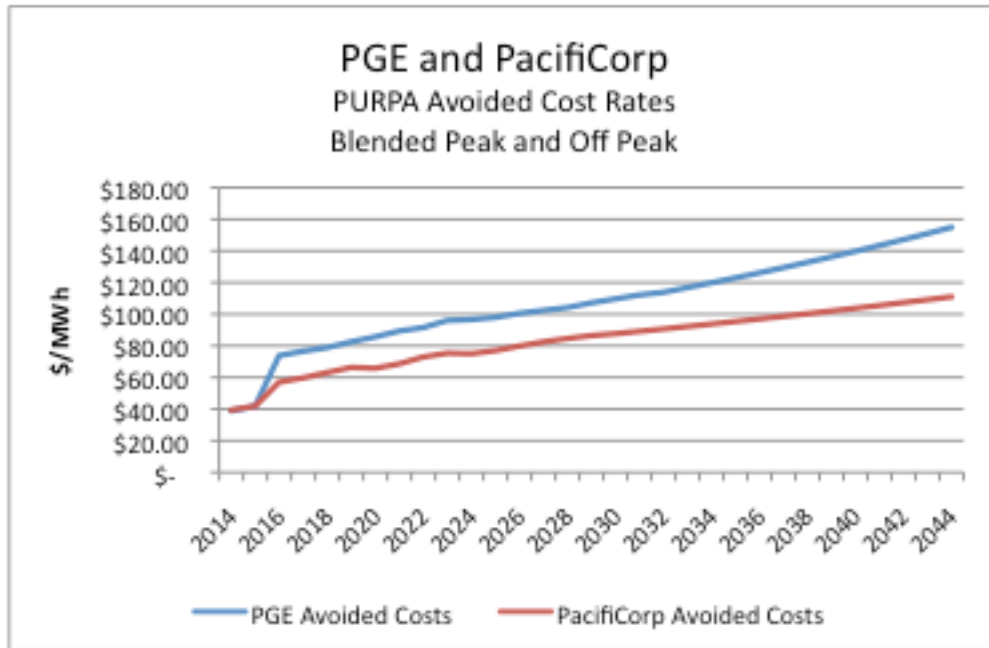
The Oregon Public Utilities Commission (PUC) regulates the PURPA Avoided Cost Rate schedules for PGE, PacifiCorp and Idaho Power Company (IPC) in their Oregon service areas. These rates are defined on a \$/MWh basis through 2030. In the economics presented later we do not analyze scenarios for IPC, which has somewhat lower avoided costs than PacifiCorp, and similar MWh per MW production as Redmond. The economics in IPC territory would resemble the PacifiCorp cases

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Figure 2: PGE and PacifiCorp Avoided Cost Rates⁸

Source: PGE and PacifiCorp Avoided Cost Rate Schedules

(Note: These avoided costs represent the blended rate of daytime on peak for Monday through Saturday and Sunday off peak)



A PV Power Plant is a QF and qualifies for a standard offer contract PPA if it is built in Oregon, sells energy to PGE or PacifiCorp, and has a nameplate capacity of 10MW-ac or less. A standard offer contract PPA simplifies negotiations between the plant developer and utility. If a PV power plant is larger than 10 MW (or if its production costs are greater than the avoided cost rates) its owner must negotiate a Power Purchase Agreement with the utility. A long-term PPA contract is necessary for a PV power plant to be financeable.

⁸ Avoided cost rates are escalated at 1.7% per year after 2030. The Energy Trust of Oregon uses a 2% escalation rate. Neither one will be “correct” in that avoided cost rates will fluctuate either higher or lower, as opposed to a linear extension.

Avoided cost rates for PacifiCorp may be found at [http://www.pacificpower.net/content/dam/pacific power/doc/About Us/Rates Regulation/Oregon/Approved Tariffs/PURPA Power Source Agreement/Schedule 37 Avoided Cost Purchase From Qualifying Facilities of 10000 KW or Less.pdf](http://www.pacificpower.net/content/dam/pacific_power/doc/About%20Us/Rates%20Regulation/Oregon/Approved%20Tariffs/PURPA%20Power%20Source%20Agreement/Schedule%2037%20Avoided%20Cost%20Purchase%20From%20Qualifying%20Facilities%20of%2010000%20KW%20or%20Less.pdf)

For PGE the avoided costs are at [http://www.portlandgeneral.com/our company/corporate info/regulatory documents/pdfs/schedules/sched 201.pdf](http://www.portlandgeneral.com/our_company/corporate_info/regulatory_documents/pdfs/schedules/sched_201.pdf)

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Standard offer PPA contracts for QF power plants are fifteen years at the published avoided cost rates, and are extended beyond the contract timeframe at market rates.

It is worth emphasizing important caveats about the long-term avoided cost of energy. The avoided costs beyond 2030 for PacifiCorp and PGE will not be a simple linear extension of the rates in place at that time, though this is what the economic model assumes.

Energy market prices are historically volatile. It is probably reasonable to plan for higher prices. However, due diligence requires power plant developers to understand the contingency effect of volatile and perhaps lower long-term prices on their power plant financial performance. If low cost solar power plants proliferate the utilities' avoided cost rates could decline, reflecting the cost of solar energy rather than the cost of a gas-fired combustion turbine.

PPA contracts for energy sales lock in the avoided cost rates that are in place when the contract is signed. These rates are revised about every two years. Given low natural gas prices it is likely that avoided costs will trend lower as they are revised over the next two year cycle, and perhaps further into the future.

Non-Energy Economic Benefits of PV Power Plants⁹

There are potential additional revenue streams and economic benefits that could improve solar power plant economics, but they are not included in the economic analysis. Some, like payments for avoided carbon emissions, may occur in the future and are dependent on changes in policy. Some benefits are currently negligible, such as selling the environmental attributes of green energy production into voluntary markets. Others are found in active markets elsewhere in the US but not in Oregon, such as providing power factor correction services for the grid. Still others are not presently accounted for, such as reducing the risk of volatile future energy costs and reducing the cost of transmission services.¹⁰

Some of these real and potential benefits can provide extra revenue for a PV power plant owner while others are economic benefits to the electric utility system and not monetized at the level of the power plant owner.

Avoided Carbon Risk. Electric utilities in the US are increasingly factoring the cost of carbon risk into their plans. The risk is that fossil fuel generators will inevitably

⁹ For a detailed presentation of numerous additional benefits see Amory Lovins, et al., *Small is Profitable: The Hidden Economic Benefits of Making Electric Resources the Right Size* (Snowmass, CO: Rocky Mountain Institute, 2003)

¹⁰ A docket at the Oregon PUC, Solar Resource Value - UM 1559, is considering other costs and benefits of solar energy.

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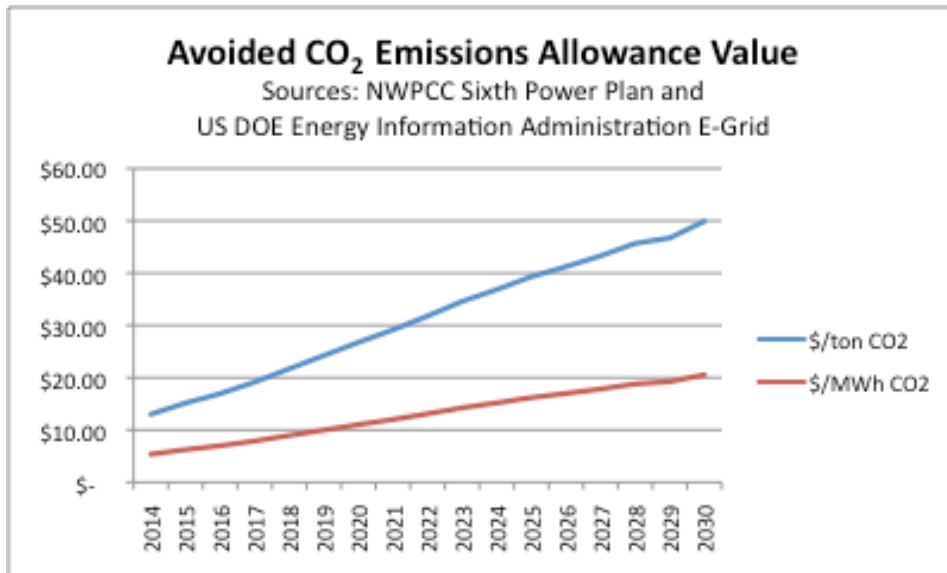
be held financially accountable for their greenhouse gas emissions (GHGs), the pollutants that contribute to global warming and climate change. A future carbon tax, cap and trade, or other mechanism will likely increase the cost of the carbon-based fuels, such as coal, oil, and natural gas.

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Greenhouse gas emissions from electric power system energy production are reduced as PV systems are built and operated. This reduces the risk and future cost of carbon regulation to the utility system.

In its 2010 6th Power Plan the Pacific Northwest Power and Conservation Council specified a Carbon Allowance Value. It estimated the mean value of carbon emissions at \$13 per ton in 2014. The economic value of carbon risk reduction increases over time as the probability of GHG regulation and likely cost of damage to the climate increases. For comparison, the federal government uses a value of \$21/ton of avoided CO₂ emissions when analyzing the impact of energy efficiency and other measures that reduce GHG emissions.

Figure 3: Value of Avoided Carbon Emissions to the Electric Utility System
 Source: Northwest Power and Conservation Council 6th Power Plan, Appendix I-15, US DOE Energy Information Administration and VISOR analysis



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The risk of future carbon regulation makes solar energy sources more economically attractive today for the electric utility system. However, the Council's carbon allowance value is not monetized directly at the level of the power plant owner's financial performance. Instead the plant owner may sell the avoided carbon emissions into existing markets.

Each MWh of solar energy has associated with it a "green tag," also known in some regions as a Solar Renewable Energy Certificate ("SREC" or solar REC). Solar RECs or green tags represent all of the environmental attributes of the solar energy. These are tradable securities that resemble commodities. The green energy attributes can be bundled as Solar RECs or green tags or marketed as separate components (e.g. reductions of power system emissions of NO_x, SO₂, CO₂, mercury, etc.). QF PV power plant owners may sell their green energy attributes into either the Oregon compliance REC market, or into voluntary markets.

The Renewable Energy Certificate compliance market is related to Oregon's Renewable Portfolio Standard (RPS). Oregon's electric utilities must produce or acquire a growing fraction of their electricity from renewable energy. The RECs from PV power plants could be valuable to Oregon utilities in the future as the RPS standard increases their renewable energy requirements.

A voluntary market also exists where PV power plant owners may sell environmental attributes such as avoided carbon emissions. Active Oregon players in this market include the Climate Trust and Bonneville Environmental Foundation. The Chicago Board of Trade and others also make markets for avoided carbon emissions. The value of Solar RECs in the voluntary market in 2012 was small, perhaps \$2 - \$4 per SREC.

Create jobs and economic development. A significant, local employment impact can be expected from a large-scale commitment to the solar resource. Oregon is already a national hub for solar PV manufacturing, and installation and support services will continue to rise with increasing solar development. During the lackluster economic performance of the past few years, solar jobs continued to increase, and the rate of increase outpaced the national jobs growth rate by six times.

As an example, in late October 2012 David Brown of Obsidian Finance Group, LLC presented an overview of their new utility scale solar power plants in Lake County. He reported there were 43 construction workers on-site for three months to build the 5 MW Outback Solar project.¹¹

¹¹ http://nebc.org/Documents/OR_Energy_Forum/EnergyForum_10-31-12_OutbackSolar.pdf

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Reduce price volatility. PV's stable energy costs can help to dampen electric utility price volatility, so PV systems could be credited with a financial hedge value. The price of natural gas is historically volatile, and Oregon uses a lot of natural gas to generate electricity. Bullish forecasts of a long-term supply of cheap natural gas must be tempered with uncertainty about its price and supply. By way of illustration, no natural gas supplier in North America will write a 30-year contract to deliver gas at a specified price.

Gas price volatility and uncertainty is driven by environmental impacts, the possibility that significant quantities of gas will be exported to the world market, diversion of natural gas to vehicle fuels, rapid depletion of gas fields, and increased substitution of gas for coal in the nation's power supply. Low prices can, as they have in the past, turn quickly into high prices.

Stable PV energy costs also hedge price volatility that occurs when a low water year reduces the available hydroelectric generation. The forecasts of changing rainfall, snowpack and run-off patterns due to global climate change may increase this hedge value.

Improve asset utilization in the grid. Solar energy systems are interconnected to the electric grid with inverters. Three-phase inverters can provide valuable power factor correction services to the grid operator. This service is available about 95 percent of the time when PV plants are not producing their rated output.¹²

Providing power factor correction can reportedly increase the value of a solar energy system.¹³ This increase in value, if compensated by the utility in an ancillary services market, would provide an extra revenue stream to the solar power plant owner, while improving T&D reliability and asset utilization. The value of this economic benefit is not known for the Oregon utilities, and is not included in the *VISOR* economic analysis.

A rapid build-up of PV could require increased and accelerated smart grid investments, especially in the area of network communications. Such investments may provide benefits well beyond the facilitation of a growing solar resource.

In addition, significant growth of solar capacity would likely require imposing costs for integration and balancing. The utilities may also require charges for additional transmission capacity if it is needed.

¹² http://www.solren.com/wp-content/uploads/2011/12/Smart_PV_inverter_benefits_for_utilities_NovDec_2011.pdf

¹³ Personal communication with Patrick Schellerup, Lite Solar

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Distributed generation PV on buildings may be able to help relieve stresses and reduce costs in the electric distribution system on circuits that have a summer peaking profile. The use of inverters to provide power factor correction on cold January mornings may have a similarly beneficial effect on the grid. These possible benefits are different for PGE and PacifiCorp. As an example, PGE's service area is compact and circuits can be reconfigured more easily to serve changing load patterns. However, neither utility has published analyses of their distribution systems to determine if their systems may benefit from summer peak PV power output, or from inverter based power factor correction during both summer and winter months.

PGE appears to have made progress in developing the capability to analyze these issues and leverage the benefits. In a description about their system-wide capability to use real time data, PGE engineers reported that, "...PGE strives to maximize equipment utilization factors without causing overload conditions that could shorten the life expectancy of our equipment." They created a data management system in which "...we could be aware of the real-time loading of our equipment... We designed a series of one-line diagrams containing all of the critical operating data at each substation, including megawatts, megavars, mva, phase currents, bus voltages, ambient temperatures, etc. ... Being able to monitor and react quickly to equipment loading situations has increased our equipment utilization factors without lowering equipment life expectancy, thus resulting in fewer customer outages."¹⁴

Transmission cost savings. Utility-scale solar power plants can be designated by the utility as network resources. If located in PacifiCorp and PGE service areas the solar plants would reduce the amount of energy that must be imported over BPA's transmission system. This would reduce the overall transmission bill for all PGE and PacifiCorp customers. It would also reduce the transmission and distribution losses that are inherent in the power system as energy is moved over long distances.

¹⁴ http://www.electricenergyonline.com/?page=show_article&mag=16&article=125

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Solar Technology's Recent Capital Cost Reduction

Capital cost (or, installed cost \$/MW) is the primary factor in the cost of producing and delivering solar energy (\$/MWh). There are zero fuel costs and low operating costs.

Since the 1970s the cost of solar energy technology has declined nearly continuously. For most of that time solar was a niche technology that was too expensive to be worth pursuing as a major energy resource. That era is now over due to deep cost reductions in solar technology.

The challenge is to elegantly transition PV, from a highly promising and previously expensive option, to a highly competitive player in electricity industries around the world.

The recent cost reductions were driven mostly by a drop in silicon prices of about 95% since 2008 and high volume manufacturing from China and Germany, which forced other manufacturers to drive costs out of their manufacturing process in order to remain competitive.¹⁵ Deep cost reductions are also occurring throughout nearly every aspect of the PV value chain. Cost reduction is expected to continue, driven by industry and government sponsored R&D.

Because capital cost is integral to the economics of solar energy systems, *VISOR* presents a range of estimates and perspectives from which to draw conclusions about the potential for solar in Oregon.

In its 2010 *Sixth Pacific Northwest Conservation and Electric Power Plan*, the Pacific Northwest Power and Conservation Council concluded that PV power plants were not cost-effective by a large margin, and would not be cost-effective for decades. The 6th Power Plan assumed that PV power plant capital cost was \$9,000 per kW (\$9.00/Watt), and that costs would decline by 8% per year.

In 2012 a team of leading solar industry participants writing for Bloomberg New Energy Finance stated, "The PV industry has seen unprecedented declines in module prices since the second half of 2008. Yet, awareness of the current economics of solar power lags among many commentators, policy makers, energy users and even utilities... The challenge is to elegantly transition PV from a highly promising and previously expensive option, to a highly competitive player in electricity industries around the world."¹⁶

¹⁵ Jigar Shah, personal communication, November 2012

¹⁶ Morgan Baziliana, IjeomaOnyeji, Michael Liebreich, Ian MacGill, Jennifer Chase, Jigar Shah, Dolf Gielen, Doug Arent, Doug Landfear, and Shi Zhengrong. *Re-considering the Economics of Photovoltaic Power*, Bloomberg New Energy Finance, 2012,

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Writing in October 2012, Michael Parker of Bernstein Research stated, “By the end of 2013, solar – on an un-subsidized basis – will be...cost competitive with fossil fuels in many ... parts of the world. The technology and energy sectors will no longer simply be one another's suppliers and customers. They will be competing directly. For the technology sector, the first rule is: costs always go down. For the energy sector ... the first rule is: costs (almost) always go up. Given those trajectories ... the coming tussle between solar and conventional energy is not going to be a fair fight.”¹⁷

Consider these recent data points:

- On a public conference call in August 2012 First Solar announced their all-in price target of \$1.00/Watt for utility scale power plants built to come into service in 2016.
- In November 2012 Jigar Shah wrote "Solar PV is at \$2/W-dc for large projects (> 5 MW) in the USA right now including profit. Gehrlicher's new 300 MW project in Spain is coming in at 1 EURO per watt (US \$1.40/W-dc) using the new installation robot they invented."¹⁸
- Michael Parker, in “The Other Side of the Sun,” reported that solar power plants in China were being built at US \$0.96/W. Corrected to US labor rates these plants would cost about \$2.00/W.
- Several large solar construction firms, each with Oregon knowledge and experience, expect to be able to build large-scale (10 MW or greater) solar power plants for delivery in 2014 in Oregon at \$2.00 per Watt or less on an “EPC” (Engineering, Procurement and Construction) basis, which does not include land, siting studies, land use approvals, legal fees, costs of financing and developer profit. The respondents expect all-in power plant prices to continue to decline through the end of the decade by 4 – 6 percent per year.

Project data compiled by Bloomberg New Energy Finance captures this point in the figure below.¹⁹

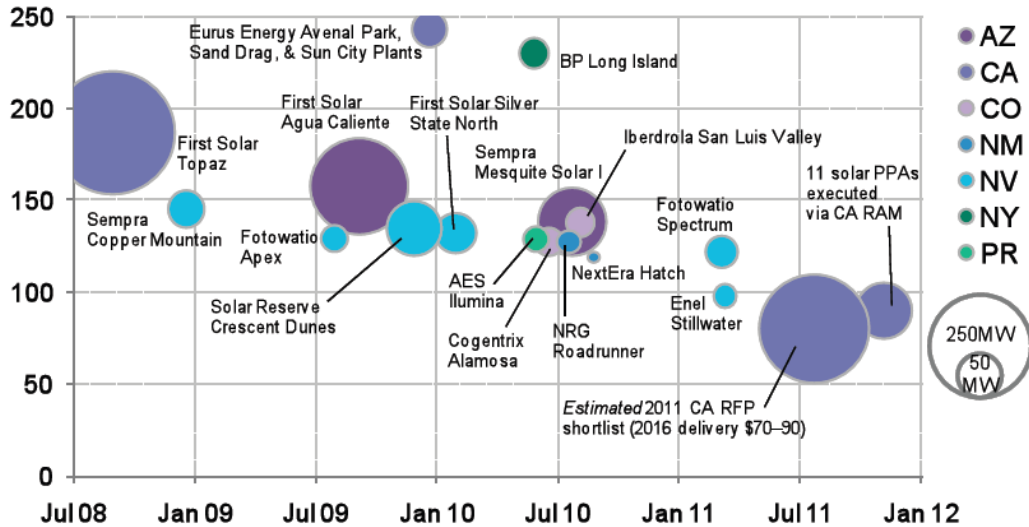
¹⁷ Michael W. Parker, et.al. *The Long View: The Other Side of the Sun. What Happens Once Solar Becomes Cheaper Than Fossil Fuels?* Bernstein Research, October 4, 2012 (used with permission, subscription required)

¹⁸ Jigar Shah, a global thought leader in the solar industry and founder of Sun Edison, comments via personal communication and on Green Tech Media at <http://www.greentechmedia.com/articles/read/Solar-Balance-of-System-Accounts-for-68-of-PV-System-Pricing-New-GTM-Repo/>.

¹⁹ Stefan Linder, *Solar industry Trends*, Bloomberg New Energy Finance, presented at the MDV SEIA conference, Nov. 28, 2012

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Figure 4: Solar Power Purchase Agreement Prices
 Source: Bloomberg New Energy Finance



Note: Does not include PPAs under 5MW. 'Banded' PPA prices are pegged at the average price over the period of project operation. The California RFP resulted in 7.5TWh of shortlisted generation, of which about half was PV. California RFP price estimates are sourced from developers. Topaz PPA price estimate based on first-year total PPA revenues (\$198.8m).

Source: Bloomberg New Energy Finance, FERC

Researchers at the National Renewable Energy Lab (NREL) reported in 2012 that the cost of utility scale, single axis tracking PV power plants would go from about \$4.50/W in 2010 to about \$1.90/W in 2020. The NREL researchers describe their forecast as an “evolutionary” trend, based on gradual improvements in many cost factors.²⁰

The US DOE SunShot Initiative is designed to create even deeper capital cost savings in solar energy systems. (SunShot is an intentional metaphor that mimics the 1960s moon-shot program that John F. Kennedy announced in 1962.) The SunShot goal for the year 2020 is \$1.00 - \$1.20/W for utility scale plants using crystalline silicon modules and single axis tracking arrays. This target will require successful innovation to drive costs down to that level. SunShot is aiming for breakthroughs in PV plant economics across a wide array of project cost components.²¹

IHS Emerging Energy Research analyzed cost data from 2,191 PV projects (1,717 MW of capacity) completed between Q1 2007 and Q2 2012. Another 43 projects

²⁰ NREL, 2012, Residential, Commercial, and Utility-Scale Photovoltaic (PV) System Prices in the United States: Current Drivers and Cost-Reduction Opportunities

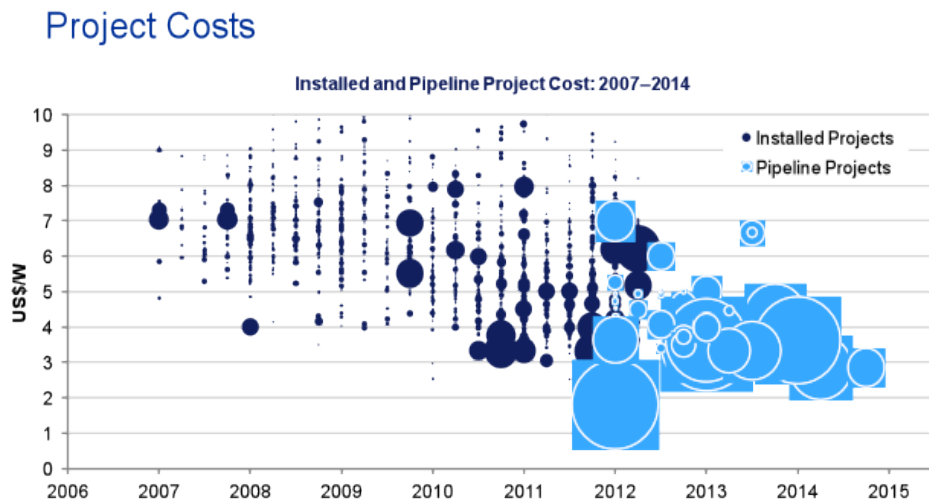
²¹ For more on the SunShot Initiative, see http://www1.eere.energy.gov/solar/sunshot/vision_study.html

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(1,921 MW in total) under construction or in development and scheduled to be completed between 2012 and Q4 2014 are also included in this analysis. Project data is from National Renewable Energy Laboratory, California Solar Initiative, and IHS Emerging Energy Research databases. Projects analyzed range in size from 100 kW to 275 MW. Their research is presented in Figure 5.

Figure 5: Solar Energy Capital Costs 2007 – 2014.

Source: IHS Emerging Energy Research, 2012 North America Solar Cost Report (used with permission, subscription required)



Rocky Mountain Institute published in 2010 another source of PV power plant cost trends. Their study was based on a design charrette attended by 50 leaders from the solar industry. Its aim was to define pathways for cost reduction in the non-module part of the PV power plant. This cost segment is known as the Balance of System and includes many cost drivers, such as permits, time lags, contracts, racking, inverter life and many others. Their results yielded a Levelized Cost of Energy of \$80 per MWh.²²

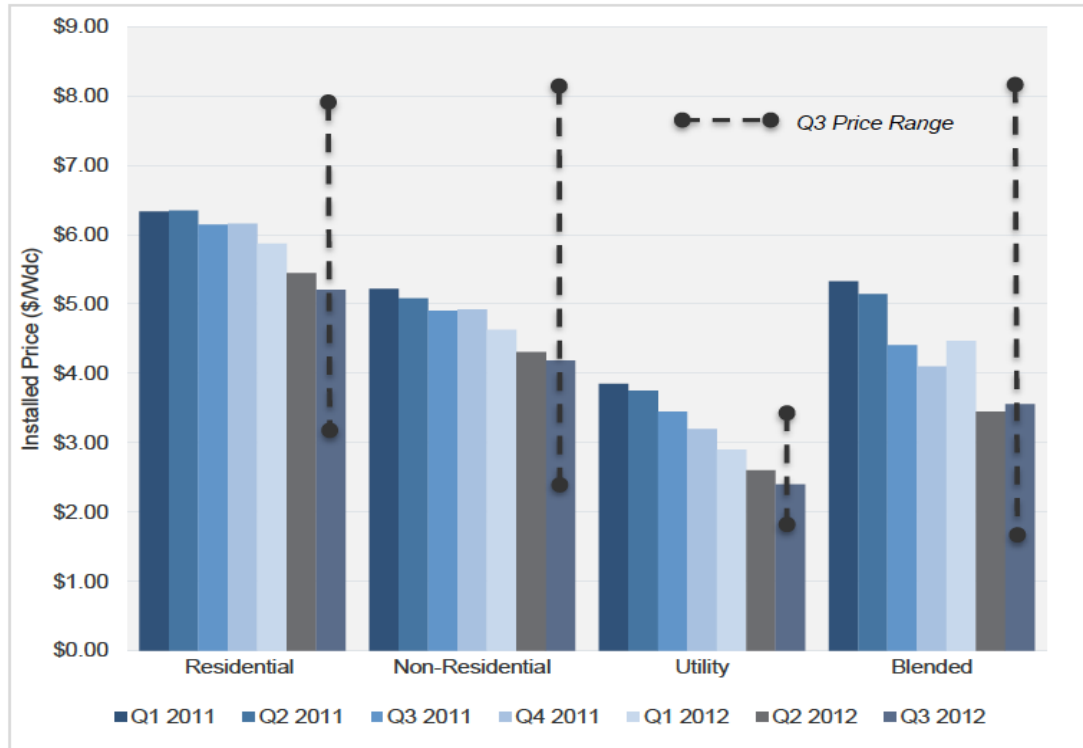
In December 2012, Green Tech Media and the national Solar Energy Industries Association published their Third Quarter 2012 Market Insight report. The following figure appears in the executive summary. This figure reports on US installed cost history for PV installations at various scales: residential, non-residential and utility. The data is presented quarterly from the first quarter of 2011 through the end of the third quarter of 2012. The utility scale power plant average cost in third quarter 2012 was \$2.40/W. The range in installed cost ranged from \$1.80 - \$3.50/W. These are all-in costs, including developers' fees.

²² Lionel Bony, Stephen Doig, Chris Hart, Eric Maurer, Sam Newman, *Achieving Low-Cost Solar PV: Industry Workshop Recommendations for Near-Term Balance of System Cost Reductions*, Rocky Mountain Institute, 2010

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Figure 6: “Average Installed Price by Market Segment, Q1 2011 – Q3 2012”
 Source: Green Tech Media and Solar Energy Industries Association²³

Figure 2.4 Average Installed Price by Market Segment, Q1 2011 – Q3 2012



Each of these studies of solar energy costs reinforces the conclusion that the cost of solar energy has recently declined markedly, and there is every reason to believe Oregon can expect a similar experience. With these market research data we now compare the cost of solar energy with electric utility avoided costs.

²³ <http://www.greentechmedia.com/research/ussmi>

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Results: Utility Scale Power Plant Economics

Figures 7 through 10 on the following pages illustrate the solar energy resource economics for PV power plants ordered today and built to start coming into service in 2014. They would be QF plants and would sell their energy to PGE or PacifiCorp. Power plant production cost and revenue are stated in levelized 2012 dollars.

The revenue a plant earns is based on the published Avoided Cost Rate Schedule for each utility. The solar energy production cost includes capital and operating costs (O&M, asset management, insurance, after tax debt service, federal investment tax credit, after tax depreciation, property taxes). The model assumes a debt term of 20 years, and a power plant life of 30 years. If a plant is interconnected to BPA its production costs include transmission, integration, balancing and ancillary services. (See assumptions in Appendix A.)

The economic analysis assumes that 10 MW scale plants ordered today for delivery in 2014 would cost \$2.40/Watt-dc in 2012 dollars. This assumption is in line with the Q3 2012 data reported by GTM and SEIA. The technology assumed is single axis tracking on a flat site with easy interconnection and a design that can be easily replicated. (Some Oregon industry reviewers think the capital cost assumption used in the economic analysis should be greater than \$3.00/Watt, and some think it should be closer to \$2.25/Watt.)

For both utilities, the plants as modeled are cost-effective if they are interconnected directly to either PGE or PacifiCorp. If interconnected to BPA the economics are more challenging due to the need to pay for transmission services costs.

A key project finance assumption is that the plant owner can use the Investment Tax Credit (ITC) and accelerated depreciation. This is not a conservative assumption, unless Congress acts to extend the so-called 1603 grant-in-lieu of tax-credit program. (See page 39, Federal Tax Credit Policy, for additional perspective on this issue).

A significant operating cost is the amount of property tax that each plant would pay. The assumption in this analysis is that the property tax rate would be equal to 1.1 percent applied to 70 percent of the project capital cost, and would decline by a factor of 5 percent per year. The property tax in this example represents about 40 percent of total operating costs. Solar energy systems built on a “net metering” or “behind the meter” basis (almost all projects on buildings) are exempt from property tax through 2018.

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Figure 7: Portland General Electric utility-scale solar resource economics; Location in mid-Willamette Valley, interconnected to PGE
Source: VISOR analysis

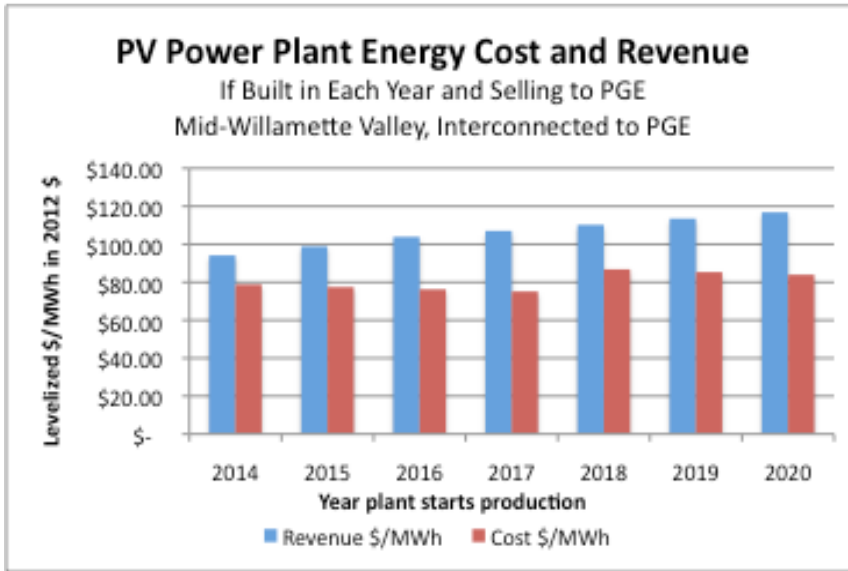
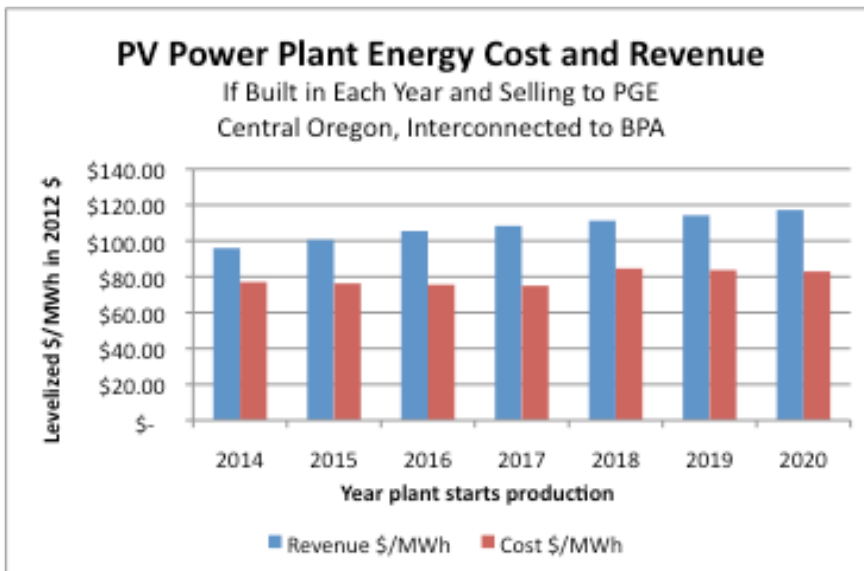


Figure 8: Portland General Electric utility-scale solar resource economics; Location in Central Oregon, interconnected to BPA
Source: VISOR analysis



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Figure 9: PacifiCorp utility-scale solar resource economics. Location in Central Oregon, interconnected to PacifiCorp
Source: VISOR analysis

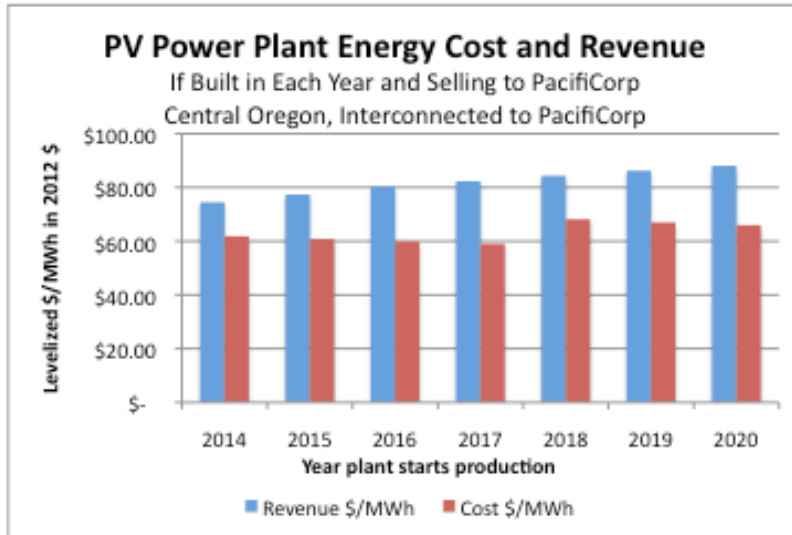
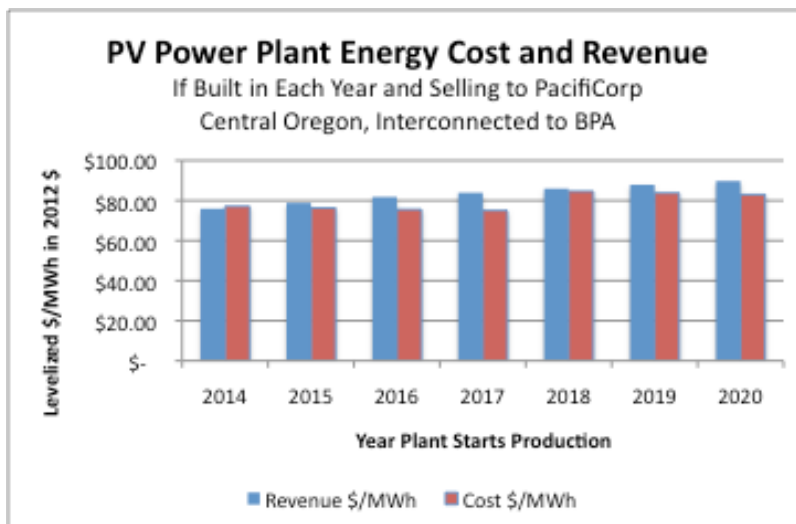


Figure 10: PacifiCorp utility-scale solar resource economics; Location in Central Oregon, interconnected to BPA
Source: VISOR analysis



In spite of these economics, why aren't developers and utilities already building large-scale plants? First, the steep drop in solar technology prices has only recently

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changed the relative economics. Second, there are formidable barriers that inhibit the rapid growth of the solar resource. The next section discusses these barriers.

Key Barriers to Utility Scale Solar Expansion

Large-scale solar power plant technology can now be considered economically cost-effective. However, formidable market barriers strongly inhibit the solar power plant market. State and local government can resolve most of these barriers, which include:

- Land availability
- Transmission and distribution system constraints
- Lack of cost-effective finance
- Property tax rates
- Labor rules that increase installation costs

Additionally, important issues for the Congressional delegation are related to federal tax credits for solar energy.

Governor Kitzhaber's Ten-Year Energy Action Plan addresses most of the crucial barriers to utility scale solar energy development. In his letter that released the draft plan, the Governor highlighted these action priorities.

“Enhancing clean energy infrastructure development by removing finance and regulatory barriers. Since 2007, renewable energy development has resulted in more than \$5 billion investment in Oregon. However, the state's ability to attract new investment and pursue promising new technologies is hampered by three things: outdated and inadequate energy transmission and infrastructure; inefficient and disjointed local, state and federal regulatory processes; and limited public resources. The plan calls for landscape level planning and streamlined permitting to give clean energy developers more certainty and predictability and to ensure the State's natural resources are protected. In addition, the plan calls for developing a new regional infrastructure bank to leverage public and private investment for infrastructure projects.”²⁴

²⁴ http://www.oregon.gov/energy/AnalyticsReports/Ten_Year_Energy_Action_Plan.pdf

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Land availability

Solar energy production at utility scale can be economical for Oregon. However, land use regulations must permit use of sufficient land if it is to be developed at scale.

Oregon's Statewide Planning Goals anticipated the future need for land for this purpose. It states in part, at Goal 13, "Plans directed toward energy conservation within the planning area should consider as a major determinant the existing and potential capacity of the renewable energy sources to yield useful energy output."²⁵

If Oregon were to produce 20 percent of its energy supply from utility scale solar power plants, it would require building about 6,000 MW. A total of 65 square miles of land would be required, distributed across rural Oregon. At 10 MW scale per plant²⁶, each would require about 70 acres, and 600 separate land parcels would be devoted to energy production. Because of transmission constraints we assume 55 percent of solar energy capacity would be located in the Willamette Valley, on about 36 square miles of land.

To put this into perspective, the land area needed to build 6,000 MW is 0.07 percent of the land in Oregon (96,000 square miles), or ¼ of 1% percent of Oregon agricultural land (25,600 square miles). To build 55 percent of the capacity in the Willamette Valley would be the equivalent of less than 3 percent of the Valley's agricultural land, if only agricultural land was used.

Land suitable for solar development could include areas that are already disturbed by agriculture, wind farms, military use, rights of way, and other uses. Co-locating solar power plants and agriculture is common throughout Europe, where grazing sheep are used to produce food and control grass.

Power plants have to interconnect to the transmission and distribution (T&D) grid in order to send energy to market. The best sunshine and most of the non-arable land in the state is East of the Cascades and in Southern Oregon. Most of this land is not close to electric transmission systems.

Even if land is near transmission there is very little spare capacity to move the power from sunny areas to Oregon's major electric load centers in the Willamette Valley. Building new transmission is exceedingly difficult and time consuming. Land use policy is one of the pillars of Oregon's political history with a highly structured, comprehensive approach to protecting the state's most valuable natural

²⁵ <http://www.oregon.gov/LCD/docs/goals/goal13.pdf>

²⁶ In reality plants of many sizes would likely be built. *VISOR* assumes 10 MW as a simplified way to discuss numbers and scale. If a PV power plant is 10 MW or less it qualifies for a Standard Offer contract to sell energy to the utilities.

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resources. Solar energy development, defined as an industrial use, has caused concern among land use advocates and agricultural interests because of the potential impact on habitat and traditional farm and ranch use.

In October 2011 the state Land Conservation and Development Commission adopted rules that specified the conditions in which local governments could approve solar energy power plants on lands that are zoned agricultural (See OAR 660-033-0130 (38, h)). The rules permit “Photovoltaic solar power generation facilities as commercial utility facilities for the purpose of generating power for public use by sale”.²⁷ Adoption of these rules followed a lengthy, somewhat contentious process involving a diverse working group composed of relevant state agencies, farmers, ranchers, developers, environmental advocates, and municipal governments.

Legislation was introduced in 2011, then again in 2012, to remedy what some believed to be an unacceptable result of the initial rulemaking exercise. Though no new legislation was passed, the outcome influenced further amendments to the rules to increase the acreage threshold from 100 to 250 acres on non-arable Exclusive Farm Use zoned land for a solar energy facility without need of an exceptions review process.

As of the writing of this report, further edits are being made to protect critical habitat without creating unnecessary steps in the environmental assessment phase of a project’s development, as well as resolving jurisdictional authority between local municipalities and the state’s Energy Facility Siting Council. Throughout the legislative and rulemaking processes, the persistence of policy makers, state agency staff, and stakeholders to collaborate and compromise has helped move Oregon in the right direction.

However, there are still obstacles to overcome, particularly in the Willamette Valley where agricultural land dominates the region. Presently, land zoned Exclusive Farm Use restricts solar energy development to either 12 or 20 acres depending upon the designation of the soil. But power plant scale is important. A solar power plant on 12 or 20 acres is too small to achieve economies of scale, so its energy production costs would be significantly greater than a plant built on 70 or 80 acres.

²⁷ Land Conservation and Development Department, Oregon Administrative Rules, Chapter 660, Division 033, Rule 0120, Table 1
http://arcweb.sos.state.or.us/pages/rules/oars_600/oar_660/tables_660/660-033-0120_2-14.pdf

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An exception to these limitations is possible, though the probability of litigation to challenge the exception adds time, cost and uncertainty to the process. This makes larger scale project development on land in the Valley unlikely unless rules change.

Recent changes to land use policy and the introduction of the Governor's Ten Year Energy Action Plan preceded this report. But hopefully, legislation, rule changes and regulatory reforms inspired by the Governor's Ten Year Energy Action Plan will allocate sufficient land for the solar resource to be built out, and streamline the regulatory process to enable efficient processing of land use permits for solar and other renewable energy technologies. In the end, policy makers will need to balance both priorities of clean energy development and land use planning.

The inclusion of "landscape level planning" is one example in which the Governor's plan hopes to provide more certainty for developers to identify sites and build projects while providing adequate protection to the state's critical habitat, natural resources and rural economy.

This relatively new means of managing energy development aligns with Oregon's experience of comprehensive land use planning and gives rise to both opportunities and challenges. It may clear the path for long-term, sustainable renewable energy production; however, its simplicity in concept is in contrast to the complexity of implementation.

Can Oregon commit to facilitating availability of sufficient land for solar energy development?

It would be useful if relevant agencies could develop integrated maps of the state's electric transmission and distribution systems and state's land use and soil types. The goal for mapping should be to identify lands that have access to T&D with available capacity. Policy makers can then make informed and balanced decisions about how much land to allocate to the solar resource.

Land for solar power plants should be dispersed on the landscape because geographic diversity in power plant siting has important technical and economic benefits to the utility system. When clouds pass over an individual solar power plant its energy production drops and must be backed up, or "balanced," with generation held in reserve.²⁸ In contrast, the power output of a fleet of geographically diverse solar power plants is less affected during periods of partly cloudy weather than would be a single plant. This reduces the cost to the grid of balancing power supply and demand.

²⁸ BPA charges for "Variable Energy Resource Balancing Services" in its 2012 Transmission, Ancillary and Control Area Service Rates if solar plants are interconnected to its system. Both PacifiCorp and PGE would presumably need to implement some form of balancing charges if a large number of solar power plants are interconnected to their systems.

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Protecting the environmental quality of the land used for solar energy should be a high priority. Design criteria can specify that land be able to be returned to its earlier use. Power plant equipment must be removable by the owner without damaging the land.

Can Oregon commit to facilitating availability of sufficient land for solar energy development? This is a question that policy makers, advocates and citizens will have to decide. The process of answering it will determine the extent to which the solar resource contributes to Oregon's energy economy.

VISOR envisions that Oregon can produce 20% of its electricity from solar energy. Assuming half the production is in the Willamette Valley, it would require about 36 square miles, or 93 square kilometers of Valley land. In this map each of the boxes is 100 square kilometers.²⁹ The solar resource in the Valley would use a little less than one of the squares on the map, although it would be dispersed across the landscape on plots less than 100 acres.

²⁹ <http://landcover.trends.usgs.gov/west/eco3Report.html> "Willamette Valley ecoregion and surrounding ecoregions. Information shown includes land-use/land-cover data from the 1992 National Land Cover Dataset (Vogelmann and others, 2001) and the 32 randomly selected 100 km² sample blocks used to create estimates of change for the entire ecoregion."

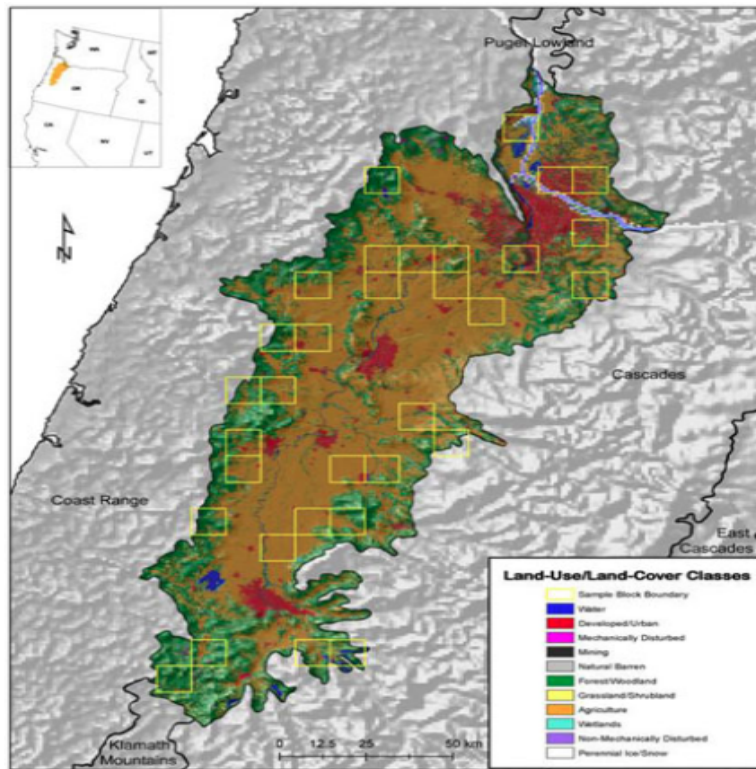


Figure 11: Willamette Valley Land-Use Land-Cover Classes
Source: US Geologic Survey

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Transmission and Distribution Constraints

According to solar developers and utilities alike, transmission access is a major barrier to solar power plant development outside the Willamette Valley. They report there is very little spare transmission capacity with which to move solar energy into the Valley from the east side of the Cascades. By contrast, in the Willamette Valley the T&D network is easily accessed.

If sufficient transmission is built to enable solar resources to be located in sunny Oregon in a meaningful time frame, then that would reduce the need for land in the Willamette Valley to be used for solar energy development. However, Oregon's solar goals should not depend on a transmission planning process that could take well over a decade to build capacity.

The region's transmission owners and stakeholders ought to initiate a high priority review of the recent and forecast solar industry economics, and develop engineering and investment plans for the T&D system that can accommodate its growth.

Building transmission systems is a difficult thing to do in Oregon. Many competing interests make it difficult to get consensus on transmission construction plans. The development time frame for transmission is 7 to 10 years if everything goes well. PGE's Cascade Crossing transmission line has been in planning since 2003 and is not yet approved for construction.

Even with those caveats, Oregon's and the region's transmission owners would appear to have an interest in building transmission to move energy from sunnier Oregon to the Valley. The region's transmission owners and stakeholders ought to initiate a high priority review of the recent and forecast solar industry economics, and develop engineering and investment plans for the T&D system that can accommodate its growth. This planning process should be coordinated with land use discussions and with regional utility transmission stakeholders.

In 2011 the Western Electricity Council (WECC) published its "WECC 10-Year Regional Transmission Plan Summary."³⁰ WECC's responsibility is to help stakeholders understand what mid- to long-term changes to the transmission system in the Western US may be required. WECC transmission plan assumptions will likely need to be revisited, and models developed that accommodate the new low cost solar resources.

Transmission contracts may also be a source of transmission system flexibility. Firm transmission access requires a generator to pay for transmission capacity for

³⁰<http://www.wecc.biz/committees/BOD/09212011/Lists/Minutes/1/Approval%20Item%20-%20WECC%2010-Year%20Regional%20Transmission%20Plan%20Summary.pdf>

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each of the 8760 hours of the year. This may be appropriate for traditional generators that have high capacity factors, or for variable energy resource generators like wind that may need transmission at any time of the day or night. But a solar power plant that operates 20 percent of the hours in a year, and only during the day, must buy 5 times more transmission than it needs. Transmission owners may be able to structure contracts that accommodate the solar resource when it is producing, and makes room for other generators when the sun is not shining.

There may be room for other innovations in power market rules to facilitate solar siting. Obsidian Finance recently completed two pioneering solar plants in Lake County. Lack of transmission access almost prevented one of these projects from being built. David Brown, Obsidian's CEO, is now advocating for new power market rules that would enable developers to put energy onto the grid in a local area, displacing the energy that would otherwise be delivered to that area by the utility, and freeing up power on the grid to be delivered elsewhere.

Distribution system constraints are also a significant barrier. In the Willamette Valley a large fraction of the distribution system is at relatively low voltage and will need to be upgraded to accommodate the addition of significant solar resources. The utilities and solar developers will need to re-conductor circuits and perform substation upgrades. Energy planners and regulators should have a high priority on the question of how to finance and pay for these upgrades.

Increased transparency in transmission and distribution interconnection would help to reduce risk and cost in solar development. In California, Pacific Gas & Electric provides developers access to on-line maps of their transmission and distribution system to help developers locate lines where T&D capacity exists.

Lack of Cost-Effective Financing

The lack of cost-effective financing remains a fundamental barrier to solar development according to Oregon developers.³¹ How to use the proposed new regional infrastructure bank could be important to this market.

One could imagine creating an Oregon Solar Fund, to channel a small part of Oregon's pension fund investments to finance Oregon based solar energy power plants. The plant debt service would be supported by power purchase agreements with the utilities. An Oregon Solar Fund might even provide interest rate discounts if plants use products made in Oregon and sell energy to Oregon's utilities. This could increase sales for the state's equipment manufacturers, earn competitive returns for the state's investments, build Oregon jobs and businesses, and facilitate access to debt financing. The brand could be "Made, Financed and Powered in Oregon."

³¹ Personal conversation with David Brown, Obsidian Finance.

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Property Taxes

Solar equipment used for net metering, on buildings or near irrigation pumps is typically exempt from property taxes. However, in large scale solar plants property taxes for the installed equipment can be a large fraction of annual operating costs. Property tax rates can change project economics from positive to negative if they are set too high.

Property tax rates were a subject at issue in the past legislative session. OSEIA advocated for a fixed \$1.00/Watt valuation of solar power plants. A reason for low property tax rates is that solar plants add negligible cost to local government functions.

In the section on economic results the figures on project cost-effectiveness assumed the property tax rate would be 1.1 percent applied to 70 percent of the total investment in the plant, and would decline 5 percent per year. In these cases property tax represented about 40% of total annual operating costs excluding debt service.

Labor Rules

Labor rules require Oregon plants to use journeyman electricians to carry and bolt solar panels on the racks. While journeymen expertise can play an important role in solar project development, there are markets throughout the U.S. that allow laborers to perform many of these tasks. The cost difference can be significant.

At a large solar power plant under construction today in Spain a robot is installing panels with reportedly much lower cost and higher quality. This can be expected to proliferate. Automation fits into situations where tasks are exactly the same and are performed thousands of times. This reduces the labor cost component of a single plant, but makes many more plants possible.

Since cost reduction continues to be a driving factor in promoting solar development, the labor rules should be reviewed and revised to accommodate appropriate skill levels and technology.

Federal Tax Credit Policy

Two issues in federal tax policy affect the LCOE of solar power plants.

The Investment Tax Credit is presently 30% of capital cost. It is scheduled to revert to 10% in 2017. The Solar Energy Industries Association and others advocate extending the ITC beyond 2016 and creating a ramp down from 30% to 10%. The

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VISOR analysis assumes that the 30% ITC will revert as planned to 10% beginning in 2017.

Only investors with significant federal tax liabilities are able to use the ITC. To enable project developers with small tax bills to use the ITC, solar energy project finance specialists invented a financial engineering structure that recruits so-called “Third Party Tax Equity Investors.” These parties, usually big banks, will co-invest with developers in large solar projects in return for a fraction of the value of the tax benefits. The result is an inefficient mechanism that increases the cost of solar power plants.

During the financial crisis and recession the pool of third party investors shrank as big banks were not profitable and had no need for tax credits. The American Recovery and Reinvestment Act (ARRA) streamlined availability of the ITC by making it available as a simple grant from the Treasury, known as a “Section 1603 cash grant” in which the cost to the Treasury remained the same as the ITC.

As the US Treasury notes on its web site, “The purpose of the 1603 payment is to reimburse eligible applicants for a portion of the cost of installing specified energy property used in a trade or business or for the production of income. A 1603 payment is made after the energy property is placed in service...”³² The 1603 payments made project finance easier and cheaper for developers, which created a surge of energy projects across the nation.

This report assumes the power plant owner will use the ITC and accelerated depreciation in the power plant project finance structure. This assumption is not conservative, since extension of the 1603 program is uncertain. At the time of this report’s writing the extension of the 1603 program was part of the budget negotiation in Washington DC.

Distributed Solar Generation on Buildings

On buildings, solar electricity is called “distributed generation” or “DG.” Unlike utility-scale power plant cost-effectiveness, PV on buildings still has ground to cover, but much progress has and can be made to further reduce costs.

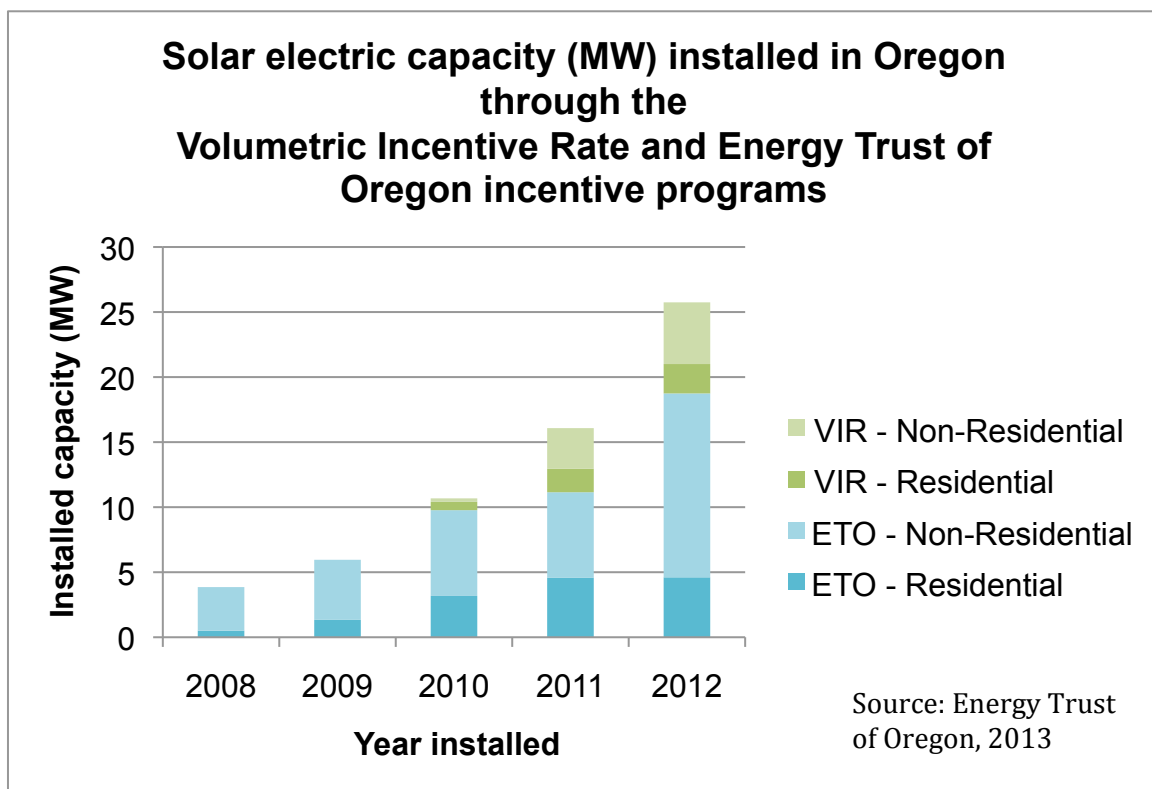
The DG markets vary widely in systems size. Residential systems are generally less than 10 kW, while commercial systems are often in the hundreds of kilowatts and industrial systems may be several megawatts in size.

³² <http://www.treasury.gov/initiatives/recovery/Pages/1603.aspx>

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According to Energy Trust of Oregon data, as of the end of 2012, over 6100 projects and 65 MW-dc of PV have been installed in Oregon, of which roughly 85% represents distributed generation. In the last two years, the average system size for residential projects is just under 4 kW-dc, while the commercial sector has averaged 33 kW-dc since 2008. Larger projects during this time frame, which ETO refers to as utility-scale, totaled 15 projects and over 7 MW of capacity. The following figure charts the growth of installed solar capacity from 2002 through the end of 2012.

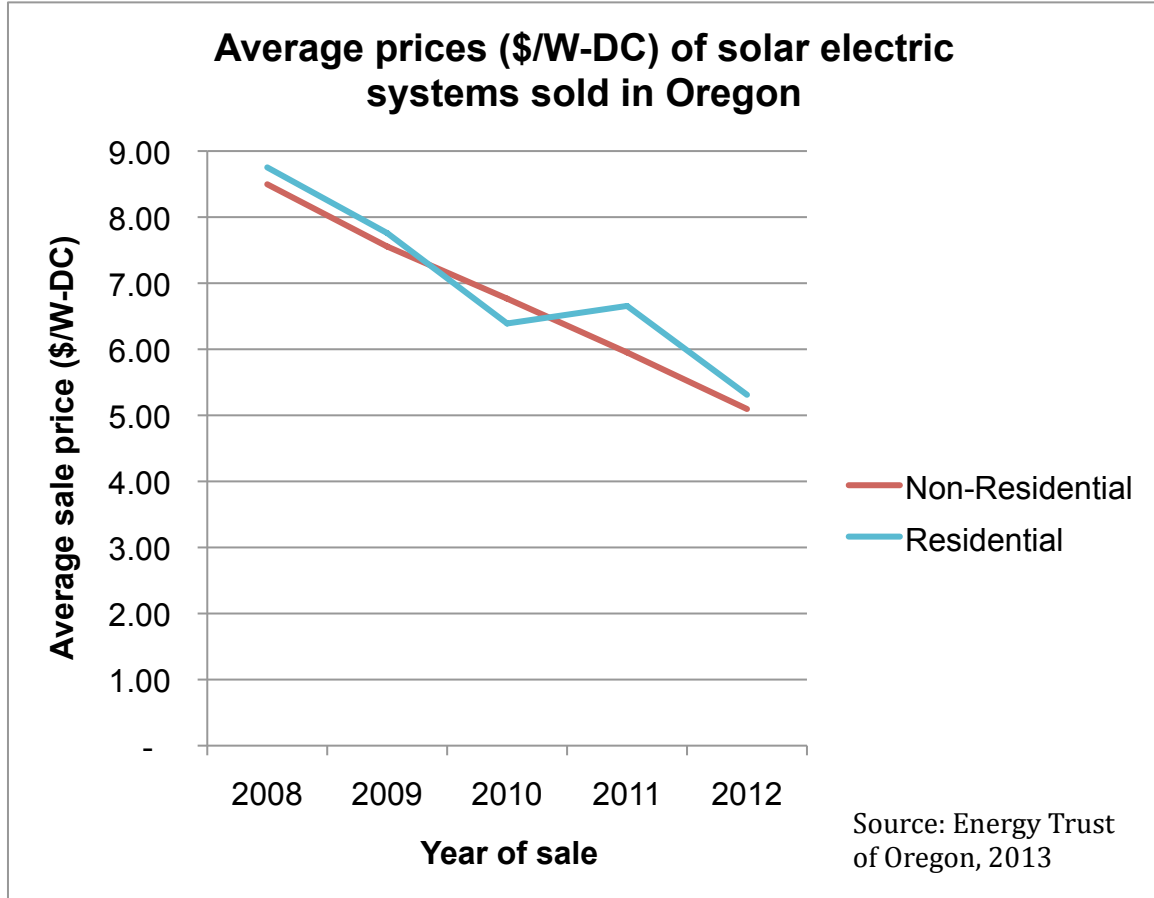
Figure 12: Installed PV capacity trend 2008 –2012
 Source: Energy Trust of Oregon Solar Program data



Pricing for these systems has been trending downward. The ETO data indicates the average commercial sector price in 2010 was \$6.77/W-dc compared to \$5.10 in 2012, or a 25% reduction in just 2 years. During this same timeframe, residential price per Watt was \$6.39 and \$5.31, respectively – a 17% decline. These are significant cost reductions, and more can be expected if market barriers are addressed effectively. Figure 13 charts the impressive decline in residential and commercial installed costs from 2008 through 2012.

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Figure 13: Installed cost trends for residential and commercial PV systems 2008 – 2012. Source: Energy Trust of Oregon Solar Program data



US prices for Q3 - 2012 are reported in the recent GTM and SEIA 2012 Third Quarter Market Insight. Average residential price was slightly more than \$5.00/W and the non-residential average price was about \$4.20/W. The range of prices was extreme, with residential prices reported from a low of about \$3.25/W to a high of more than \$8.00, and the non-residential sector ranging from about \$2.40/W to about \$8.00/W.³³

German Solar Energy Systems Cost Less Than US Systems

In Germany, the cost of a residential PV system is about 40 percent of the cost in Oregon. According to Barry Cinnamon, a US solar industry executive with extensive

³³ GTM and SEIA, op. cit.

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installation business experience, the difference is mainly caused by market design and transaction costs.³⁴

Cinnamon reports that in Germany a homeowner can call a solar contractor and eight days later have a PV system installed and producing energy. This may be a best-case scenario, but it illustrates a smoothly functioning market. A one-page form enables utility interconnection, permitting, energy sale contract, and long-term financing. The customer gets a long-term contract to sell energy to the electric utility at a known price, which is set at an adequate level to pay for the system and earn its owner a modest return on investment over time.

The German model is called a Feed-in-Tariff or FIT. Its simplicity reduces costs and risks for both contractor and customer. To compete for their customers' business, contractors work hard to reduce costs throughout their business processes.

German and US technology costs are about the same. However, US contractors experience "market friction" which leads to higher costs to accommodate a reasonable profit after covering overhead, sales, permitting, supply chain and labor costs.

Though some Oregon solar energy installers have been in business for decades, the Oregon DG PV market is still small and immature. Customer acquisition is time-intensive and costly. Once a contract is signed the installation process presents its own unique challenges. Permitting can be cumbersome and expensive depending upon the municipality. Interconnection to the utility's grid may have hidden costs, and the approval can be slow. Systems are typically smaller in the US than in Germany, which increases the installed cost/kW. In addition, financing generally must be arranged on a project-by-project basis. Banks are often reticent to lend money on unfamiliar technologies, such as solar energy systems, especially in the past few years.

The result is that a 4 kW system in Germany costs \$8,000 (\$2.00/W) and in Oregon it was a bit more than \$20,000 (\$5.08/W) in 2012. For comparison, the US DOE SunShot initiative has a \$1.50/Watt price target for residential systems in 2020. That would equal an installed cost of \$6,000 for a 4 kW residential system.

The scale of the German model also helps to reduce costs. German contractors have a larger market in which to work, with 20 times more PV capacity installed there than in the US. More customers enable business operations to scale up. That

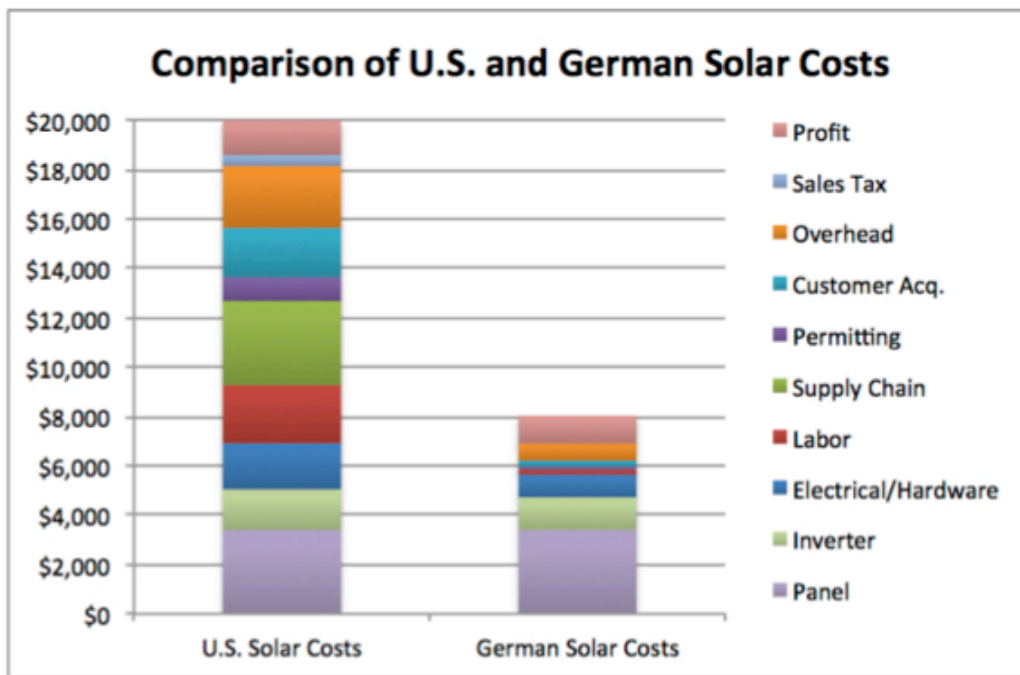
³⁴ Barry Cinnamon, *Cut The Price Of Solar In Half By Cutting Red Tape*, Forbes, July 7, 2012 <http://www.forbes.com/sites/toddwoody/2012/07/05/cut-the-price-of-solar-in-half-by-cutting-red-tape/>

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spreads contractors' fixed costs over more sales, which reduces individual installation costs.

German PV systems tend to be larger than in the US. This is because the systems are sized to the rooftops and available grid interconnection capacity. In Oregon our "net metering" rules restrict homeowners from producing more solar energy than their annual (in some places, monthly) energy usage, which limits system size. Germany's larger installations help contractors achieve lower installed costs per kW. The following figure illustrates the US versus German cost differences and their distribution.

Figure 14: Comparison of US and German Solar Costs for a 4 kW Residential System
Source: Barry Cinnamon, Forbes³⁵



How the State and Communities Can Help Cut the Costs for Solar on Buildings

Communities have a role to play in helping to reduce costs for solar energy installations. The Solar Friendly Communities "12 Best Practices: Roadmap to a Solar Friendly Community" provides details for local governments to "work on streamlining their processes and making solar permitting easier for both citizens and city or county staff."³⁶ The best practices include a dozen techniques that local

³⁵ Barry Cinnamon, op. cit.

³⁶ <http://solarcommunities.org/about-us/>

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jurisdictions can implement to streamline the process and reduce the cost of solar installations.

Figure 15 presents the graphic image used by the Solar Friendly Communities. When accessed on-line, each of the petals of the sunflower image can be opened to reveal details of the recommendation, typical ordinances, and related materials.

Figure 15: Solar Friendly Communities “12 Steps to Reduce Cost of Solar on Buildings”



As part of the Federal government’s approach to cutting the cost of solar energy, the National Renewable Energy Lab offers in-depth technical assistance to state and local governments. NREL and Oregon state government agencies are currently working together to implement this technical assistance. It “...is designed to support the development of solar markets by reducing barriers to wide-scale deployment of solar PV and/or reducing "balance of systems" costs of solar PV.”³⁷

Oregon’s Solar Energy Financial Incentives for Distributed Generation

The structure of existing solar energy financial incentives in Oregon is complicated. It includes a federal income tax credit, an Oregon Residential Energy Tax Credit

³⁷ http://www.nrel.gov/ap/solar_tech_assistance/index.cfm

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("RETC"), Energy Incentive Program for businesses, and rebates offered by Energy Trust of Oregon and other municipal or cooperative utilities.

DG solar installations are governed by a "net-metering" agreement with the servicing utility. Under a net-metering agreement, the customer's electric meter essentially runs backwards whenever the solar system is making more electricity than the customer is using at that time. Any excess energy produced above and beyond the customer's usage over a specified period of time (one year for some utilities, but as little as one month for others), "will be credited ... to customers enrolled in Oregon's low-income assistance programs."³⁸

Net metering rules vary widely among Oregon's utilities. The majority, if not all, contractors would prefer Oregon's net-metering rules to be uniform across the state to simplify the process from utility to utility.

In 2009, to explore alternatives to the current system of solar energy financial incentives, the Oregon Legislature established a solar pilot program akin to a feed-in tariff. The Oregon FIT pilot is available to customers of the state's investor-owned utilities, PGE, PacifiCorp, and Idaho Power. FIT customers receive a 15-year fixed "volumetric incentive rate," ("VIR") for power generated by their solar PV systems, less the retail rate paid for the customer's actual energy use.

A feed-in tariff can be an effective and efficient means with which to promote solar PV projects and drive down the cost of installation, as demonstrated throughout the world in countries like Germany where solar is cheaper and twenty times more prevalent than in the U.S. However, it is incumbent upon policy makers, regulators, industry and stakeholders to thoughtfully design and implement a program that embodies the "TLC" principles – transparency, longevity and certainty.

Oregon's pilot FIT program experienced turbulence upon launch and it continues to operate with fundamental challenges. For example, the initial VIR was set unexpectedly high by the Public Utilities Commission, which resulted in a series of unpredictable downward price adjustments. This, combined with a shift in the methodology for automatic rate adjustments, ran counter to the goal of transparency.

Customers and contractors alike have been confused and frustrated by repeated changes to the enrollment process that shifted from a first-come, first-served approach to a lottery-style to a combination of lottery and competitive bidding.

Contractors endure a boom-and-bust cycle of semi-annual allocations in which capacity is limited, especially for non-residential mid-sized systems. Finally, meter

³⁸ http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=OR03R&re=1&ee=0

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charges and insurance requirements that are not required in the net-metering program impose higher “soft costs,” placing upward pressure on incentive rates.

Non-residential, small-scale projects have incurred a significantly high failure rate. These failed projects successfully made it into the FIT program but did not get built. They lacked financing to cover the higher upfront costs and the investment returns were not attractive.

The increasing number of solar PV installations under the feed-in tariff program has raised concerns among utilities and ratepayer advocates. Incentive payments have the effect of increasing cost across all ratepayer classes, and the issue of fairness and equity, particularly for low-income ratepayers, is one that requires attention.

Utilities’ estimates suggest that Oregon’s feed-in tariff pilot has increased rates by roughly one-quarter of one percent. These costs should be viewed as short-term pump-priming investments that are key to producing long-term benefits.

Best Practices in Feed-in Tariff Design (Now Known as Clean Energy Contracts)

The California based Clean-Coalition.org³⁹ is a US center of excellence in the design of Clean Energy Contracts (known as Feed-in-Tariffs in Europe and elsewhere). Their large, well-funded staff and exceptional board gives the Clean Coalition a depth of experience in business, energy, technology, policy and consumer behavior. They provide technical assistance and policy analysis for stakeholders in states and localities that are interested in establishing advanced clean energy financing and deployment strategies. Their web site provides this description of their mission.

“The Clean Coalition is a nonprofit organization whose mission is to accelerate the transition to local energy systems through innovative policies and programs that deliver cost-effective renewable energy, strengthen local economies, foster environmental sustainability, and enhance energy security. The Clean Coalition believes that the right policies will result in a timely transition to clean energy while yielding tremendous economic benefits, including new job creation, increased tax revenue, and the establishment of an economic foundation that will drive growth for decades. The Clean Coalition is active at the national, state, and local levels.”

Their core perspective is that “Policies and regulations should be simple, fair, and effective ... should deliver both economic leadership and environmental sustainability ... must be well supported by analyses and empirical data based on logic and facts ... should be established on market-based mechanisms ... (and) must deliver transparent programs and level playing fields for all market participants.”

³⁹ <http://www.clean-coalition.org/about-the-clean-coalition/>

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Oregon's stakeholders should pay serious attention to the work of the Clean Coalition, and seek best practices with which to plan the next generation of Oregon's renewable energy financial incentives.

A fair number of Oregonians have already been engaged in discussions of what the next generation of clean energy contracts might look like. This effort should be expanded in terms of stakeholders, and in depth of energy, business, land use, environmental, consumer and utility experience.

Both the small scale distributed generation market and the utility scale power plant market should be considered for advanced clean energy contracts. The DG market is an obvious candidate for these contracts. The market is small, fragmented and not cost-effective.

The utility scale solar power plant market should also be considered for clean energy contracts because of several issues. The PURPA Avoided Cost Rates could become quite volatile. If the rates fall, it could discourage solar development. If the rates increase then solar developers would be earning large returns for little risk.

Considering both markets together would give policy makers a chance to balance the contributions each would make to Oregon's energy economy, and to achieve a long-term reasonable average cost of the growing solar energy resource.

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Conclusion and Summary

Next Steps

OSEIA launched the *VISOR* research to determine if solar energy could become an important part of Oregon's energy supply, and if so how, where and when. The market research, economic analysis, and discussion of the relevant issues clearly demonstrate that solar energy could be significant in Oregon's future energy supply and economy. However, substantial market barriers inhibit growth of the solar industry in Oregon.

To facilitate solar industry growth, stakeholders and policymakers ought to consider the following action items and next steps.

Count all the benefits, and monetize those when possible. Solar energy produces significant benefits in addition to its energy production. These include:

- Reduce carbon emissions
- Reduce carbon risk to the electric utility system
- Improve grid efficiency and reliability through such attributes as power factor correction and on-peak energy production
- Reduce transmission costs
- Reduce line losses

Resolve market barriers. Actions to accomplish this could include:

- Allocate sufficient land in both sunny Oregon and the Willamette Valley
- Map the transmission and distribution systems to identify locations suitable for solar development
- Identify distribution circuits and substations that need to be upgraded, and develop plans to finance and build the upgrades
- Set reasonable property tax rates for solar installations
- Build an Oregon fund and brand to enable Oregon's industry to thrive; "Made, Built, Financed and Energized in Oregon"
- Establish uniform net metering rules throughout Oregon
- Reconsider labor rules to match job skills with tasks, and to include the possibility for technology automation substitution
- Transmission owners should take a fresh look at their plans and resources, with the objective of enabling solar resource growth through modified contracts and related technical adjustments

The Congressional delegation should consider strongly supporting extension of the Section 1603 cash-grant-in-lieu-of the investment Tax Credit. It has zero effect on treasury receipts, and substantially reduces cost for project developers.

Establish new goals for Oregon's solar resource, and the market mechanisms to enable to goals to be met. Implement a Clean Energy Contracts program to fund

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both utility scale and distributed solar generation. Create a clear path to 20% of Oregon electricity from solar energy resource by the year 2030.

Appendix A: Technical Basis of Utility-Scale Economic Analysis

Power Plant Design and Operation

Unit scale for analysis	1 MW-dc
De-rate from DC to AC	83%
Plant nameplate capacity	0.83 MW-ac
Energy production degrades	0.5% per year
O&M, insurance and asset management	\$34,000 per year \$/MW-ac
Inverter replacement cost in year 15	\$130,000
Power plant life	30 years
Transmission line losses BPA system	1.9% (NWPPC 6 th Plan)

BPA Transmission and Ancillary Services Charges

Transmission service PTP-12	\$1.298 per kW-month
Scheduling, system control and dispatch	\$0.0203 per kW-month
Variable Energy Balancing Services	\$0.22 per kW-month
Operating Reserve, Spinning	9.52 mils per kWh
Operating Reserve, Supplemental	10.95 mils per kWh

Value of Carbon Dioxide Emissions

PNW average grid CO ₂ -e emissions	823.4 pounds per MWh (EIA eGrid, 2009)
Short tons of CO ₂ -e	0.412 per MWh
CO ₂ allowance mean forecast value	NWPPC 6th Power Plan Appendix I-15 Escalated post-2029 at 6.8% per year

Economic Terms

Discount rate	5%
Inflation rate	2%
Interest on power plant debt	3.75%
Debt service term	20 years
Corporate tax rate	40%
Depreciation	5 year MACRS
Investment Tax Credit	30% through 2016, then 10%
Fraction of Investment ITC basis	95%
Power plant equity	20%

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Power plant debt	51.5%
Property tax rate	1.1%
Property tax basis	70% of plant investment
Property tax declines at	5% per year

Power Plant Annual Energy Production AC MWh per DC MW Horizontal single axis tracking (source PV Watts)

<u>Location</u>	<u>MWh/yr</u>	<u>Capacity Factor</u>
Redmond	1773	20.2%
Pendleton	1654	18.9%
Burns	1718	19.6%
Medford	1618	18.5%
Mean Sunny Oregon	1691	19.3%
Salem	1392	15.9%

Power Plant Capital Costs

<u>Year</u>	<u>\$/W-dc</u>
2014	\$2.40
2015	\$2.26
2016	\$2.12
2017	\$1.99
2018	\$1.87
2019	\$1.76
2020	\$1.66

Land Required for Solar Power Plants if Produce 20% of Oregon Energy

2010 Oregon electric utility sales MWh	45,673,659
20% of 2010 MWh	9,134,732
Acres per MW horizontal single axis PV	7

	<u>Sunny Oregon</u>	<u>Willamette Valley</u>
PV energy production MWh/MW-yr	1,691	1,392
MW for 10% energy each location	2,701	3,281
Square miles each location	29.5	35.9
Total MW required for 20% Oregon MWh	5,982	
Total square miles solar land required	65.4	

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Solar Energy Lands Required As Fraction of:

Area	Square Miles	PV %
Oregon total lands	95,988	0.07%
Oregon agricultural lands	25,625	0.26%

		Blended Peak and Off Peak PURPA Avoided Cost Rate Schedules \$/MWh	
		2012	2013
<u>Year</u>	<u>PacifiCorp</u>	<u>PGE</u>	
2014	\$ 39.40	\$ 38.88	
2015	\$ 41.90	\$ 41.85	
2016	\$ 57.04	\$ 73.85	
2017	\$ 59.76	\$ 76.57	
2018	\$ 63.10	\$ 78.91	
2019	\$ 66.34	\$ 82.51	
2020	\$ 65.79	\$ 85.66	
2021	\$ 68.61	\$ 89.39	
2022	\$ 72.94	\$ 91.52	
2023	\$ 75.37	\$ 96.06	
2024	\$ 75.00	\$ 96.56	
2025	\$ 76.94	\$ 97.98	
2026	\$ 79.87	\$ 100.52	
2027	\$ 82.49	\$ 102.36	
2028	\$ 84.61	\$ 104.15	
2029	\$ 86.44	\$ 107.14	
2030	\$ 87.66	\$ 109.67	
2031	\$ 89.15	\$ 112.13	
2032	\$ 90.66	\$ 113.83	
2033	\$ 92.20	\$ 116.79	
2034	\$ 93.77	\$ 119.83	
2035	\$ 95.37	\$ 122.94	
2036	\$ 96.99	\$ 126.14	
2037	\$ 98.64	\$ 129.42	
2038	\$ 100.31	\$ 132.78	
2039	\$ 102.02	\$ 136.24	
2040	\$ 103.75	\$ 139.78	
2041	\$ 105.52	\$ 143.41	
2042	\$ 107.31	\$ 147.14	
2043	\$ 109.13	\$ 150.97	
2044	\$ 110.99	\$ 154.89	
2045	\$ 112.88	\$ 158.92	

PURPA Avoided Cost Rate Schedules for PGE and PacifiCorp

Avoided Cost Rates are published through 2030, after which VISOR escalates each company's rates by 1.7% per year.

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Typical Power Plant Economic Analysis

Solar Power Plant Levelized Costs PP&L PURPA Qualifying Facility Interconnected to PacifiCorp Excludes credit for avoided carbon risk				In Service Date Location		1/1/14 Redmond											
Capital Cost	\$ 2,496,960			PV of MWh:	\$ 24,909												
ITC	\$ 711,634	28.50%		PV of Cost:	\$ 1,540,789												
Debt	\$ 1,285,934	51.50%		PV of Revenue:	\$ 1,855,348												
Equity	\$ 499,392	20.00%		Levelized Cost \$/MWh:	\$ 61.86												
				Levelized Revenue \$/MWh:	\$ 74.48												
Year	Equity Investment and ITC	After Tax Debt Service	After Tax Depreciation (Benefit)	Insurance, O&M & Asset Management	Avoided Carbon Risk (Benefit)	Transmission & Integration	Wheeling	Spinning and Supplemental Reserve	Property Tax	Total Costs	MWh less degradation	PV of Costs	PV of MWh	PP&L QF Avoided Cost Rate	PP&L QF Plant Revenue	PV of PP&L QF Plant Revenue	
2012	0																
2013	1	\$ 1,211,026								\$ 1,211,026	0	\$ 1,153,358					
2014	2	\$ (711,634)	\$ 73,250	\$ (169,793)	\$ 29,360	\$ -	\$ -	\$ -	\$ -	\$ 19,227	\$ (759,591)	1,773	\$ (688,971)	1,608	\$ 39.40	\$ 69,856	\$ 63,361
2015	3		\$ 73,914	\$ (271,669)	\$ 29,947	\$ -	\$ -	\$ -	\$ -	\$ 18,265	\$ (149,542)	1,764	\$ (129,180)	1,524	\$ 41.90	\$ 73,917	\$ 63,852
2016	4		\$ 74,604	\$ (163,002)	\$ 30,546	\$ -	\$ -	\$ -	\$ -	\$ 17,352	\$ (40,499)	1,755	\$ (33,319)	1,444	\$ 57.04	\$ 100,127	\$ 82,375
2017	5		\$ 75,319	\$ (97,601)	\$ 31,157	\$ -	\$ -	\$ -	\$ -	\$ 16,494	\$ 25,160	1,747	\$ 19,714	1,368	\$ 59.76	\$ 104,367	\$ 81,775
2018	6		\$ 76,062	\$ (97,601)	\$ 31,780	\$ -	\$ -	\$ -	\$ -	\$ 15,660	\$ 25,701	1,738	\$ 19,179	1,297	\$ 63.10	\$ 109,655	\$ 81,626
2019	7		\$ 76,832	\$ (48,900)	\$ 32,416	\$ -	\$ -	\$ -	\$ -	\$ 14,877	\$ 75,225	1,729	\$ 53,461	1,229	\$ 66.34	\$ 114,714	\$ 81,525
2020	8		\$ 77,631		\$ 33,064	\$ -	\$ -	\$ -	\$ -	\$ 14,133	\$ 124,829	1,720	\$ 84,489	1,164	\$ 65.79	\$ 113,182	\$ 76,606
2021	9		\$ 78,460		\$ 33,726	\$ -	\$ -	\$ -	\$ -	\$ 13,427	\$ 125,612	1,712	\$ 80,971	1,103	\$ 68.61	\$ 117,458	\$ 75,714
2022	10		\$ 79,320		\$ 34,400	\$ -	\$ -	\$ -	\$ -	\$ 12,755	\$ 126,476	1,703	\$ 77,645	1,046	\$ 72.94	\$ 124,243	\$ 76,275
2023	11		\$ 80,213		\$ 35,088	\$ -	\$ -	\$ -	\$ -	\$ 12,118	\$ 127,418	1,695	\$ 74,499	991	\$ 75.37	\$ 127,738	\$ 74,686
2024	12		\$ 81,139		\$ 35,790	\$ -	\$ -	\$ -	\$ -	\$ 11,512	\$ 128,440	1,686	\$ 71,520	939	\$ 75.00	\$ 126,473	\$ 70,425
2025	13		\$ 82,099		\$ 36,506	\$ -	\$ -	\$ -	\$ -	\$ 10,936	\$ 129,541	1,678	\$ 68,698	890	\$ 76.94	\$ 129,101	\$ 68,465
2026	14		\$ 83,096		\$ 37,236	\$ -	\$ -	\$ -	\$ -	\$ 10,389	\$ 130,721	1,669	\$ 66,023	843	\$ 79.87	\$ 133,344	\$ 67,348
2027	15		\$ 84,130		\$ 37,980	\$ -	\$ -	\$ -	\$ -	\$ 9,870	\$ 131,980	1,661	\$ 63,485	799	\$ 82.49	\$ 137,020	\$ 65,969
2028	16		\$ 85,202		\$ 38,740	\$ -	\$ -	\$ -	\$ -	\$ 9,376	\$ 133,319	1,653	\$ 61,075	757	\$ 84.61	\$ 139,853	\$ 64,088
2029	17	\$ 151,086	\$ 86,315		\$ 39,515	\$ -	\$ -	\$ -	\$ -	\$ 8,908	\$ 285,824	1,645	\$ 124,704	718	\$ 86.44	\$ 142,161	\$ 62,024
2030	18		\$ 87,470		\$ 40,305	\$ -	\$ -	\$ -	\$ -	\$ 8,462	\$ 136,237	1,636	\$ 96,609	680	\$ 87.66	\$ 143,437	\$ 59,601
2031	19		\$ 88,668		\$ 41,111	\$ -	\$ -	\$ -	\$ -	\$ 8,039	\$ 137,818	1,628	\$ 94,539	644	\$ 89.15	\$ 145,146	\$ 57,439
2032	20		\$ 89,911		\$ 41,933	\$ -	\$ -	\$ -	\$ -	\$ 7,637	\$ 139,462	1,620	\$ 92,569	611	\$ 90.66	\$ 146,876	\$ 55,356
2033	21		\$ 91,201		\$ 42,772	\$ -	\$ -	\$ -	\$ -	\$ 7,255	\$ 141,228	1,612	\$ 90,893	579	\$ 92.20	\$ 148,626	\$ 53,348
2034	22				\$ 43,628	\$ -	\$ -	\$ -	\$ -	\$ 6,892	\$ 50,520	1,604	\$ 17,270	548	\$ 93.77	\$ 150,397	\$ 51,413
2035	23				\$ 44,500	\$ -	\$ -	\$ -	\$ -	\$ 6,548	\$ 51,048	1,596	\$ 16,620	520	\$ 95.37	\$ 152,189	\$ 49,548
2036	24				\$ 45,390	\$ -	\$ -	\$ -	\$ -	\$ 6,220	\$ 51,611	1,588	\$ 16,003	492	\$ 96.99	\$ 154,002	\$ 47,751
2037	25				\$ 46,298	\$ -	\$ -	\$ -	\$ -	\$ 5,909	\$ 52,207	1,580	\$ 15,417	467	\$ 98.64	\$ 155,837	\$ 46,019
2038	26				\$ 47,224	\$ -	\$ -	\$ -	\$ -	\$ 5,614	\$ 52,838	1,572	\$ 14,860	442	\$ 100.31	\$ 157,694	\$ 44,350
2039	27				\$ 48,168	\$ -	\$ -	\$ -	\$ -	\$ 5,333	\$ 53,502	1,564	\$ 14,330	419	\$ 102.02	\$ 159,573	\$ 42,741
2040	28				\$ 49,132	\$ -	\$ -	\$ -	\$ -	\$ 5,067	\$ 54,198	1,556	\$ 13,826	397	\$ 103.75	\$ 161,474	\$ 41,191
2041	29				\$ 50,114	\$ -	\$ -	\$ -	\$ -	\$ 4,813	\$ 54,928	1,549	\$ 13,344	376	\$ 105.52	\$ 163,398	\$ 39,697
2042	30				\$ 51,117	\$ -	\$ -	\$ -	\$ -	\$ 4,573	\$ 55,689	1,541	\$ 12,885	357	\$ 107.31	\$ 165,345	\$ 38,257
2043	31				\$ 52,139	\$ -	\$ -	\$ -	\$ -	\$ 4,344	\$ 56,483	1,533	\$ 12,447	338	\$ 109.13	\$ 167,315	\$ 36,869
2044	32				\$ 53,182	\$ -	\$ -	\$ -	\$ -	\$ 4,127	\$ 57,309	1,525	\$ 12,027	320	\$ 110.99	\$ 169,309	\$ 35,532

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