Investigation into the Effectiveness of Solar Programs in Oregon

Prepared by:

Public Utility Commission of Oregon

July 1, 2014

EXECUTIVE SUMMARY

The 2013 Oregon Legislature passed House Bill 2893 directing the Oregon Public Utility Commission to study the effectiveness of the state's solar energy incentive programs and report to the Legislature on its findings. Specifically, HB 2893 directs the PUC to:

a) Investigate the resource value of solar energy,
b) Investigate the costs and benefits of the existing solar incentive programs,
c) Forecast future costs for solar energy systems,
d) Identify barriers to the development of solar energy systems, and
e) Recommend new programs or program modifications that encourage solar development in a way that is cost effective and protects ratepayers.

Based on its investigation, the Commission offers the following findings:

FINDINGS

A. Solar Photovoltaic System Characteristics

1. Solar photovoltaic systems convert sunlight directly into current that can be used to meet the electricity needs of homes and businesses. The direct conversion of sunlight to electricity means that during operation there is no reliance on fossil fuels and there are no environmental emissions.

2. Solar systems can come in many sizes. The size of solar system is based on its peak output. Rooftop systems for homes range from 1 kilowatt to 10 kilowatts or more. On-site systems for businesses and other enterprises typically range from 10 kilowatts up to several megawatts. Central station (off-site) utility-scale systems can have generating capacities up to hundreds of megawatts.

3. Solar generation is an intermittent resource. Solar generation varies by hour, day, and season. Accordingly, absent storage facilities, other generating resources must be used to serve electricity demand when the sun is not shining.

B. Oregon Solar Programs

1. For nearly 35 years, Oregon has promoted the development of solar systems. Currently, Oregon offers a wide range of programs to spur the development of solar photovoltaic systems. Programs include net metering, utility and Energy Trust incentives, feed-in tariffs, solar capacity standards, and state federal tax credits. Solar systems are also eligible for federal investment tax credits.

2. Other states have begun experimenting with new programs to encourage solar development such as community solar programs and Value of Solar tariffs.

C. Solar Development in Oregon

1. In 2013, the total generating capacity of solar photovoltaic systems installed in Oregon represented less than 1 percent of the electric generating capacity used to serve Oregonians.

2. The number of solar photovoltaic installations has increased rapidly in recent years. The estimated number of installations in Oregon has grown from about 1,000 systems in 2009 to more than 8,000 systems in 2013.

3. Most of the residential and commercial solar projects installed in Oregon in recent years have been developed and financed by third party companies. Under these third party arrangements, solar users pay none of the upfront cost of systems but pay a lease fee or ongoing charge.

D. Cost of Solar Systems

1. The total cost of electricity from solar systems varies based on size of system, system location, system efficiency, solar panel cost, system design, cost of physical installations, permitting and application costs, and many other factors. In general, the larger the system, the more efficient the system, the cheaper the panel costs, and the sunnier the clime, the lower the cost of electricity from solar photovoltaic systems over their lifetime.

2. In 2013, the residential solar systems installed in Oregon, on average, cost of $4.73 per watt or about 43 cents per kilowatt-hour on a 20-year levelized basis. The installed costs of individual systems varied widely.

3. In 2013, the large solar systems were installed at a cost, on average, of about $3.34 per watt or 20 cents per kilowatt-hour on a 20-year levelized basis. The installed costs of individual systems varied widely.

4. Solar system costs in Oregon, as elsewhere, have dropped substantially over the past decade. From 2011 to 2013, the average cost of small systems dropped from $6.63/watt to $4.69/watt, the average cost of medium-sized systems fell from $5.88/watt to $4.06/watt, and the average cost of large systems dropped from $5.37/Watt to $3.34/watt.

5. Solar system costs can be split into equipment costs (such as the solar panels) and non-equipment costs that cover a wide range of costs. Equipment costs have dropped more sharply than non-equipment costs. Panel costs for Oregon systems, on average, have dropped from $3.00/Watt to $1.25/Watt from 2010 to 2013. During that same time, average non-equipment costs nationally have dropped from $3.50/Watt to $2.50/Watt. Non-equipment costs now account for most of the total costs of a system.

6. Future cost declines are projected. The National Renewable Energy Laboratory predicts that the average cost of panels will go to $1 per watt by 2020. The U.S. Department of Energy, in its Sunshot Initiative, has set a goal of reducing non-equipment costs to less than $1 per watt by

2020. If both predictions come true, the installed cost of a standard home system will go below $2 per watt by 2020.

E. Solar Resource Value

1. The resource value of solar refers to the value of the benefits solar generation brings to the utility system and electricity ratepayers in general. It does not include potential social benefits such as improved environmental quality.

2. The resource value of solar includes such factors as avoided energy costs, avoided capacity additions, reduced transmission line losses, avoided transmission and distribution investments and many other factors.

3. A number of studies in recent years have tried to estimate the value of solar. The estimates range widely from 4 cents per kilowatt-hour to 25 cents per kilowatt-hour. There is no agreed-upon approach to estimating the value of solar. The studies use different assumptions, different calculation methods, and quantify different combinations of value elements.

4. The Oregon Commission required utilities to estimate the value of solar based on three factors – avoided energy and capacity costs and avoided transmission losses. The Oregon utility estimates range from 5 cents per kWh to 6.7 cents per kWh. These estimates do not include value estimates for many potential factors.

F. Evaluation of Solar Programs in Oregon

1. The Oregon PUC evaluated the five common combinations of current state programs available for solar PV systems. These are: (a) Net metering combined with Energy Trust rebates and residential tax credits; (b) Net metering combined with Energy Trust rebates and business energy tax credits; (c) Volumetric incentive rates for small residential and commercial systems; (d) Volumetric incentive rates for large systems; and (e) the Solar Capacity Standards for Oregon utilities.

2. The Oregon PUC evaluated the five combinations of programs using four criteria: (a) cost to ratepayers and taxpayers; (b) impact of the program on the cost of solar installations; (c) greenhouse gas emission reductions; and (d) jobs impact. Based on those criteria, the PUC finds:
    a. After accounting for the size of systems, system location, and system design, there is no discernible difference in total cost of systems installed from program to program.
    b. The average cost to ratepayers and taxpayers from the five combinations of programs ranged, on average, from about 15 cents per kilowatt-hour to about 29 cents per kilowatt-hour. The average costs to ratepayers alone from the five combinations of programs ranged from 6 cents per kilowatt-hour to 21 cents per kilowatt-hour.
    c. No single program appears to be more effective than others at lowering installation costs.

   d. The Volumetric Incentive Rates varied based on size of system, location, and procurement method. Incentives for Eastern and Southern Oregon systems are 35 percent lower than in the Willamette Valley.
   e. Greenhouse gas reduction benefit is solely tied to the amount of solar power produced under a program.
   f. The types of jobs created vary based on the size and type of systems installed. Programs for small residential and commercial PV projects support local installers. Programs that promote large projects create jobs during construction.

3. For program participants, the benefits from bill savings coupled with incentives tend to pay for costs they incur over time. For non-participants, the cost of solar installations includes impacts on electricity rates and bills from incentives and the lost tax revenues from tax credits. The primary benefits to non-participants flow from the avoided costs of capacity and energy of foregone power purchases or generation.

4. Stakeholders identified lack of upfront financing, the "confusing" array of incentive programs, duplicative incentive application requests, and lack of long-term program stability as major program barriers to solar development.

G. Other Issues

1. Under net metering programs, solar users may not pay for their share of fixed costs of the generation, transmission, and distribution services embedded in electricity rates thereby shifting costs on to other ratepayers. Whether and how much, such cost shifting is occurring depends on the value of solar generation to other ratepayers.

2. Smart inverters will alleviate reliability problems that may crop up at higher levels of solar penetration.

RECOMMENDATIONS AND NEXT STEPS

At this time, the Commission offers no recommendation for changes to programs.

The Commission will undertake the following actions:

1. The Public Utility Commission will open a formal proceeding to determine the resource value of solar and the extent of cost-shifting, if any, from net metering. As part of this docket, the Commission will evaluate the reliability and operational impacts of increasing levels of solar generation. We believe that such an investigation is necessary before offering specific recommendations on programs.

2. The Commission will begin workshops to examine the use of smart inverters and track national efforts to change interconnection standards. When the timing is right, the Commission will consider new interconnection requirements.

Introduction

The 2013 Oregon Legislature passed House Bill 2893 directing the Oregon Public Utility Commission to study the effectiveness of the state's solar energy incentive programs and report to the Legislature on its findings. Specifically, HB 2893 directs the PUC to:

a) Investigate the resource value of solar energy,
b) Investigate the costs and benefits of the existing solar incentive programs,
c) Forecast future costs for solar energy systems,
d) Identify barriers to the development of solar energy systems, and
e) Recommend new programs or program modifications that encourage solar development in a way that is cost effective and protects ratepayers.

The report is organized into six chapters.

Chapter 1 describes solar photovoltaic (PV) systems and their characteristics as an energy resource. It also examines trends in solar development in Oregon.

Chapter 2 describes Oregon's policies and programs to encourage the development of solar PV systems and new programs offered elsewhere in the U.S.

Chapter 3 examines the current and future costs of solar PV systems. It describes the major cost components and the factors affecting solar costs. It also shows the trends in costs over time.

Chapter 4 discusses the value of solar power to the energy system and society as a whole. It examines the components of value, methods for valuing those components, and estimates of value that have been produced.

Chapter 5 evaluates the costs and benefits of Oregon's solar incentive programs and compares the different programs. It also identifies barriers to solar development.

Chapter 6 discusses three issues surrounding the development of solar in Oregon – recovery of utility fixed costs under net metering, use of "smart inverters" to connect solar generation to utility distribution systems, and efforts to reduce the non-hardware costs of solar systems.

Chapter 1: Solar Development in Oregon

Solar PV systems consist of arrays of thin plate-like panels containing specially configured semiconductor materials. When sunlight hits the panels, an electric current is generated that can be used to power loads. The more sunlight striking the photovoltaic panel, the more electricity is produced.

Solar generation can meet both the energy and capacity needs of the electricity systems and its users. Solar PV systems' direct conversion of sunlight to electricity means that during operation there is no reliance on fossil fuels for the electricity produced and there are no environmental emissions.

Solar generation is an intermittent resource. The reliance on sunlight means that solar generation varies by hour, by day, and by season. As an intermittent resource, absent a way to store electricity, buildings drawing from on-site solar generation must still be connected to the power grid to access power from other resources at night and on cloudy days. Utilities must have resources available to ramp up and down with the varying solar generation.

Solar panels can be small enough to be mounted directly on a building roof to serve some or all the building's power needs, while large solar arrays can supply bulk power to the electricity system. The size of systems is measured by their instantaneous peak output under ideal conditions. For example, a 3 kilowatt system theoretically will generate up to 3 kilowatts instantaneously.

For ease of analysis and discussion in this report, solar installations are categorized by size: small, medium and large.

Small systems range from 1 to 10 kilowatts. Most residential systems and some small commercial systems are within this range. Small systems are typically mounted on the roofs of buildings or dwellings and are fixed so they face the same direction at all times.

Medium systems range from 10 to 100 kilowatts. Systems in this range are usually fixed on rooftops like small systems.

Large systems are above 100 kilowatts. The larger systems can be installed on rooftops or on the ground with tracking mechanisms that enable the solar panels to follow the sun as it travels, providing more consistent generation throughout the day.

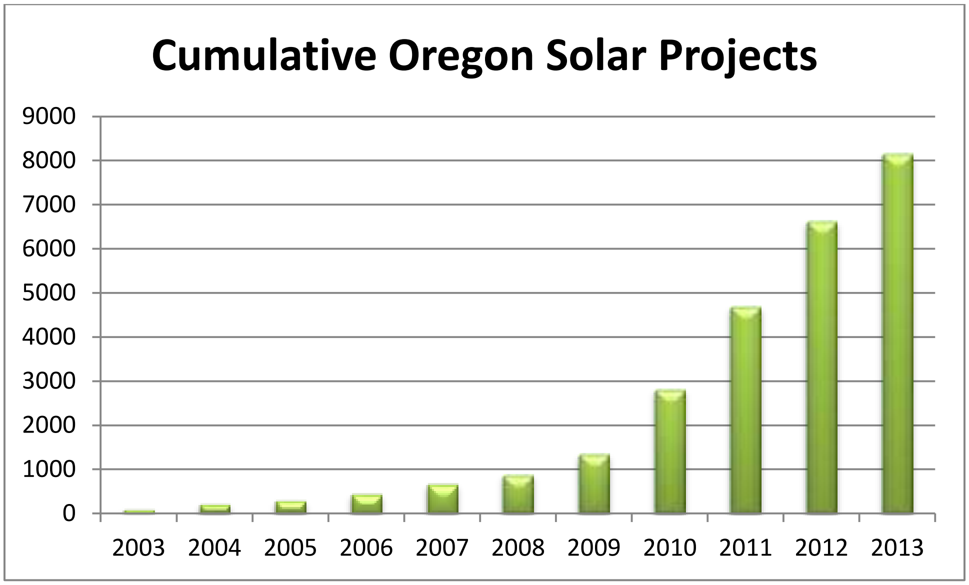
Systems installed at or very near the load are referred to as distributed generation, whereas central station systems are systems, usually large, installed far from load.

Trends in Solar Development

Before 2003, comparatively few solar PV systems were installed in Oregon. The number of solar systems has increased steadily, particularly since 2008. The total known number of systems installed has grown from about 1,000 systems in 2009 to more than 8,000 systems at the end of 2013.

Figure 1.1 below shows the cumulative number of solar projects in Oregon since 2003:

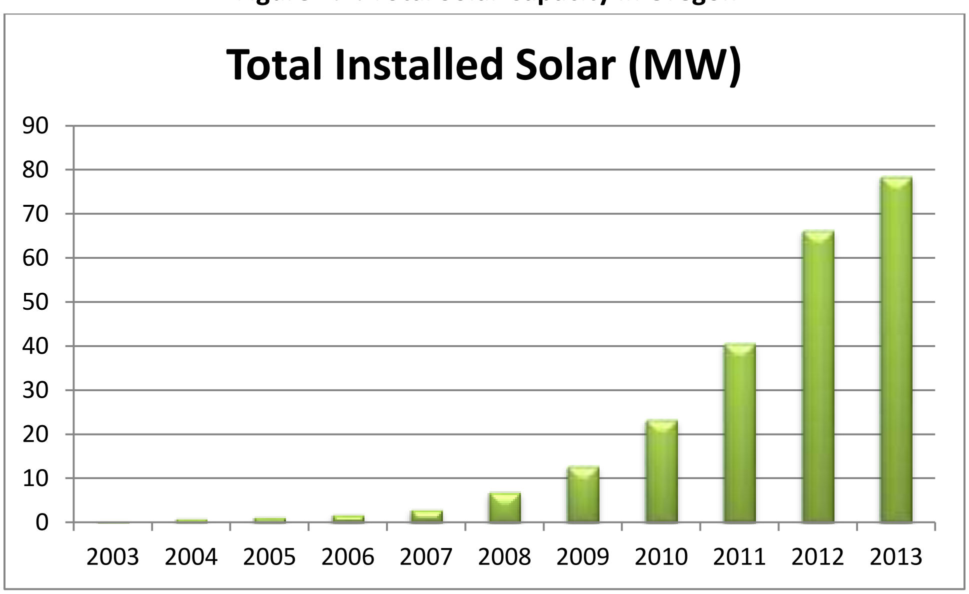
Figure 1.1: Cumulative Number of Solar Installations in Oregon



The more than 8,000 systems installed through 2013 translate into about 77 megawatts of solar PV generating capacity. For comparison, Oregon's peak load is about 8,200 megawatts.[1]

About 37 percent of the 77 megawatts of generating capacity is from small systems, 48 percent from medium-sized systems, and 15 percent from large projects built by utilities or from which the utilities have purchased power to meet statutory targets for installed solar system capacity.

Figure 1.2: Total Solar Capacity in Oregon



[1] Email from M. Jourabchi, NW Planning and Conservation Council, to Adam Bless/OPUC, April 18, 2014.

Role of Third Party Solar Companies

Since 2011, the majority of solar projects in Oregon have been developed and financed by third party companies such as Solar City, Sun Run, and Lite Solar Corporation. These companies buy, install, own, and operate the solar PV systems on their clients' property. The companies either lease the equipment to the client for a fee or sell the electricity generated to the client at rates contracted for 10 to 20 years. The customer pays no upfront costs for a system.

Third party companies aggregate various federal and state incentives and offer customers a solar energy contract at or below the utility's retail rate.[2] Under the third party business model, the customer is unencumbered by the array of incentive program requirements. Third party companies also bundle the various financial incentives in a way that enables them to effectively raise capital. Further, third party companies can take advantage of tax credits for solar PV systems when they enter into contracts with entities that cannot, such as schools and churches.

Third party company offers have been combined with other Oregon incentives such as Energy Trust of Oregon (Energy Trust or ETO) rebates and volumetric incentive rate Pilot Program output prices. For example, in 2013, 68 percent of the participants in PGE's volumetric incentive rate Pilot Program entered into contracts with third party companies.

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[2] *See* "Distributed Solar Power: A Path Forward," Solar City, December 5, 2013.

Chapter 2: Solar Programs

For nearly 35 years, Oregon has promoted the installation of solar PV systems to supply electricity to Oregon homes and businesses. Since 1977, Oregon households have been eligible for tax credits to offset part of the costs of solar projects and businesses were eligible for such tax credits from 1979 to 2012. In 1999, the Oregon Legislature passed a law requiring Oregon utilities to offer net metering to customers with on-site systems. Some utilities have supplemented the net metering incentives with direct incentives for projects. Since 2003, the Energy Trust has offered incentives for the installation of solar PV projects by Oregon customers of PacifiCorp and Portland General Electric (PGE). In 2007, the Oregon Legislature adopted the Renewable Portfolio Standard (RPS) requiring Oregon's electric utilities to meet a percentage of their loads with renewable resources. In 2009, the Oregon Legislature directed the Commission to establish a pilot program to examine the effectiveness of a volumetric incentive rate (VIR) in developing solar PV systems. That same year, the Legislature also created a Solar Capacity Standard requiring PacifiCorp, Portland General Electric, and Idaho Power to meet specific targets for the development of solar systems exceeding 500 kilowatts.

Today, Oregon offers a wide array of programs comprised of those identified above and others aimed at encouraging the installation of solar PV systems.

We describe each of these programs below.

Net Metering

Since 1999, Oregon has required all Oregon electric utilities to provide net metering for the output from solar PV panels installed on homes and small businesses. Under net metering, customers enter into an agreement with their utility to interconnect their solar system to the utility's distribution system. The electricity generated by the customer's solar system offsets the electricity supplied to the customer by their utility. In effect, the customer is paid the utility's retail rate for the power generated by the solar photovoltaic system.

The customer can generate more than they use in a given month and apply the excess generation towards charges in future months. However, under Oregon law, the customer cannot get credit for annual generation in excess of what they use in a year. If the customer's annual generation exceeds their annual load, the excess generation credits are donated to the utility's low-income assistance program.

Oregon law limits the size of individual net metering systems to 25 kilowatts, unless the Public Utility Commission elects to set a higher limit for systems in the service areas of PGE, PacifiCorp, and Idaho Power. Current, the Public Utility Commission has a 25 kilowatt capacity limit for residential systems and 2 megawatt limit for non-residential systems.

Oregon law authorizes the Commission to limit the cumulative generating capacity of net metered systems in a utility's service territory to one-half of one percent of the investor-owned utility's peak load. The total capacity of the net metered systems in both PGE's and PacifiCorp's service areas exceed this threshold. Before setting a cap, the Commission must provide an opportunity for public comment and assess the environmental and societal benefits of net metering.[3] The Commission has taken no action to cap the total capacity of net metered systems for either utility.

Through 2013, about 7,000 net-metered systems have been installed in Oregon. These systems have a total capacity of about 42 megawatts. About 6,000 net-metered systems are residential systems and about 1,000 net-metered systems are non-residential systems. A little under a 1,000 systems were installed in the service areas of Oregon's consumer-owned utilities. The rest were installed in the service areas of PGE, Pacific, and Idaho Power.

Energy Trust of Oregon

Since 2003, the Energy Trust has offered rebates for solar PV installations at homes and businesses served by PGE and PacifiCorp. Customers who receive an Energy Trust rebate must have a net metering agreement with their utility.

The rebates are funded through a charge collected from customers of PGE and PacifiCorp. Customers of these utilities pay a three percent charge on their bills that goes for electricity conservation, renewable resource, and low-income energy programs. Seventeen percent of the money collected from the charge goes to programs to encourage the development of renewable resources such as solar. Only resources of 20 megawatts or below are eligible for Energy Trust incentives.

The Energy Trust incentives help pay the down the upfront capital cost of the solar system. The amount of the rebate is tied to the kilowatt capacity of the system. Energy Trust incentives have varied over time. Recently, residential customers can receive rebates of up to $1.00 per installed watt, up to a limit of $10,000.

From 2002 through the end of 2013, the Energy Trust has provided rebates for nearly 6100 systems, including 5292 residential systems, 786 commercial systems, and 16 utility-scale projects.[4]

Utility Rebates

Seven consumer-owned utilities also offer rebates for solar investment:

- Ashland Electric offers a rebate of $.75/Watt (residential) or $1.00/Watt (commercial), with a limit of $7500 per system.
- Consumers Coop offers a rebate of $.50/watt, with a limit of $3000 per system.
- Eugene Water and Electric Board (EWEB) offers a rebate of $.60/Watt (residential) or $.50/Watt (commercial). The EWEB program is funded by participants in its voluntary "Green Power" program. Thus, the EWEB incentive has no impact on non-participating ratepayers.

[3] ORS 757.300.
[4] Data on systems completed by December 2013 provided by Energy Trust.

- Oregon Trail Electric Coop offers a residential rebate of $500 for a 1 kW installation (equivalent to $.50/watt).
- Salem Electric offers a rebate of $600 for the first 3 kW and $300 for each kW above that.
- Columbia River PUD offers up to $1.50/Watt up to a total of $3,500.
- Emerald PUD offers $0.75/Watt up to a limit of $3,500 for residential installations and $10,000 for commercial installations.

Through December 2013, the consumer-owned utility programs have spurred the development of 960 systems with a total capacity of 5.5 MW.

Renewable Portfolio Standard (RPS)

In 2007, the Oregon Legislature adopted a Renewable Portfolio Standard (RPS) to promote the development of renewable resources. Oregon's three largest utilities – PGE, PacifiCorp, and EWEB – must meet the following percentage of their electricity load with eligible renewable generating resources:

- 5 percent by 2011,
- 15 percent by 2015,
- 20 percent by 2020, and
- 25 percent after 2025.

Oregon's other utilities have a target of either 5 or 10 percent in 2025, depending on their size.

Eligible renewable resources include wind, solar, geothermal, biomass, ocean resources, hydrogen derived from certain renewable resources, low-impact hydroelectric facilities, and hydroelectric upgrades built after 1995. Generation must come from a Western U.S. plant.

Utilities can meet the standard by building an eligible generating facility or buying energy from one; buying "unbundled" renewable energy certificates; or making "alternative compliance payments." An investor-owned utility can choose to not comply with the RPS in a particular year if the cost of compliance with the RPS would exceed an amount equal to four percent of the utility's revenue requirement for that year.

To date, PGE and PacifiCorp have met their RPS targets largely through the use of renewable energy certificates and direct investments in wind and hydroelectric upgrades (Figures 2.1 and 2.2). Neither utility has developed any appreciable amount of solar to meet the standard. However, as discussed below, the utilities have developed solar to meet the Solar Capacity Standard, which also counts toward RPS compliance.

Figure 2.1: PGE RPS Compliance by Year and Generation Type

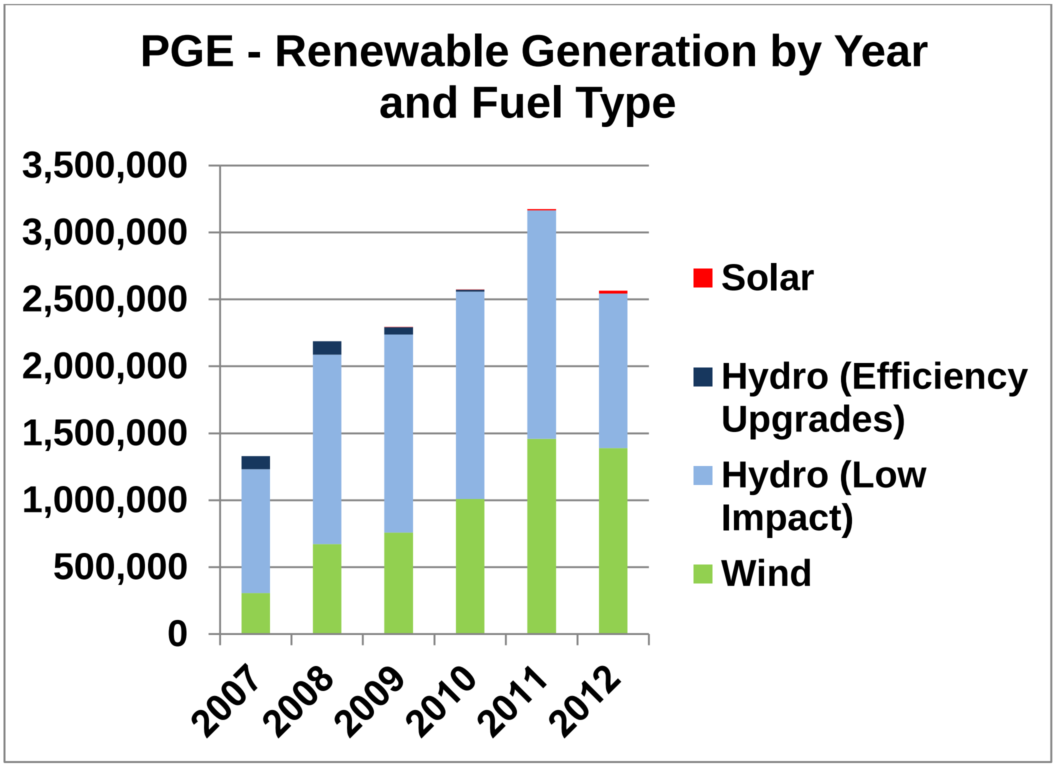
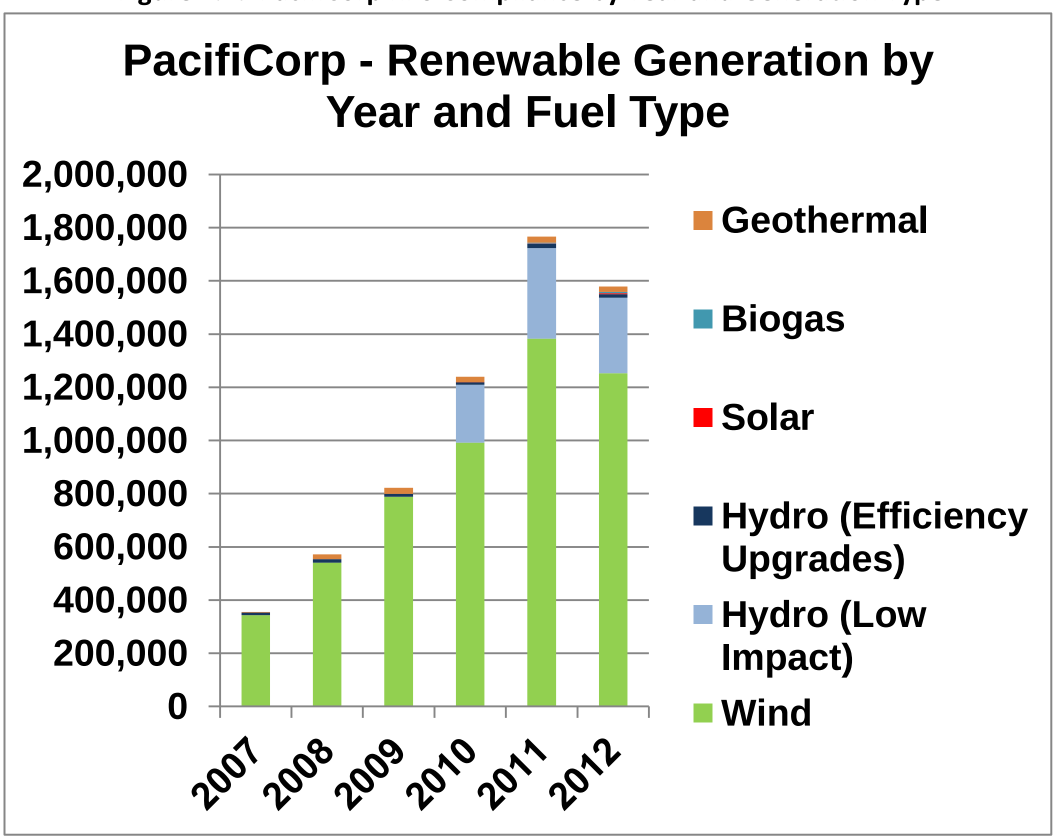


Figure 2.2: PacifiCorp RPS Compliance by Year and Generation Type



Solar Capacity Standard

The 2009 Oregon Legislature adopted a Solar Capacity Standard for PGE, Idaho Power and PacifiCorp. Under the standard, the three utilities must acquire a PUC-apportioned share of 20 megawatts of solar generating capacity by 2020 with systems that are 500 kilowatts or more. No single system can exceed 5 megawatts. The output from these projects can count "double" toward compliance with the RPS (i.e. for every kilowatt-hour of production, the utility gets credit for two kilowatt-hours of production towards the RPS). Utilities can build their own project or buy the output from another developer.

To date, Oregon utilities have built or acquired power from five systems with a total nameplate capacity of 15.4 megawatts.

Volumetric Incentive Rate (VIR) Pilot Program

The 2009 legislature directed the Public Utility Commission to establish a Volumetric Incentive Rate (VIR) Pilot Program in the service territories of PGE, PacifiCorp, and Idaho Power. The purpose of the pilot is to demonstrate the use and effectiveness of paying a fixed price, in cents per kilowatt-hour, for solar electricity produced by retail customers. The fixed price (incentive rate) established by the Commission is set to recover the system's total installation cost over time and attract customer and solar developer interest. Systems less than 500 kilowatt are eligible for the program. Participants in this pilot are not eligible for state tax credits or Energy Trust rebates.

The Oregon Legislature originally set a cap of 25 megawatt of installed capacity for the program. In 2013, it raised the cap to 27.5 megawatts.

Seventy five percent of the program capacity is allocated to "residential qualifying systems and small commercial qualifying systems." A "residential qualifying system" has a nameplate capacity of 10 kilowatts or less. A "small commercial" system has a nameplate capacity between 10 kilowatts and 100 kilowatts. The remaining program is allocated to systems between 100 kilowatt and 500 kilowatt.

Under the VIR Pilot Program, the customer executes a 15-year agreement with their utility and is paid the approved incentive rate for each kWh of solar power they generate. A portion of the total program capacity is allocated to small and medium systems twice a year during enrollment windows. Initially, capacity was allocated to small and medium sized systems on a first-come, first-served basis. Currently, capacity is allocated to small systems by lottery and to medium systems by competitive bid. The incentive rate for small systems is subject to adjustment by the Commission prior to each enrollment window. However, each customer will receive the rate in effect at the time they execute their contract for the duration of the contract. After 15 years, the utility may pay its prevailing avoided cost price for solar power generated by the customer.

The incentive rate was originally set in 2010 at 65 cents/kWh for smaller systems in the Willamette Valley, and 60 cents/kWh in Eastern and Southern Oregon. These rates have steadily declined. The incentive rate is now 39 cents/kWh in the Willamette Valley and 25 cents/kWh in Eastern and Southern Oregon.

Competitive bidding has produced lower incentive rates for the medium and large systems. In 2010, the Commission established a VIR rate for medium systems of 39 cents/kWh.[5] The current VIR for medium systems, set by competitive bid, is 17.5 cents/kWh in the Willamette Valley and 16 cents in Eastern and Southern counties.

Winning bids for large systems have declined substantially since 2010. The most recent winning bids were slightly less than 11 cents/kWh.

From 2010 through 2013, about 1300 systems were installed through this program with a capacity of 18 megawatts. Residential systems account for 8 megawatts of capacity and commercial systems account for 10 megawatts.

Oregon state income tax credits and grants

State income tax credits for solar installations have been available to Oregon residents since 1977 and to businesses in Oregon since 1979.

Today, residents who install solar systems on their property can receive a Residential Energy Tax Credit. Homeowners can receive $1.90 per installed watt, up to a limit of 50 percent of the total installation cost or $6,000 (whichever is less), and may claim no more than $1,500 in one tax year.

The residential energy tax credit includes a "pass-through" provision. Project owners can transfer their tax credit to an organization with tax liability in return for a lump-sum cash payment upon completion of the project.

About 6,000 residents have received a tax credit for installing a solar system. The residential tax credit is scheduled to sunset on January 1, 2018.[6]

Before 2012, businesses that installed solar systems on their property could receive a Business Energy Tax Credit. Through 2006, the credit was 35 percent of eligible project costs. The Legislature increased the credit to 50 percent of eligible costs effective January 1, 2007. The Legislature terminated BETC in 2012 but subsequently adopted a two-year eligibility extension for projects under construction before April 2011. Nearly 1,000 businesses have received a tax credit for installing a solar system. The two-year eligibility extension will end on July 1, 2014.

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[5] From 2010 through 2011, only projects larger than 100 kW participated in competitive bidding. Beginning in 2012, projects between 10 kW and 100 kW also received an incentive rate determined by competitive bid.
[6] Or Laws 2005, ch 832.

The Business Energy Tax Credit was replaced in 2011 with a portfolio of energy incentives that include a Renewable Energy Development Grant program. This competitive grant program offers grants up to 35 percent of project cost or $250,000 (whichever is less) to facilities that generate energy from solar or other renewable energy resources. Funding for the grant program is capped at $3 million per biennium.

Other Solar Development

Other means or tools for developing solar generation exist outside the solar-specific policies established by the Oregon Legislature. These include both the normal regulatory path for developing a utility generation portfolio in Oregon and federal policies that impact solar development in the state. Although they are outside the context of specific solar policies in Oregon and this report, we identify them here.

Utility System Resources

Investor owned utilities may develop renewable resources and seek cost recovery through the normal ratemaking process before the Public Utility Commission. The Integrated Resource Plan process is an opportunity for the utility and stakeholders to explore the reasonableness of including solar resources as part of a least cost/least risk generation portfolio. The prudently incurred costs of a solar development that is consistent with a least cost/least risk path are eligible for cost recovery.

Federal Public Utility Regulatory Policy Act

In 1978, the United States Congress enacted the Public Utility Regulatory Policy Act (PURPA). PURPA created a class of small independent power producers called "qualifying facilities" (QFs) that can sell their generation to local distribution utilities at prices based on utilities' "avoided cost." "Avoided cost" is the cost the utility would pay for the energy and capacity if they were generating it themselves or buying it in wholesale markets.

PURPA is not specific to solar but applies to renewable resources in general.

To date, Oregon has three solar QFs with a total capacity of 124 kilowatts. Also, Idaho Power recently signed QF contracts with developers of six additional solar PV projects in Oregon, each sized at 10 megawatts.[7] None of these facilities have been built yet.

Federal Investment Tax Credit

Since 2006, the federal government has offered an investment tax credit for solar installations, equal to 30 percent of expenditures, with no maximum amount. Anyone with a tax liability is eligible for the tax credit. The federal tax credit can be combined with state incentives, greatly reducing the customer's total cost.

[7] Idaho Power letter from Michael Youngblood to John Savage, March 24, 2014.

This incentive is administered by the U.S. Internal Revenue Service. The credit is scheduled to expire for residential systems and decrease to 10 percent for commercial systems on December 31, 2016.

Other Approaches Outside of Oregon

Community Solar

Some states encourage "community solar" in which the output of a single large solar PV installation is shared among several customers. Community solar allows tenants in one apartment building to share the costs and output of a single solar PV installation. Or, several homeowners in a neighborhood can buy shares in a single large installation and share the output. Community solar has proved popular in Colorado and Arizona.[8]

Value of Solar Tariff

In 2012, the municipal utility in Austin, Texas implemented a "Value of Solar" tariff. Under this tariff, customers receive a price for their solar power based on its value to the utility, the utility's ratepayers, and society. The utility calculates this value taking into account the value of the energy, capacity, transmission and distribution savings, fuel cost hedging, and the value of environmental and societal benefits.

The Minnesota Public Utility Commission recently approved a Value of Solar tariff patterned on the Austin, Texas tariff.[9] The major features of Minnesota's Value of Solar Tariff are that it;

- is an alternative to net metering,
- is based on an estimate of the value of the solar electricity to the utility, its customers, and society, whereas net metering customers receive credit for energy they generate and use based on the utility's retail rate, and
- allows customers to receive credit for the energy generated so long as the energy does not exceed the customer's usage over the course of a year.

[8] PGE has proposed a community solar project for its service territory, called "Solar Shares." The project has not been approved yet. Also, in 2014, the Oregon Legislature adopted Senate Bill 1520, which removed certain financial barriers to the development of community solar in Oregon.

[9] Minnesota Public Utility Commission Docket No. E-999/M-14-65, order issued April 1, 2014. Although the Minnesota Commission has approved a calculation methodology, no utility in Minnesota has yet implemented a Value of Solar tariff.

Chapter 3: Solar System Cost Trends and Projections

The cost of solar PV systems vary based on system size, location, system efficiency, system design, panel manufacturing cost, the cost of physical installation, permitting and application costs, and many other factors. In general, the bigger the system, the more efficient the system, the cheaper the panel costs, and the better the location, the lower the cost of producing electricity from solar PV systems.

In 2013, residential solar PV systems installed in Oregon, either under net metering or the VIR Pilot Program, cost an average of about $4.73 per watt.[10] This average does not reflect the wide range of installation costs seen in Oregon. The installed costs of individual systems in 2013, as reported by the installing contractors, ranged from about $2.25 per watt to more than $11.00 per watt.

The average installed cost of system varied by region of the state. In Central and Southern Oregon, residential systems cost about $4.62 per watt. In the Willamette Valley, similarly sized residential systems cost about $4.89.

Cost per kilowatt-hour of system output shows more spread between different regions of the state. On an energy basis, the energy from systems costs 34 cents per kilowatt-hour in Central and Southern Oregon, versus 47 cents per kilowatt-hour in the Willamette Valley.[11] The difference reflects the superior solar conditions in Central and Southern Oregon.

In 2013, commercial solar PV systems installed in Oregon cost – on average- about $4.03 per watt. Again, the installed cost of individual systems ranged widely – from less than $2.50 per watt to more than $10 per watt.

On an energy basis, the larger commercial on-site systems are lower cost. The net-metered systems installed in 2013 in the Willamette Valley produce electricity at an average cost of 23 cents per kilowatt-hour; systems in Central and Southern Oregon cost, on average, about 19 cents per kilowatt-hour.[12]

Trends in Costs of Solar Systems

The average installed cost for all sizes of Solar PV systems has been dropping. Figure 3.1 shows the trends for the costs of solar systems under the ETO and VIR programs by size.

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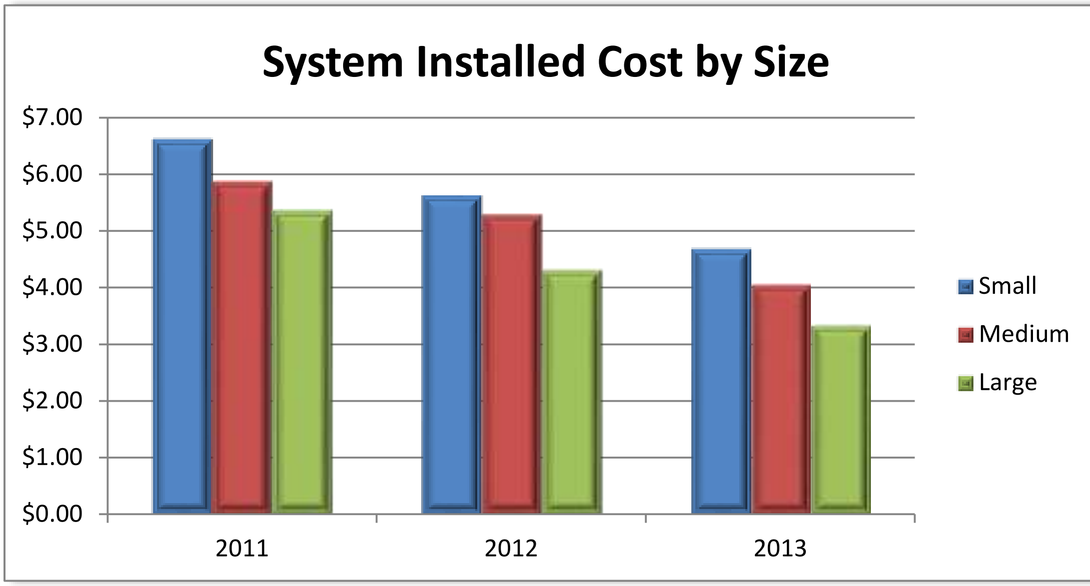
[10] A small residential solar PV facility is 10 kW or less. A kW is 1000 watts.
[11] Based on data provided by ETO.
[12] Kilowatt hours are used to measure the amount of electricity generated by solar PV systems.

Figure 3.1: Cost of System Installation by Size



Over the past four years, solar installation costs have declined substantially. Between 2011 and 2013 the average cost of small installations fell from $6.63/watt to $4.69/watt. Similarly, the average costs of medium systems declined over the same period from $5.88/watt to $4.06/watt.

The average costs of projects ranging in capacity from 100 kilowatts to 5 megawatts have also shown a significant decline.

The average cost of projects exceeding 100 kilowatts that received either Energy Trust rebates or VIR prices dropped from about $5.30 cent per watt in 2011 to about $3.00 per watt in 2013.

Another indicator of the trend in costs is bid prices received for systems larger than 100 kilowatts under the VIR Pilot Program. Under the VIR Pilot, winning bid prices declined by nearly 70 percent from 2010 to 2013 (Table 3.1).

Table 3.1: Winning Competitive Bid Prices in the VIR Pilot Program (cents/kilowatt-hour)

	2010	2011	2012	2013
PGE	39	22.5	21	17
PacifiCorp	24	23	17	11

Trends in Solar PV System Cost Components

The total cost for solar PV can be divided into equipment and non-equipment costs.

- *Equipment Costs* are the costs of the PV panels and other electronic components needed to connect the system to the grid. The major cost in this category is the cost of the solar PV panels themselves. Panel manufacturers have brought panel prices down to about one third of what they were in 2010.[13]

  The electronic components needed to deliver the solar energy to the grid include the inverter that converts the Direct Current produced by the solar panels into Alternating Current. Inverters also include power control features that are needed for safety and grid reliability.

- *Non-equipment costs cover a wide range of costs incurred by the solar developer or customer. They include:*

  - Supply Chain Costs – the price that a small developer pays to various "middlemen" if they cannot buy components directly from the manufacturer.
  - Installer/Developer Profit – the installation company's cost of doing business, including a reasonable rate of return.
  - Financing – the cost to obtain financing from a bank or other lending institution.
  - Incentive Application Costs – the cost to apply for a particular incentive. The contractor generally navigates their customer through the application process. The Oregon Department of Energy is working with the Energy Trust to implement a common, streamlined incentive application process.
  - Customer Acquisition – solar developer's cost to market their services, work with customers to design the installation, and help the customer understand the different incentive programs. In states where solar is very popular, developers get much of their business through word of mouth. Because solar penetration is lower in Oregon, developers incur higher costs marketing their services.
  - Permitting and Inspection – the cost to obtain applicable city and county building permits and electrical inspections. The Oregon Building Codes Division has worked to streamline the inspection requirements.
  - Labor – the cost to install the system. This cost varies from project to project, and is higher per watt for small residential projects than for large commercial ones.

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[13] Photovoltaic system pricing trends: Historical, Recent and Near Term Projections, NREL July 16, 2013.

Figures 3.2 and 3.3 show, by year, the average of panel costs and non-equipment costs for systems installed for the VIR Pilot Program. On average, panel costs have dropped from $3.00 per watt in 2010 to $1.25 per watt in 2013. Non-equipment costs have come down but not as fast. On average, non-equipment costs dropped from about $3.50 per watt in 2010 to a little more than $2.50 per watt in 2013.

Figure 3.2: Cost of PV Panels Used in the VIR Pilot

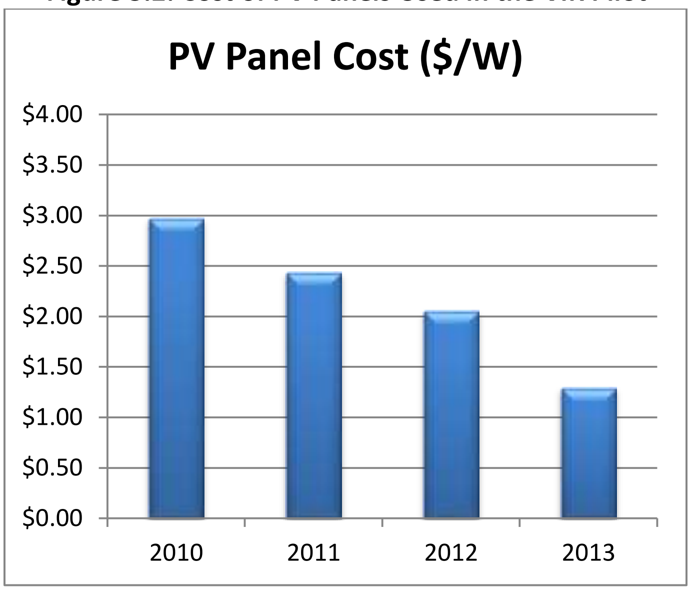
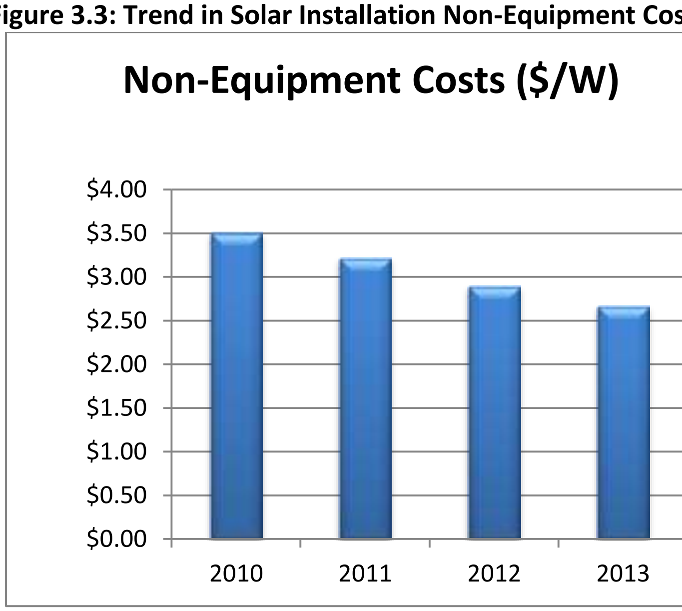


Figure 3.3: Trend in Solar Installation Non-Equipment Costs

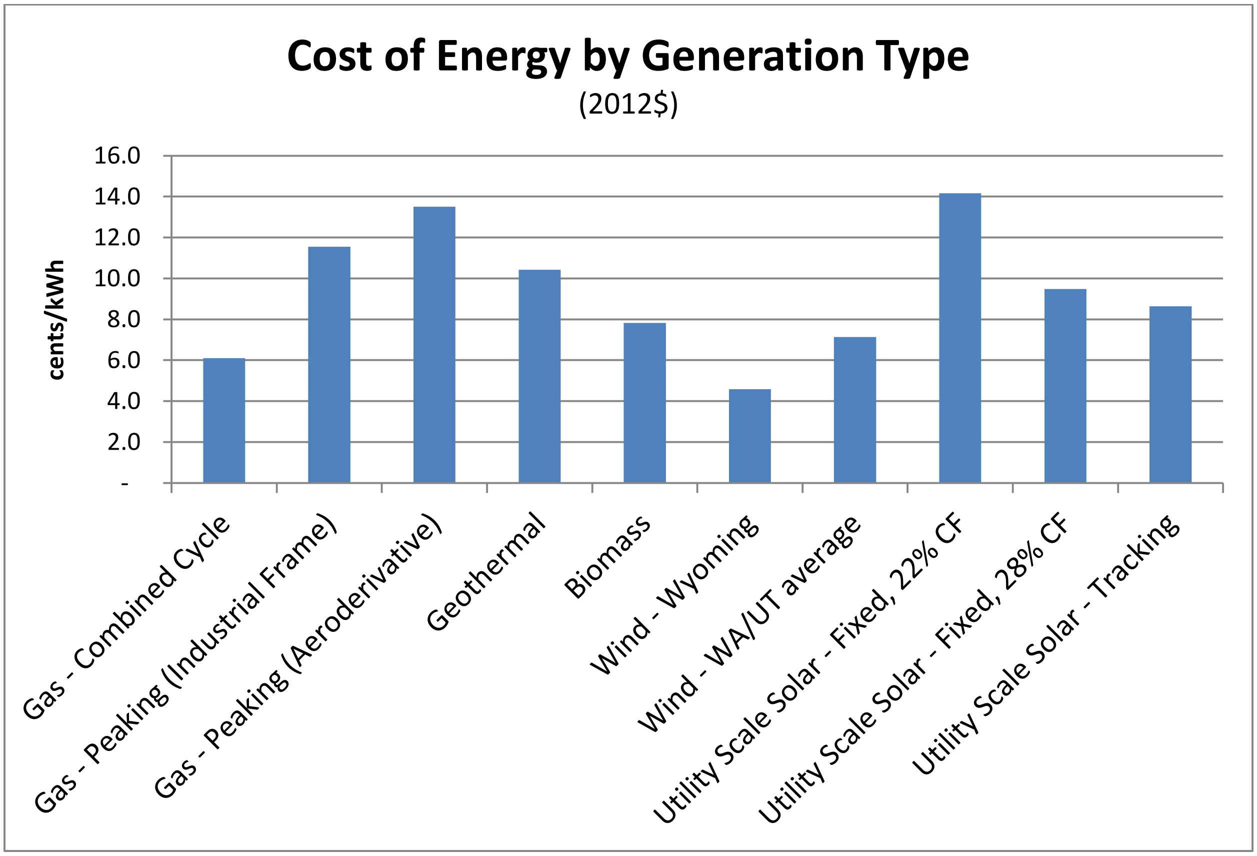


One result of the differential drop in costs is that non-equipment costs now make up the majority of the installed cost of small and medium solar systems. Oregon's experience mirrors the national trend. The National Renewable Energy Laboratory (NREL) compiles detailed statistics on Solar PV cost trends. NREL reports that nationwide, non-equipment costs account for over 60 percent of total installation cost.[14]

Cost of Solar PV compared to other resources

Figure 3.4 compares the cost of energy from different resources that a utility might acquire in order to serve load. Residential and small commercial systems are not represented on this chart and would be higher in costs than the resources shown. These comparisons are based on Oregon utility estimates as of 2013.

Figure 3.4: Comparison of Levelized Cost of Energy from Utility Generation Sources



Source: PacifiCorp 2013 Integrated Resource Plan (IRP), April 30, 2013, inclusive of CO2 tax, and tax credits as applicable. PacifiCorp's IRP is a recently vetted source for resource costs.

[14] "Benchmarking Non-Hardware Balance of System Costs for U.S. Photovoltaic Systems, Using a Bottom-Up Approach and Installer Survey-Second Edition" NREL, October 2013.

Projections for Solar PV Costs

NREL projects that PV panel prices will continue to decrease, but not as rapidly as they have over the last six years. NREL projects that total equipment costs nationally, on average, will decrease from their current level of slightly more than $2/Watt to about $1/Watt by 2020.

There are substantial opportunities to bring down the non-equipment costs of solar systems. The U.S. Department of Energy – working with individual states – has set of goal of reducing non-equipment costs, on average, to less than a $1/watt by 2020.

If NREL's projections of equipment costs are correct, and if the USDOE goal for reducing non-equipment costs is met, then solar costs could drop to below $2/watt by 2020.

Chapter 4: Resource Value of Solar

The resource value of solar refers to the benefits from solar generation that accrues to the utility system and its ratepayers. We distinguish resource value from a broader definition of value that would include society-wide benefits such as improved environmental quality or net increase in employment.

There are many potential benefits to the utility system from solar generation. Some of the benefits can be quantified with known calculation methods. Others are difficult to measure and quantify and are subject to dispute about both the existence and level of the benefit to ratepayers. Potential benefits of solar generation include:

- The value of the energy that the utility would otherwise generate or purchase,
- Avoided need for new generating capacity,[15]
- Savings in transmission line losses,
- Value in preventing or recovering from blackouts,
- Improved power quality,
- Avoided need for new transmission and distribution investments,
- Hedge against future gas price volatility, and
- Reduced cost of complying with current or anticipated environmental regulations.

Solar Benefit Estimates

A number of studies have been conducted recently to estimate the value of solar. Most of these studies are summarized in a 2013 Rocky Mountain Institute (RMI) report.[16] Table 4.1 below summarizes the results of the studies reported by RMI:

[15] In this report, "capacity" means the amount of generating resources needed to meet peak load.
[16] "A Review of Solar PV Benefit & Cost Studies" RMI, September 2013.

Table 4.1: Summary of Nationwide Avoided Cost Study Results (per kWh)

	BENEFITS/COSTS per KWH						
	Energy	Transmission Losses	Avoided Generation	Avoided Transmission & Distribution	Grid Support	Fuel Hedge	Other
AZ	2.7		0.72	0.14			
AZ	7.91 to 11.1		0 to 1.85	0 to 0.82			
AZ	6.4 to 7.5		6.7 to 7.6	2.4 to 2.5	1.5		0.1
Austin	6		1.7	1			2
Austin	7.8	0.7	1.5	0.11			2.2
CA	6	0.2	4.5	2	0.5		2
CA	6	1	4	2	0.5		2
MN	6.7		2.4	1.1			3.1
NREL	3.2 to 2.7		1.1 to 10	0.1 to 10	0 to 1.5	0 to 0.9	0.4 to 6.2
NJ	6.1		1.6 to 2.2	1 to 8		2.5 to 4.7	2.3 to 5.5
TX	10.6		1.6 to 1.9	0.5		2.6	
CO	3.6 to 7.6	0.5 to 0.8	1.15	0.1		0.7	0.5
RMI	2.5 to 12	0 to 4.5	0 to 13	0 to 11	<1 to 1.8	0 to 4.5	0.5 to 5.5

As seen in the table, the benefit estimates by category and in total vary widely. Estimates of the total benefits of solar generation range from 4 cents per kilowatt-hour to 25 cents per kilowatt-hour. Here are some specific examples:

- In a 2009 study of the benefits of solar to an Arizona utility, Arizona Public Service Company, yielded a result of 12 cents/kWh. For the same utility, a 2013 study by the same consultant resulted in value of 4 cents/kWh. A different consultant performed a study of the same utility in 2013 and calculated a value of 21 cents/kWh.
- In 2012, Austin Energy calculated the value of solar at 12.8 cents/kWh. In January 2014, the same utility, using the same consultant, lowered the rate to 10.5 cents/kWh.
- A paper by the Interstate Renewable Energy Council (IREC) described how the utility serving San Antonio, Texas, 80 miles from Austin, calculated the value of distributed solar at roughly half of its retail rate. IREC noted that a competing study, sponsored by Solar San Antonio, showed a value of over 17 cents/kWh, nearly twice the same utility's retail rate.[17]
- The California PUC took a different approach, comparing the costs and benefits of net metering. In 2012, a study by consultant E3 calculated distributed solar benefits at 13 cents/kWh. A competing study by consultant Crossborder calculated benefits at over 20 cents/kWh.

[17] See "A Regulator's Guidebook: Calculating the Benefits and Costs of Distributed Solar Generation: Interstate Renewable Energy Council, October 2013.

The wide range in solar benefits is driven by assumptions, methodologies, and decisions about which costs and benefits to quantify. For example, some studies reported levelized cost and benefit over 20 years; others used a 25- or 30-year life. The Arizona values are not levelized at all, but are a "snapshot" of value in the year 2025, discounted back to 2012. Different studies used different approaches to estimating avoided costs of energy, capacity, and transmission and distribution costs. Some states placed a dollar value on environmental and societal benefits; others did not. No two studies placed values on the same set of benefits.

Range in Benefits from Avoided Energy, Capacity, and Transmission

To estimate the benefit from avoided energy and capacity and avoided transmission losses, most states used similar methodologies. Even so, there is a wide range of estimates for these benefits:[18]

- *Energy*: Some states used the avoided cost from producing a kilowatt-hour in a natural gas power plant; others estimated the value of an avoided market transaction at prevailing wholesale rates. Estimates in the studies summarized by RMI ranged from 3 cents/kwh to as high as 11 cents/kWh.
- *Transmission losses*: Most estimates ranged from 0 to 1 cent/kWh, but a few were higher. Some utilities, such as the municipal utility in Austin, Texas, do not report a value for avoided transmission losses but include them in the calculation of energy benefit. The benefits of reduced transmission losses apply to distributed generation but not necessarily to large central station solar.
- *Avoided Investments in Generating Capacity*: Most estimates for this benefit were in the range of 1 to 2.5 cents/kWh, but one California study had an estimate of 10 cents/kWh.

Table 4.2 below shows the range of these benefit estimates among studies outside Oregon. The midrange values of benefits are those that fell into a central range in all or most of the studies:

Table 4.2: Estimates of Energy and Capacity Benefits in Studies Outside Oregon[19]

Benefit (in cents/kWh)	Low	Midrange"	High
Avoided Energy Cost	2.7	6 - 8	12
Avoided Transmission Losses	0	0.5	4.5
Avoided Investment in Generating Capacity	<1	1-2.5	13

Benefits That Are Hard to Quantify

Benefits such as grid services, fuel price hedge, and societal, environmental, or economic benefits are more difficult to quantify and more uncertain. For example, there are many different ways of estimating benefits from carbon emission reduction. Estimates of such benefits range widely, depending on assumptions and approaches. Some states did not attempt to estimate these benefits at all, and no

[18] This comparison excludes values in the RMI study that were dated before 2007.

[19] Values in this table are from "A Review of Solar PV Benefit & Cost Studies" RMI, September 2013. "Typical" values are those that represent the range where the majority of estimates fell.

state made estimates of all of the potential benefits. The following examples show the range in estimates for such benefits from state to state:[20]

- *Hedge against fuel price volatility*: Many states acknowledge that this benefit exists, but few tried to quantify it. Most estimated the value between 0 and 1 cent/kWh, but one study in Texas calculated a benefit of 3 cents/kWh, and a study in New Jersey calculated nearly 4 cents/kWh.

- *Avoided need for investments in Transmission and Distribution*: Estimates for this benefit ranged from 0 to 11 cents/kWh, but most estimates "clustered" from 1 to 2.5 cents/kWh. Even with distributed solar, any potential transmission and distribution investment avoidance is necessarily site specific.

- *Grid Support Services*: Some states considered the services that solar energy might provide to help with grid stability and reliability, also called "ancillary services," as a benefit. Six studies assigned a dollar value to this benefit. In four studies, the value was close to zero, but one study in Arizona estimated 1.5 cents/kWh.

- *Environmental Benefits*: Again, there is widespread agreement that solar energy has some environmental benefits, but no agreement on the level of benefit or how to calculate those benefits. The uncertainty around carbon regulation makes estimating a value difficult. We found 11 studies that had a dollar estimate for environmental benefit. Most of the estimates were "clustered" around 2 cents/kWh, with some estimates as high as 4 cents/kWh.

- *Societal and Economic Benefits*: There is no agreement on the value of societal and economic benefits, or even whether they exist. Nationwide, we found only one study that included a dollar figure for economic benefits. That study, done by New Jersey, showed a value of 4.5 cents/kWh.

Table 4.3 below shows the wide range in estimates of benefits among studies outside Oregon.

Table 4.3: Estimates of Other Benefits in Studies outside Oregon

Benefit (in cents/kWh)	Low	Midrange	High
Hedge against fuel price volatility	0	1	4.7
Avoided Transmission and Distribution Investment	0	1-2.5	11
Grid Support	0	0-0.5	1.8
Environmental Benefits	<1	2	4
Societal and Economic Benefits	0	?	4.5

[20] Examples are from "A Review of Solar PV Benefit & Cost Studies" RMI, September 2013.

Oregon Commission Docket UM 1559

Under the VIR Pilot Program, Oregon's utilities must report the solar resource value every two years. The reporting requirement uses the definition of resource value in ORS 757.360(5), which is:

a) The avoided cost of energy, including the avoided fuel price volatility, minus the cost of firming and shaping the electricity generated from the facility; and
b) Avoided distribution and transmission cost.

The resource value will be used to determine payments to VIR Pilot Program participants at the end of the 15-year pilot program.

Because of stakeholder concerns over the values reported early in the VIR Pilot Program, the Commission opened an investigation into the appropriate method of calculating resource value. At the conclusion of that investigation, the Commission determined that it was not necessary at that time to choose a specific approach to calculate solar resource value. The Commission concluded that prior to the expiration of the first fifteen years of program participants' contracts; ORS 757.365(9) required only that the Commission make a finding on whether or not the resource value was greater than the VIR incentive rate. The Commission concluded that the resource value was not greater than the incentive rates. That finding was not disputed.[21]

The Commission directed utilities to estimate the benefits of avoided energy, avoided investments in capacity, and avoided transmission line losses. The Commission chose to not require calculations of avoided transmission and distribution investments, firming and shaping costs, fuel price hedging, or carbon costs. The Commission stated that a certain threshold level of solar penetration in Oregon likely is needed before these costs and benefits should be considered and become measurable. In addition, certain benefits are highly site-specific.

Utilities were required to estimate the value of avoided energy benefits using three methods:

i. The "Standard" method used to set the Avoided Cost Price under PURPA,
ii. A "Renewable" method, also used to set the Avoided Cost under PURPA, and
iii. An "IRP" method, which uses computer models to compare the utility's total cost to serve its loads with and without the solar generation. The Commission also directed utilities to calculate the capacity contribution of solar using the "Effective Load Carrying Capacity" or "ELCC" method, a computer based method recommended by ODOE and Commission staff.[22]

The table below shows the resource values reported by utilities.

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[21] Order No. 12-396; *In the Matter of the Public Utility Commission of Oregon Investigation into the Appropriate Calculation of Resource Value for Solar Photovoltaic Systems,* Docket No. UM 1559.
[22] In our review of solar value studies outside Oregon, we found several that also used the ELCC method for this purpose.

Table 4.4: Solar Resource Value cents/kWh Reported by Oregon IOUs[23]

Solar Value Cents/kWh Reported by Utilities under OAR 860-084-0370			
Calculation Method	**PGE**	**Idaho**	**PAC**
Standard	6.7	6.5	6.3
Renewable	6.7	N/A (*)	5.9
IRP	5.5	5.0	5.5

**Idaho Power did not report a value using the "Renewable" method because the Commission has not required Idaho Power to create a renewable avoided cost price for qualifying PURPA facilities.*

[23] Values for all utilities were adjusted to 2014 dollars using the Oregon Consumer Price Index reported by the Oregon Department of Economic Analysis.

Chapter 5: Evaluation of Solar Programs

In this chapter we compare the solar programs that we described in Chapter 2, and evaluate them for cost effectiveness and impact on non-participating ratepayers. We discuss the potential for long term solar growth. Finally, we discuss barriers within the programs for promoting solar generation.

We chose five criteria to evaluate the various solar incentive programs:

- Total Cost of Energy – the cost per kilowatt-hour of energy produced under each program over a 20 year period.
- Cost of Program to Ratepayers and Taxpayers – the total cost per kilowatt-hour of incentives paid out under each program. This shows how much a solar project is subsidized under each program, and whether that subsidy comes from utility ratepayers or state taxpayers.
- Impact on Cost of Solar – reduction to installation costs of solar generation.
- Greenhouse Gas Reduction – how much fossil fuel fired power is displaced by solar.
- Jobs – the number of jobs attributable to the different programs.

In the tables below, we compare the different programs under each of the above criteria. We limit our analysis to programs for which we have sufficient data. The Renewable Portfolio Standard (RPS) does not appear in these tables because no solar facilities in operation were installed specifically as a result of this statute. Although ETO rebates and state tax credits are separate programs, in practice nearly all net-metered installations in investor-owned utility territory took advantage of both programs. For the purposes of the analysis we are examining the impact of both programs on small/medium (RETC) and large (BETC) systems.

Total Cost of Solar Energy and Cost to Ratepayers and Taxpayers

Table 5.1 below, shows the total cost of solar energy over a 20-year period, based on the projects' total installation costs as reported by the participant or their installation contractor, without taking into account incentives or subsidies, and shows the cost of the energy from these programs to ratepayers and taxpayers. The programs show the combination of offerings available for different solar PV systems in Oregon. All cost values shown are averages.

This information is for a snapshot in time. For the net metering or feed-in-tariff programs, the costs below are for projects completed in calendar 2013. For the Solar Capacity Standard systems, we used the data from 2009 through 2012, when those projects were installed (no Solar Capacity systems were installed in 2013). Based on the costs trends discussed in Chapter 3 of this report, similar projects installed today would likely be lower in cost. In addition, the Business Energy Tax Credit is no longer active and the Residential Energy Tax Credit is due to end in 2018.

Table 5.1 shows the average levelized cost of energy acquired through each program and breaks out the cost of the program to ratepayers (Energy Trust and rates) and taxpayers (RETC and BETC). This table does not show the impact of federal investment tax credit.

Table 5.1: Average Levelized Cost of Energy and Average Levelized Cost to Ratepayers and Taxpayers under Oregon programs

Program	Levelized Cost of Energy (¢/kWh)	Levelized Cost to Ratepayers (¢/kWh)	Levelized Cost to Taxpayers (¢/kWh)
Net metering –ETO rebate with Residential Tax Credit	43	6.4	9
Net metering –ETO rebate with Business Tax Credit	33	6.4	14.6
Solar Capacity Standard	29	16.6	12
VIR Pilot - Residential and Small Commercial	39	21	0
VIR Pilot- Large	20	16.5	0

* Projects under the Solar Capacity Standard were installed in 2009, 2011, and 2012, before the recent decline in large project cost. The 28 cents/kWh cost to ratepayers and taxpayers include the average output contract price of 9.6 cents/kWh, 12 cents/kWh of BETC, and 7 cents/kWh of Energy Trust incentives.

The costs of energy from these programs are ultimately a function of the size and vintage of the projects supported by the program. The cost of energy declines with a larger system size and due to the dramatic decrease in solar panel costs. The program for small systems supported by the Energy Trust and the RETC produce energy at a higher cost than the projects funded with the BETC, which supports larger systems. The larger systems installed as a result of the Solar Capacity Standard have a higher cost of energy compared to the large VIR Pilot Program systems, because they are of an older vintage (2009-2012 compared to 2013).

The average cost to ratepayers and taxpayers of the various combinations of measures ranged, on average, from about 15 cents per kilowatt-hour to about 29 cents per kilowatt-hour. The costs to ratepayers alone ranged, on average, from a little more than 6 cents per kilowatt-hour to 21 cents per kilowatt-hour.

Program Effectiveness in Reducing Installation Costs

Table 5.2 shows the decline in solar cost under each program between 2010 and 2013:

Table 5.2: Reduction in Installation Cost

Program	Cost in 2010 ($/Watt)	Cost in 2013 ($/Watt)	% Decrease
Net metering –ETO rebate with Residential Tax Credit	$6.88	$4.62	32.8
Net metering –ETO rebate with Business Tax Credit	$6.74	$5.23[24]	22.4
Solar Capacity Standard	$5.83	$3.90*	33.1
VIR Pilot - Residential and Small Commercial	$6.48	$4.57	29.5
VIR Pilot- Large	$3.71	$2.31	37.7

- Installation costs declined consistently under all of the programs. Large commercial projects were consistently lower in cost, due to economies of scale.
- Projects funded through Energy Trust rebates decreased in cost by about the same amount as similarly sized feed-in tariff projects.
- Solar Capacity Standard projects declined in installation cost by 33 percent from 2010 to 2012. There were no Solar Capacity Standard projects built in 2013.
- As discussed in Chapter 3 above, the decline in project costs was driven largely by lower PV panel prices. That price depends on market conditions worldwide, not Oregon incentives.
- The decrease in installation cost was greatest for the VIR Pilot for large systems, whose incentive rate was determined through competitive bid.

[24] No solar project received BETC in 2013.

Greenhouse Gas Reduction

Table 5.3 is a measure of each program's impact on Oregon's greenhouse gas emissions:

Table 5.3: Greenhouse Gas (CO_2) Reduction[25]

Program	Tons CO_2 Displaced/Year
Net metering –ETO rebate with Residential Tax Credit	15,652
Net metering –ETO rebate with Business Tax Credit	12,318
Solar Capacity Standard	6,160
VIR Pilot Program - Residential and Small Commercial	5884
VIR Pilot Program– Large	1990

Greenhouse gas reduction benefit is directly related to the amount of solar power produced. A kWh of solar energy from one program reduces emissions the same amount as a kWh of solar from another program.

Jobs Created

The Oregon Solar Energy Industries Association (OSEIA) reports that an estimated 1,239 individuals made their living in Oregon's solar industry in 2013, with installation and manufacturing being the top two sectors.[26] Table 5.4, below, compares the likely job impact of the different solar programs

[25] Assumes that all solar generation replaces energy from a natural gas combined cycle combustion turbine.
[26] Email from Paul Israel, OSEIA to Adam Bless Re: Employment Data for Solar Incentive Programs, May 3, 2014.

Table 5.4: Jobs

Program	Jobs
Net metering –ETO rebate Net metering – State Tax Credits VIR Pilot Program - Residential and Small Commercial	These programs support a small, ongoing stream of smaller installation jobs, primarily in population centers.
Solar Capacity Standard VIR Pilot Program –Large	This program promotes large projects that create jobs during construction, but end when the project is complete. The jobs are located in rural areas where there is good sunlight.

There may be a trade-off between job creation and solar cost. Much of the non-equipment cost of solar is labor. Small residential rooftop projects in cities require more labor, which makes them more costly. Large-scale projects have significant economies of scale, but create fewer jobs.

Distribution of Benefits and Costs among Retail Electricity Customers

In this section, we compare the benefits and costs of solar incentive programs to participants and to ratepayers that do not participate in the programs.

Program Participants – who they are

As part of the VIR Pilot Program, PGE and PacifiCorp asked participants to fill out detailed surveys. Participation was voluntary, and not all participants gave information about their income. Of those who did:

- For PGE, 96 percent of survey respondents reported annual household income greater than $40,000 and 55 percent reported incomes greater than $80,000.
- For PacifiCorp, 89 percent of survey respondents reported annual household income greater than $40,000 and 55 percent reported incomes greater than $80,000.

On February 25, 2014, PGE gave a presentation to the House Committee on Energy and the Environment with information about the participants in its solar programs. PGE noted that its residential customers who install solar PV systems are:

- More likely to be highly educated
- More likely to have a dual income
- Likely to be high consumers of information
- Likely to value green products and buy renewable power
- More likely to own single family homes with value over $300,000[27]

Benefits to Participants

Below is a comparison of the benefits that participants receive from different Oregon solar incentive programs.

VIR Pilot Program Participants

VIR Pilot Program participants receive direct payments. Their total benefit is the incentive rate multiplied by their eligible solar kWh produced over the 15-year term of the program. A participant's eligible solar generation is the generation that is equal to or less than the participant's energy usage over the course of the year. Their average benefit is about 21 cents per kWh. Residential and small commercial VIR Pilot Program participants also receive savings on their electric bill, worth approximately 11 to 13 cents/kWh over a 20 year period. These benefits offset most, but not all, of the participants' upfront installation costs. The remainder of those upfront costs may be recovered through federal tax credits or bill savings after year 20.

Net metering participants

Net metering customers benefit from Energy Trust rebates, state tax credits, and savings on their electric bill.

- The Energy Trust rebates (residential) were about 6.4 cents per kWh on average.

- The tax credits for residential solar systems were about 9 cents per kWh on average. Many net metering participants received both Energy Trust rebates and state tax credits, for a total benefit of about 16 cents per kWh.

- Commercial net metering customers received the Business Energy Tax Credit, worth on average about 14.6 cents/kWh. Energy Trust rebates in this sector averaged about 6.4 cents, for a total of 21 cents/kwh.

- Net metering customers also receive bill savings at the utility's retail rate for each kWh they generate. For example, on average, PacifiCorp residential net metering customers decrease the net electricity received from PacifiCorp by about 40 percent, resulting in about $33/month bill savings for a typical residential customer.[28]

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[27] "Snapshot of Solar PGE Development in Oregon," PGE presentation to House Committee on Energy and Environment, Feb 25, 2014.
[28] Email from Joelle Steward/PacifiCorp, to Adam Bless/OPUC, March 28, 2014.

The bill savings to net metering customers has a levelized value of about 11 cents/kWh over a 20-year period.[29] Thus, residential net metering customers can combine Energy Trust rebates, state tax credits, and bill savings for a total benefit of about 25 cents/kWh, or about 58 percent of their investment in solar energy.

All participants can receive a federal tax credit of 30 percent of total installation cost. Schools and churches cannot directly receive a federal tax credit, but many can benefit from the federal tax credit by using the third party lease model.

Combined, these benefits are enough to cover most of the net metering participants' costs of system installation. In other words, most of the program participants' costs are paid for through incentives over time.

Benefits to Other Ratepayers

Benefits to ratepayers from solar programs are described in Chapter 4. They include the cost of energy generation and the cost of future generating capacity that utilities avoid through customer-generated solar power, and the reduced transmission line losses from distributed solar power. These savings can be quantified using accepted valuation methods. For Oregon's three investor-owned utilities, estimates of these benefits range from 5.5 to 6.7 cents/kWh.

Other benefits to ratepayers are harder to measure or quantify. They include potential improvements in local grid reliability, potential savings in local distribution cost, and hedging against future natural gas price increases. There is no widely agreed-upon method to calculate these benefits, or on the solar penetration needed for these potential benefits to be measurable.

Costs of Solar Programs to Non-Participants

To date, the rate impact of solar incentive programs has been small because the programs are limited in size. Oregon's solar generation capacity, including customer owned projects and large utility-scale projects, is currently less than one percent of Oregon's peak load.

At the end of 2012, PGE and PacifiCorp reported that the rate impact of the VIR Pilot Program was equal to about 0.25 percent of the revenue requirement for its residential customers.[30] The total rate impact of the Energy Trust rebate program is limited by statute and generally will not exceed 0.5 percent of the total annual revenue requirement for PacifiCorp and PGE.[31]

Under-recovery of fixed costs in the net-metering program is a potential cost to nonparticipants. We address this issue more fully in Chapter 6.

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[29] We estimated the value of bill savings over time using an assumption of two percent annual rate increase and a seven percent discount rate.
[30] OPUC "Solar Photovoltaic Pilot Program-Report to the Legislative Assembly" January 2013.
[31] The public purpose charge collected from customers of PGE and PacifiCorp (created by ORS 757.612(3)) is set at three percent of the annual revenue requirement of these respective utilities, of which 17 percent is allocated to development of renewables, resulting in a maximum rate impact of 0.5 percent for solar development.

Impact on Taxpayers

Finally, the Oregon taxpayer bears the cost of providing the tax credit incentives - the lost revenue not collected through taxes because of the credit. Since 2010, state residential tax credits have averaged approximately $6 million per year. The RETC is scheduled to expire in 2018. Total business energy tax credits per year averaged approximately $19 million per year from 2008 to 2012, but the BETC program expired in 2012 for projects not under construction by April 2011.

Barriers to Development

The legislature directed the Commission to "…identify barriers within the programs to providing incentives for the development of solar photovoltaic energy systems."

To identify barriers that are specific to Oregon's incentive programs, we used two sources of information: (1) barriers identified in surveys of program participants, and (2) barriers named by solar development community stakeholders in public comments during this investigation.[32]

The participants and stakeholders listed a variety of barriers, but four specific barriers were mentioned most often:

1. Financing: Stakeholders and survey participants said that financing was a key barrier. Financing was also a frequent reason cited by VIR program participants requesting additional time to complete their projects. However, the third party lease model has helped overcome this barrier for many customers, because the third party has better access to financing.
2. Confusing Array of Incentive Programs: Solar installation contractors described the difficulty of explaining the different available incentives to potential clients. VIR program survey respondents said it was difficult to figure out which program was the best "fit" for them.
3. Duplicative Incentive Application Requirements: Having different application requirements for each incentive adds extra work for solar contractors, and may be confusing to potential solar PV customers. ODOE is collaborating with the ETO to create a more uniform incentive application requirement.
4. Lack of program stability: The developer community identified the lack of certainty regarding the life of the programs, the incentive levels, and the available capacity as barriers to building a long-term business plan.

Despite these concerns, participation in the various programs has been strong. All of the available capacity in the VIR Pilot Program was reserved in every enrollment window except one, and applications for Energy Trust rebates and residential state tax credits continued to increase even after the VIR Pilot Program started.

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[32] The Commenters were the City of Portland, Idaho Power, Renewable Northwest, Sierra Club, Alliance for Solar Choice, Oregon Department of Energy, Oregonians for Responsible Energy Progress, PacifiCorp, Portland General Electric, Citizen's Utility Board, Oregon Solar Energy Industry Association, and Energy Trust of Oregon.

Chapter 6: Other Solar Policy Issues

Three related issues have surfaced with the growth in solar development in Oregon and elsewhere. These are:

i. Recovery of utility fixed costs,

ii. Using Smart Inverters to interconnect solar systems into the grid, and

iii. Reducing non-equipment costs of solar.

Recovery of Utility Fixed Costs

An issue for net metered solar projects is the potential for shifting the recovery of utility fixed costs to non-participating customer. A portion of each residential customer's electric bill goes to cover the fixed costs of generating, transmitting, and distributing electricity. Some of these costs are included in volumetric, or per kWh, rates, and some are included in a fixed customer charge. Depending on the value of the solar generated, net metered customers may avoid paying some or all of the fixed costs recouped through volumetric rates, thereby shifting those costs on to other ratepayers.

The recovery of fixed utility system costs has become a point of contention in states with significant solar development such as Arizona and California. Arizona Public Service Company (APS) proposed a charge on net metering participants in order to recover fixed costs. In a July 2013 filing with the Arizona Corporation Commission, APS proposed that existing net metering customers pay a higher customer charge based on the amount of electricity they use. This charge would range from $45 to $80 per month.[33] In November, 2013, the Arizona Commission approved the addition of a 70 cent/kW fee on net metering customers, equivalent to about $5/month for an average installation.[34] California is undertaking a major study of this issue. Assembly Bill 327 directs the California Public Utilities Commission to perform a comprehensive study of fixed cost recovery for all customers, in the context of rate reform. At the time of writing this report, the California study has not been completed.

Integrating Distributed Solar Generation Reliably into the Local Grid – Smart Inverters

All Solar PV generation, whether from small distributed installations or large grid scale projects, produces Direct Current (DC), and requires an inverter to convert power to Alternating Current (AC).

[33] See "Distributed Generation – an Overview of Recent Policy and Market Developments, American Public Power Association, November 2013.
[34] "APS Distributed Solar PV Study and AZ Update," David Weinglass, APS, December 4, 2013.

The main national standards that govern inverters in the U.S. are IEEE[35] 1547 “Standard for Interconnection Distributed Resources with Electric Power Systems” and UL[36] 1741 “Standard for Safety for Inverters, converters, Controllers and Interconnection System Equipment for Use with Distributed Energy Resources.” The Commission’s current rules at OAR Chapter 860 Divisions 39 (for Net Metering) and 84 (for the Solar Pilot Program) endorse the 2001 edition of IEEE 1547.

Distributed solar PV generation presents challenges that were not foreseen in current editions of the relevant standards and codes.[37] The Western Electric Industrial Leaders (WEIL) issued a White Paper in August 2013 signed by the senior officers of 16 western utilities, including PGE and Pacific Power. The technical issues listed in the White Paper were:

- Rapid localized fluctuations in PV power from cloud cover and fog burn-off
- Voltage swings on distribution lines
- Safety settings on older inverters causing solar PV systems to trip off-line in response to instantaneous voltage drops on the local distribution grid. This is not a problem in neighborhoods with only a small number of solar PV installations. However, if several solar PV installations on one distribution feeder trip off-line simultaneously, this can exacerbate the low voltage condition.

The WEIL committee recommended that standards be updated to permit inverters to have smart functions to address most, if not all, of the technical challenges identified by the WEIL group. These functions include:

- Communications capabilities to permit remote changing of setpoints by the utility
- Dynamic Voltage Control
- Expanded frequency trip points
- Low Voltage Ride Through (to permit solar PV to stay online during instantaneous local grid voltage drops, providing voltage support that could help stabilize the local grid).
- Randomization of timing for trip and reconnection (so that all solar PV installations on a distribution feeder with a high penetration of solar PV systems do not trip offline simultaneously).

Inverters with these features are available in the United States, but the features are disabled to comply with the current edition of IEEE 1547 and UL 1741. Modern inverters have the features built in, with firmware that enables the utility to enable or disable the features by changing program settings. Utility

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[35] The IEEE is the Institute of Electrical and Electronics Engineers, the national organization that produces consensus codes for safety and reliability of electrical devices in use by most utilities in the U.S.

[36] UL is Underwriters Laboratory, which tests and certifies electrical devices for safety.

[37] *See* “Integration of PV on the Distribution System,” presentation by SDG&E at the EUCI Distributed Solar Conference, December 5, 2013.

owned inverters are not required to comply with UL 1741 requirements, but Commission rules require compliance with this code for PV installations under the VIR Pilot Program.

The IEEE has established a code committee to update IEEE 1547. As of this writing, the updated code has not been adopted.

Using smart inverters will not greatly increase the cost of solar PV installations. The WEIL whitepaper notes that the cost to build these smart functions into currently available inverters adds about 10 cents per installed watt to the cost of an installation. For a 3 kW residential system, the WEIL white paper estimates a total cost impact of about $150, a small fraction of total cost.

Reducing Non-Equipment Costs of Solar Installation

The U.S. Department of Energy (USDOE) launched a program in 2011 called the “Sunshot” Initiative, aimed at reducing solar costs in general and in particular reducing non-equipment costs of solar. The aim of this initiative is to make solar energy cost competitive with other energy sources by the end of this decade.[38]

Non-equipment costs include permitting and inspection costs and other costs like financing, contracting, customer acquisition, and labor. Permitting and inspection are the components of non-equipment costs most directly under state and local government control. There is some potential for reducing permitting and inspection costs, but the analysis performed by the USDOE suggests that this potential is limited because permitting and inspection costs are not a large fraction of non-equipment costs overall. Oregon state and local agencies have already done much to reduce permitting and inspection costs. The Commission in 2007 adopted rules standardizing the interconnection process and requirements, based on nationally accepted engineering codes. To streamline the inspection process, the Oregon Building Codes Division issued the Oregon Solar Installation Specialty Code, standardizing solar installation electrical requirements throughout the state. In 2011, HB 3516 made residential solar installation an outright permitted use. The legislature has also exempted residential solar installations from local property taxes.

Other costs, such as supply chain costs, developer profits, transaction costs, installation labor, and customer acquisition costs, are part of the installers’ business models.

The Oregon Department of Energy is the lead agency in Oregon to investigate and reduce non-equipment cost under the Sunshot initiative. The initial installation cost data collected by the Oregon Department of Energy and the Energy Trust show that installation costs vary widely, even for installations with similar size and location. Therefore, we can reduce solar costs simply by reaching the cost levels already being achieved by some of the more efficient contractors.

[38] See US Department of Energy: SunShot Initiative. Available at http://www1.eere.energy.gov/solar/sunshot/mission_vision_goals.html

Appendices

APPENDIX 1: Matrix of Major Solar Incentive Program Capacity and Costs

Appendix 1.1: Net Metering Programs

	No. Systems	Installed kW	Average kWh/year	Total System Install Cost ($)	Incentive $	Install Cost $/Watt	KW/Project
Net Metering							
ETO (Residential)	**4,217**	**16,789**	**17,479,641**	**97,906,648**	**21,452,152**	**5.83**	**4.0**
2010	1066	3,140	3,251,531	20,577,565	5,463,480	6.55	2.9
2011	1199	4,552	4,735,180	30,114,877	7,446,650	6.62	3.8
2012	1114	4,630	4,804,332	26,052,859	5,508,179	5.63	4.2
2013	838	4,468	4,688,599	21,161,347	3,033,844	4.74	5.3
ETO (Non-Residential)	**428**	**14,945**	**15,621,712**	**87,457,861**	**15,149,531**	**5.85**	**34.9**
2010	129	4,186	4,324,544	29,568,246	5,010,322	7.06	32.5
2011	129	3,720	3,953,911	21,586,773	3,492,070	5.80	28.8
2012	127	4,538	4,691,538	25,410,426	4,576,463	5.60	35.7
2013	42	2,501	2,651,720	10,892,415	2,070,676	4.35	59.6
ETO (Utility)	**12**	**15,264**	**17,745,388**	**73,730,625**	**12,911,293**	**4.83**	**1272.0**
2010	7	2,406	2,406,096	14,083,369	2,333,913	5.85	343.7
2011	2	2,840	2,840,000	17,407,842	3,278,880	6.13	1420.0
2012	3	10,018	12,499,292	42,239,414	7,298,500	4.22	3339.4
RETC	**4,232**	**16,102**	**16,764,080**	**91,332,937**	**24,562,494**	**5.67**	**3.8**
2010	1172	3,474	3,647,246	22,264,999	6,777,192	6.41	3.0
2011	1468	5,774	6,062,873	35,285,825	8,473,479	6.11	3.9
2012	1030	4,084	4,288,591	20,893,151	6,003,493	5.12	4.0
2013	562	2,770	2,913,961	12,820,145	3,308,330	4.63	4.9
BETC	**244**	**26,299**	**31,522,282**	**114,654,682**	**57,327,367**	**4.36**	**107.8**
2010	126	7,567	9,070,082	37,117,207	18,558,620	4.91	60.1
2011	81	5,940	7,119,637	23,733,629	11,866,822	4.00	73.3
2012	37	12,792	15,332,563	53,803,846	26,901,925	4.21	345.7

APPENDIX 1: Matrix of Major Solar Incentive Program Capacity and Costs

Appendix 1.2: VIR Pilot Program

	No. Systems	*Installed kW*	*Average kWh/year*	*Total System Install Cost ($)*	*Incentive ($)*	*Install Cost $/Watt*	*KW/Project*
PacifiCorp	**481**	**6,588**	**7,760,426**	**32,656,535**	**2,710,576**	**4.96**	**13.7**
2010	50	316	358,521	2,073,121	213,920	6.55	6.3
S	50	316	358,521	2,073,121	213,920	6.56	6.3
2011	140	2,096	2,523,149	12,183,252	1,102,341	5.81	15.0
S	129	950	1,128,961	6,154,767	561,781	6.48	7.4
M	10	649	819,188	4,068,485	402,732	6.27	64.9
L	1	498	575,000	1,960,000	137,828	3.94	497.5
2012	145	2,183	2,535,367	10,704,814	775,706	4.90	15.1
S	137	982	1,152,757	5,519,648	440,831	5.62	7.2
M	6	476	495,115	2,446,289	157,694	5.14	79.3
L	2	724	887,494	2,738,877	177,181	3.78	362.0
2013	146	1,993	2,343,389	7,695,348	618,609	3.86	13.7
S	138	1,114	1,282,957	5,025,353	449,676	4.51	8.1
M	7	384	416,503	1,555,502	98,423	4.05	54.9
L	1	495	643,929	1,114,493	70,510	2.25	495.0
PGE	**833**	**10,989**	**10,989,220**	**54,435,351**	**4,418,134**	**4.95**	**13.2**
2010	86	545	544,920	3,509,025	343,205	6.44	6.3
S	85	520	519,840	3,393,195	329,411	6.53	6.1
M	1	25	25,080	115,830	13,794	4.62	25.1
2011	244	3,955	3,954,810	22,021,300	1,840,450	5.57	16.2
S	223	1,369	1,369,240	9,186,070	754,356	6.71	6.1
M	19	1,589	1,589,330	9,255,021	775,221	5.82	83.6
L	2	996	996,240	3,580,209	310,873	3.59	498.1
2012	290	3,750	3,750,200	18,694,616	1,363,631	4.98	12.9
S	273	1,850	1,850,040	10,105,866	756,040	5.46	6.8
M	14	1,155	1,154,520	5,888,856	341,336	5.10	82.5
L	3	746	745,640	2,699,894	257,255	3.62	248.5
2013	213	2,739	2,739,290	10,210,410	870,848	3.73	12.9
S	204	1,475	1,475,360	6,815,001	587,799	4.62	7.2
M	7	373	372,950	1,295,409	96,082	3.47	53.3
L	2	891	890,980	2,100,000	186,967	2.36	445.5
Idaho Power	**47**	**423**	**620,722**	**2,342,209**	**226,817**	**5.54**	**9.0**
2010	9	88	128,963	551,450	70,930	6.25	9.8
2011	30	273	401,075	1,530,472	127,141	5.61	9.1
2012	8	62	90,684	260,287	28,747	4.22	7.7

Note: L= Large; M= Medium; S= Small; all solar systems for the VIR Pilot Program in Idaho Power are small systems.

APPENDIX 1: Matrix of Major Solar Incentive Program Capacity and Costs												
Appendix 1.3: Levelized Cost Calculations												
Project Term/Discount Rate	ETO-Res		ETO-Com		RETC		BETC		PGE VIR		PAC VIR	
	LCOE	**LCOI**	**LCOE**	**LCOI**	**LCOE**	**LCOI**	**LCOE**	**LCOI**	**LCOE**	**LCOI**	**LCOE**	**LCOI**
20 year, 7.1%	$0.43	$0.06	$0.39	$0.07	$0.42	$0.10	$0.33	$0.15	$0.35	$0.29	$0.37	$0.33
20 year, 3%	$0.30	$0.04	$0.28	$0.05	$0.30	$0.07	$0.24	$0.11	$0.25	$0.28	$0.26	$0.32
25 year 7.1%	$0.39	$0.06	$0.36	$0.07	$0.38	$0.09	$0.30	$0.13	$0.32	$0.28	$0.34	$0.31
25 year 3%	$0.26	$0.04	$0.24	$0.04	$0.25	$0.06	$0.20	$0.09	$0.21	$0.26	$0.22	$0.29

Note: LCOE = levelized cost of energy **(¢/kWh)**; LCOI: Levelized cost of energy funded by ratepayers or taxpayers (¢/kWh). ETO-Res= Net metering with ETO rebate for residential customers; ETO-Com= Net metering with ETO rebate for business customers; RETC = Residential Tax Credit; BETC= Business Tax Credit; VIR= Volumetric Incentive Rates Pilot Program.

Appendix 2 - Description of the Incentive Cost Matrix

Appendix 2 provides a summary of the costs related to each of Oregon's major incentive programs: ETO rebates, state tax credits, and volumetric incentive rates, broken out by year. Since the volumetric incentive rates pilot began in 2010, we only tabulated figures for the years 2010 through 2013. Since the price of solar equipment dropped dramatically in the last five years, cost data before 2010 would provide an inaccurate view of current costs.

For each program, we tabulated the installed capacity (kilowatts), annual energy generation (kilowatt-hours), total system cost and total incentives paid. From these data we estimated a levelized cost of energy (LCOE) and levelized cost to ratepayers and taxpayers (LCOI) over 20-year and 25-year periods. We compared the various incentive programs based on projects completed in 2013, to reflect current solar costs rather than the higher costs of earlier years. The "LCOE" represents the total cost of energy generated from solar projects developed under each program.

Assumptions

In calculating the levelized cost of energy, we spread the installation cost of solar projects over all energy generated by the systems over 20-year and 25-year period. We assumed solar energy production for each system to be constant for each year. We calculated the levelized cost of energy in cents/kWh, using 7.1 percent and 3 percent discount rate.[1] Although we calculated these costs using 20 and 25 years and 7.1 percent and 3 percent discount rates, for ease of analysis, we will only report the results for the 20-year time period and 7.1 percent discount rate. Nevertheless, calculations for the 25-year time period and 3 percent discount rate are shown in Appendix 1.

The LCOE numbers described above do not take into account the 30% federal investment tax credit. The total cost of energy is based on installation costs before deducting any tax credits. The federal tax credit does reduce the cost to Oregonians. However, we do not have federal tax credit data for all projects, and many solar project participants have no federal tax liability. Moreover, the federal tax credit applies equally to all solar programs being compared here, so it does not change the relative cost-effectiveness of the various programs compared to another.

The "LCOI" represents the total of all costs paid by ratepayers or taxpayers for the energy, whether through electric rates, through the Energy Trust, or through state tax credits. Dividing the LCOI by LCOE gives the percentage of the project that is paid by ratepayers or taxpayers.

We estimated the levelized cost to ratepayers and taxpayers over the same time periods and using the same discount rates. For the volumetric incentive rates program, we assumed that payments after year 15 of the program will be based on prevailing avoided cost prices under PURPA. For tax credit programs, residential customers take the tax credit over the first four years while business customers take tax credits over the first five years.

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[1] To ensure consistency between the estimates of annual solar generation for the different programs, we used county-specific energy production factors (in kWh/installed KW) provided by the Energy Trust.

For net metering customers (those receiving ETO rebates and state tax credits), we also estimated the electric bill savings. For this analysis, we assumed a 2 percent annual escalation rate in the retail price. We also performed this estimate using a 4 percent annual escalation rate, to determine the sensitivity to rate escalation. We calculated a levelized value of bill savings assuming a seven percent discount rate. With these assumptions, the levelized value of bill savings to net metering customers was 11 cents/kWh (with 2% annual escalation) or 13 cents/kWh (with 4% annual escalation).

In Order 12-396, docket No UM 1559, the Commission directed utilities to report a solar value based on Avoided Costs under the federal Public Utility Regulatory Policy Act (PURPA). This value is the cost the utility would incur generating or purchasing energy and capacity using the least-cost source of supply. In this report, we used the values filed by the utilities in compliance with Order 12-396 to estimate the avoided energy, avoided transmission loss and avoided capacity benefit of solar generation.
All three Oregon investor owned utilities filed these compliance reports, and each compliance reported solar values calculated by three methods (standard avoided cost, renewable avoided cost, and an "IRP" method using computerized dispatch models), for a total of nine solar value estimates in all. For use in this report, we selected the highest of the nine - the 6.7 cent/kWh solar value calculated by PGE using the standard avoided cost.

Cost Shifting Associated with Bill Savings for Net Metering

Utility rates are designed to recover utility costs by charging a "per kwh" rate, based on an assumed level of retail sales. Net metering customers reduce those sales. However, a portion of that retail rate covers utility fixed costs, which are not reduced with net metering. The utility must still recover its fixed costs, which it does by increasing rates. Since the participants are producing much of their own energy, they are insulated against these rate increases. The utility's non-participating ratepayers see the increase in rates – effectively shifting fixed costs from participants to non-participants. The actual amount of fixed costs shifted to non-participants depends greatly on rate design. A focused study would be needed to provide a precise estimate. The final result would vary with utility and with rate class.

The figure below is a flow chart that illustrates the flow of costs and benefits of solar incentive programs among participants, ratepayers, and taxpayers.

Flow of Benefits Diagram