



GUIDE TO INSTALLING A SOLAR ELECTRIC SYSTEM

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This guide is designed to provide Seattle City Light customers with information on grid-connected solar electric systems. It provides background on solar electric systems, the components required, and outlines the steps to take if you want to install and interconnect a system to the utility grid.

Photo Credit: Brothers Electric and Solar

For solar questions not answered by this guide, please contact Seattle City Light’s Energy Advisors at (206) 684-3800 or by email at SCLEnergyAdvisor@seattle.gov.

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Introduction

Why you may want to install a solar electric system for your home or business:

More and more City Light customers are showing interest in solar electric systems for their homes and businesses. Why?



Photo Credit: A&R Solar

- Solar electric systems are safe, reliable, pollution free, and use a renewable source of energy—the sun. Most systems have no moving parts and are increasingly easy to install.
- The option of net metering, or interconnecting a customer generating system to the utility grid, makes solar electric systems more economically viable.
- Landmark federal and state legislation have created new financial incentives for owning and operating a solar electric system.

If you are interested in making a long-term investment to protect yourself from rising energy costs and want to reduce your personal environmental impact, now may be the time to learn more about installing a solar electric system for your home or business.

The History of Photovoltaic (PV) Technology

The first solar cell was created in 1883. It was inefficient by today's standards, converting only 1–2% of sunlight into electricity. The breakthrough in solar cell technology came in 1954 when researchers at Bell Laboratories stumbled across the photovoltaic (or PV) properties of silicon while experimenting with new transistor technologies. Three years later, PV research began

in earnest to develop an independent solar energy source for space technologies. Thanks to continuing research, modern commercial PV silicon cells have improved to 15–22 % efficiency.

Historically, PV has been used extensively in areas that are not served by a power grid. As PV prices have dropped, and grid energy has become more expensive, PV systems are increasingly used in grid-tied applications.¹

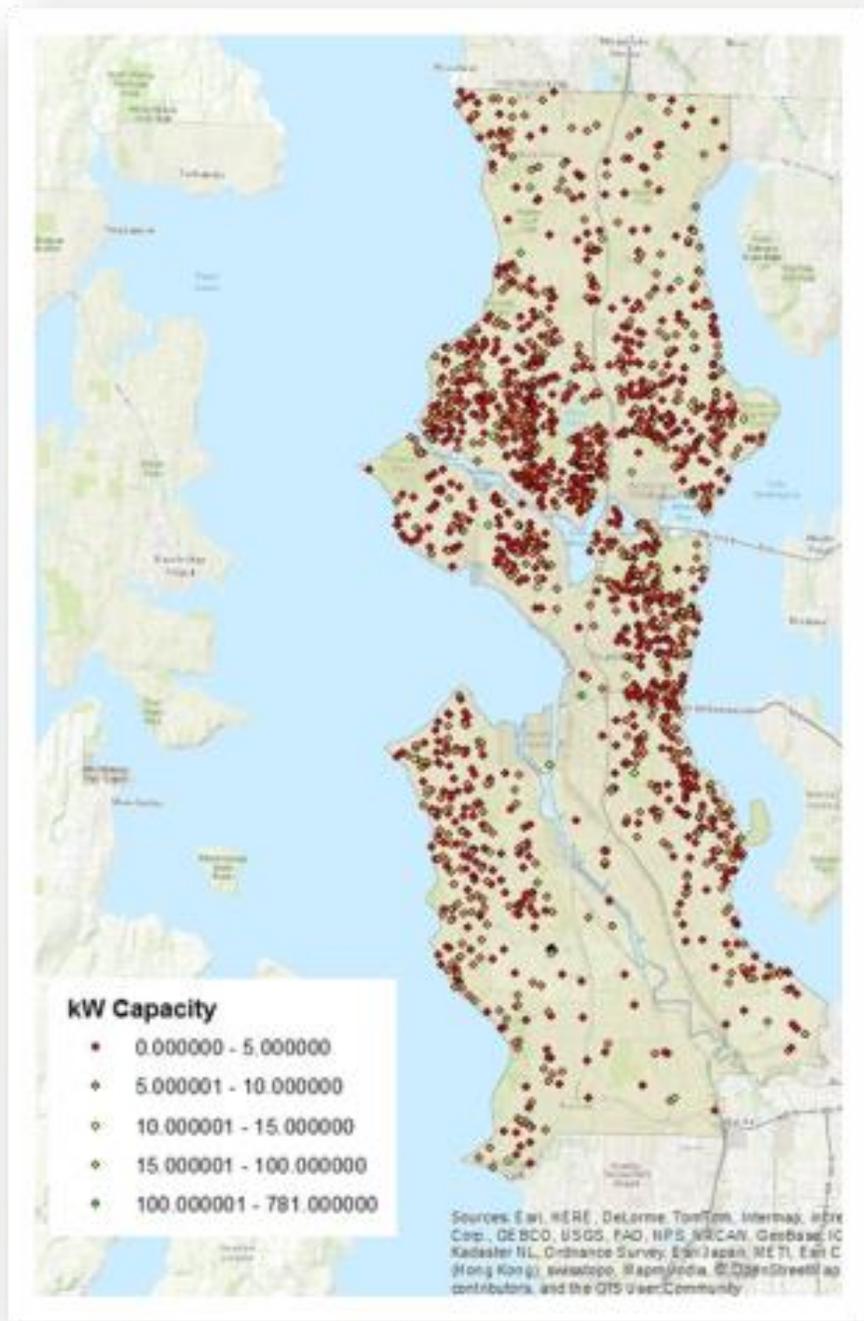
A solar electric or PV cell uses a semiconductor material similar to that used in computer chips to absorb sunlight and convert it into electricity. Multiple solar cells are linked together to form a module or panel. Multiple modules/panels are connected to form a PV array.

There are three main types of PV panels: monocrystalline, polycrystalline, and amorphous silicon (thin film). A monocrystalline cell is the most efficient per area (produces the most power per square foot) and requires the most silicon. On the other end of the scale, amorphous silicon is the least efficient per area and requires the least amount of silicon. Most mono- and polycrystalline cells are incased in a glass panel with a metal frame. Because amorphous silicon cells use less silicon, they are more flexible and can be used in a variety of applications, including a peel-and-stick panel that adheres to a standing seam metal roof.

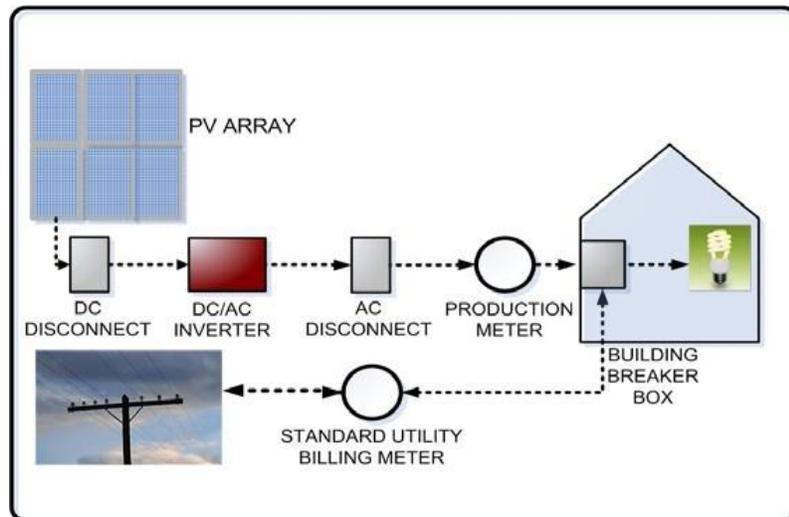
Photo Credit: Seattle City Light



Seattle City Light has worked with customers to interconnect their solar electric systems since the first installation in 2001. Currently, there are over 2000 solar customers throughout the Utility's service territory:



The Components of a Grid-Tied PV System



A PV System includes:

- 1) **PV Array** - Multiple PV panels installed together are called a PV array. Mounting arrays to rooftops is most common, yet they can also be located on a pole, a ground mounted rack, parking area shade covers, window awnings, etc. The PV array produces Direct Current (DC) power.
- 2) **DC Disconnect** - The DC Disconnect is a safety device that, when manually opened, stops power running from the array to the rest of the system. The DC disconnect is used during system installation and anytime your contractor needs to work on the system.
- 3) **DC/AC Inverter** - The PV array produces DC electricity, however, we use Alternating Current (AC) electricity in our buildings and power grid. The Inverter converts the DC power to AC power. Inverters can serve an entire PV array or a single PV panel (called a 'micro-inverter').
- 4) **AC Disconnect** - The AC Disconnect is another safety device and is often incorporated into the Inverter. Seattle City Light does not require an AC Disconnect on most small residential systems. For details on this exemption, contact your Electric Service Representative. Your ESR can be found at seattle.gov/light/electricservice.
- 5) **Production Meter** - The Production Meter measures the energy output (in kilowatt-hours, kWh) from your system and is used to record the amount of electricity generated. This component is not critical to power generation, but is

necessary in order to take advantage of Washington State's Production Incentive Program.

- 6) **Building Breaker Box and Standard Utility Meter** - also called your building's circuit panel or electrical service panel, the Breaker Box is where the power from the PV System enters the building. If the building is using electricity, the PV-produced electricity will be used first. If the building needs more electricity than the PV System is producing, utility grid power is automatically pulled into the building. When the PV System produces more electricity than is needed, the excess flows back out to the utility, spinning your utility billing meter backwards in the process. You earn credit for the excess power produced and can use that credit when the system is not producing energy. This process is referred to as "net metering."

Siting Your System

A well-designed solar electric system has clear and unobstructed access to the sun for most of the day throughout the year. Siting a PV system correctly is critical in order to achieve maximum power production and thus maximum energy offset and financial return.



Photo Credit: Sun Wind Concepts

Orientation and Tilt

Optimal orientation for solar panels is true south. As you move away from true south, a system will suffer production losses, up to as much as 15–25% for panels oriented east or west. However with advancements in technology these losses are decreasing as inverter manufacturers learn how to maximize off-of-south orientations. In Seattle, solar panels produce the maximum power annually when mounted at a tilt of roughly 30 degrees.

Shading

Avoid shading as much as possible. Even minimal shading can significantly impact power production. You will want to consider potential shading from trees, buildings,

power lines, telephone poles, and obstructions like chimneys and vent pipes.ⁱⁱ Your contractor should include the impact of obstructions on your power production estimate.

Sloped Roof

A significant portion of your system cost will be in the installation of the panels, so if you plan on replacing your roof in the next 5–7 years, consider doing that first. Otherwise, your installer will need to come back to remove the panels for the new roofing to be added, and then re-install the panels— all at your cost. Overall, you want to be sure your roof is in excellent long-term condition, because PV systems are designed to last a minimum of 20 years and many will last even longer. So, if you are unsure about the structural integrity of your roof, have it professionally inspected to verify its condition and suitability.

Flat Roof

Most residential and small commercial PV systems are installed on sloped roofs, yet it is possible to install on a flat roof. Contractors typically avoid penetrating a flat roof and instead use some sort of ballasted (weighted) means of securing the panels against wind. Building code officials will be concerned about the wind shear and roof loading of such a system. If a flat roof system is in your future, plan to submit a professional engineer (PE) stamped drawing illustrating how the system will be secured to the building.

Tracking

Most residential and commercial PV installations are mounted to roofs and are fixed in place. If your system is going to be mounted on a pole or a flat roof, you have the choice of installing a tracking device. The simplest form of tracking is to seasonally adjust the tilt angle of the panels. Automatic tracking devices allow the panels to follow the sun as it moves through the sky, receiving direct light more often than a fixed system. Electrically operated and thermally operated trackers have their own costs, benefits, and drawbacks. Keep in mind that without a tracker, your PV system has no moving parts. While automatic trackers can increase production by 20–40%, they do add moving parts to the system, so there are operation and maintenance concerns to consider. Pole-mounted systems also have the additional cost of the pole installation.

Learn more about the solar potential at your home by using the National Renewable Energy Laboratory's (NREL) PV WATTS calculator: pwwatts.nrel.gov

Selecting the Right Size System for You

Three core factors affect the sizing of your system: your electricity usage, space availability on your property, and your budget.

Your Electricity Usage

Do you want to try to produce 100% of your power or some smaller percentage?



While any excess production from month to month will carry over as a credit on your utility bill (net metering), you will not want to install a system that produces more than 100% of your power as the utility will not reimburse you for excess power produced at the end of the year.¹ You may also not want to size the system too large if you are planning more energy conservation measures for the future.

To determine how much power you use right now, look for the kilowatt-hour (kWh) consumption on your utility bill. Sum the kWh for the past year to get your annual electricity usage. For help understanding your bill, check out seattle.gov/light/paymybill.

Space Availability

The amount of unshaded, easy-to-access, space available for mounting panels will limit the size of the system. You can use In My Back Yard (IMBY), an online tool created by the National Renewable Energy Laboratory to estimate the area on your property available for mounting a system. IMBY allows you to draw a system on a map of your property and then estimates the specifications of the array given the size and orientation of your drawing.

Tree Removal

Please consider reviewing the City of Seattle's policies on tree removal if you have significant shading from trees on your property:

seattle.gov/dpd/codesrules/codes/treeprotection

¹ The year is defined as May 1st through April 30th by State Law.

Permits for solar energy systems do not consider adjacent trees or give property owners special permission to remove trees that could interfere with their system. Tip 242, Tree Protection Regulations in Seattle, summarizes tree regulations for private property.

PV panels vary in their dimensions. Home Power magazine, homepower.com, is one resource for comparing the various commercially available panels. Each year Home Power publishes evaluations of different panels. Local contractors will have particular brands they install regularly.

Rule of Thumb:

1 kilowatt (kW) of PV panels will require approximately 80 square feet of area. If PV panels are unshaded, oriented to true south and mounted at approximately 30 degrees, they will produce approximately 1,000 kilowatt-hours (kWh) per year in Seattle.

When talking with them, find out which panels they use, why they like them, if the panels are UL Listed (required for electrical inspection and utility interconnection) and the panel's warranty length. A standard industry PV panel warranty is 20–25 years, and manufacturers expect the panel will produce 80% of its rated capacity at the end of the warranty period.

Your Budget

It is a good idea to evaluate your budget and goals before choosing your system. Some questions to consider include: What is my budget for this project? Will I finance or pay for it out of my savings? Keep your budget in mind as you read the Cost and Incentives section of this guide.

Additionally, you may want to consider the following lenders to finance your solar project:

PSCCU.org

Craft3.org

Permit Requirements

Electrical Permit

Electrical permits are required for all solar electric systems and must be secured by the person doing the electrical work. In the vast majority of cases this will be your electrical contractor. Owners with the required planning and installation skills, who want to complete the installation



Photo Credit: Sunergy

themselves, can also obtain the electrical permit. Your contractor must submit an electrical drawing and the system will be subject to a field inspection after installation. Typical field-inspection permit fees for small systems are approximately \$190. If your system has a larger capacity than 7 kW or the design is atypical, your contractor may be required to go through a plan review.

Building Permit

Building permits in Seattle are required for solar arrays when any of the following apply:

- 1) The array weight is 1,000 pounds or more.²
- 2) The installation is structurally complex (determined by the Seattle Department of Planning & Development).
- 3) The solar project is part of building alterations or additions valued over \$4,000.
- 4) The solar project requires construction of stand-alone support structures valued over \$4,000.

² Building permits may be required if your system will be installed on a flat roof. In such an installation, specific calculations regarding roof loading and wind shear are required.

Rule of Thumb:

As a point of reference, a 2 kW PV system will weigh approximately 500 pounds.

Resource:

For Seattle residents, permits may be obtained at the DPD Applicant Services Center, 700 Fifth Avenue, 20th floor, (206) 684-8850, or at seattle.gov/dpd/permits.

For electrical permit questions, contact DPD's Electrical Technical Support at (206) 684-5383.

Land Use Requirements

In Single Family, Multi-family and Residential Small Lot zones, solar panels may be mounted to extend up to 4 feet above the zone's height limit, and/or extend up to 4 feet above the ridge of a pitched roof. Also, the total height from existing grade to the top of the solar panels may not extend more than 9 feet above the zone's height limit.

In the Single Family and Residential Small Lot zones, a solar panel exceeding the zone height limit must be placed so that it does not shade the property to the North on January 21, at noon, any more than a structure built to the maximum permitted size for that zone. For assistance in determining solar exposure, please see TIP 417: Sun Chart: Determination of Solar Exposure.

Set-Back Yard Requirements

Ground or pole mounted PV systems cannot be located in front yards. They must be at least 15 feet from back property line and 3 feet from side property line. More specifics on set-back requirements can be found in TIP 420.

You can view all TIPS at web6.seattle.gov/DPD/CAMS/camlist.aspx.

Costs and Incentives

Typical System Cost

Cost depends on a number of factors (e.g. roof complexity). Typical residential systems in Seattle are approximately 6 kilowatts (kW) in size with an average installed cost of \$4,500 per kW for a total investment of \$27,000.

Net Metering

Net metering allows solar customers to receive retail electricity rates for the electricity they generate. If you generate more electricity over a billing period than you consume, City Light will credit your electric bill for every kilowatt-hour of electricity sent back to the power grid. The credit is applied at the retail rate for power. Net metering will continue for the life of the solar electricity installation.

Federal Income Tax Credits

The federal Energy Policy Act of 2005, as amended by the Emergency Economic Stabilization Act of 2008, includes provisions for individuals and businesses to claim a 30% federal income tax credit for the cost of solar installations. Tax credits apply to systems placed in service through December 31, 2016.

A great resource for information on Federal Tax Credits, visit: dsireusa.org.

Washington State Sales Tax Exemption

Until June 30, 2018, all solar electric systems less than 10 kW in size are exempt from the state sales taxes. Your installer will provide required forms for the Exemption Legislation, RCW 82.08.963

Washington Renewable Energy Production Incentive

As of August 2006, Washington State provides financial incentives for electricity generated from renewable energy resources. Eligible electricity producing renewables include solar, wind, and anaerobic digesters (converts methane gas captured from livestock manure to electricity). The state production incentive program is administered by City Light.

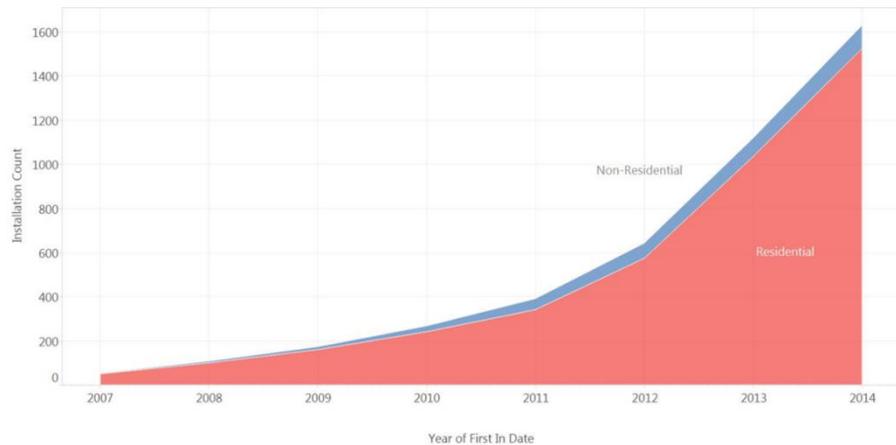
Photo Credit: Western Washington Solar



As solar generation becomes increasingly popular and customers continue to install solar systems, City Light is nearing the limit on renewable incentive payments provided by Washington State. The estimated proportional reduction of solar incentive payments will be approximately 31% for the 2016 fiscal year (July 1, 2015 to June 30, 2016). To learn more, visit the solar incentive cap webpage.

seattle.gov/light/solarenergy/Incentivecap.asp

The incentive is based on the total number of kilowatt-hours (kWh) of electricity generated between July 1 and June 30 of the following year. Customers with eligible generation systems that have

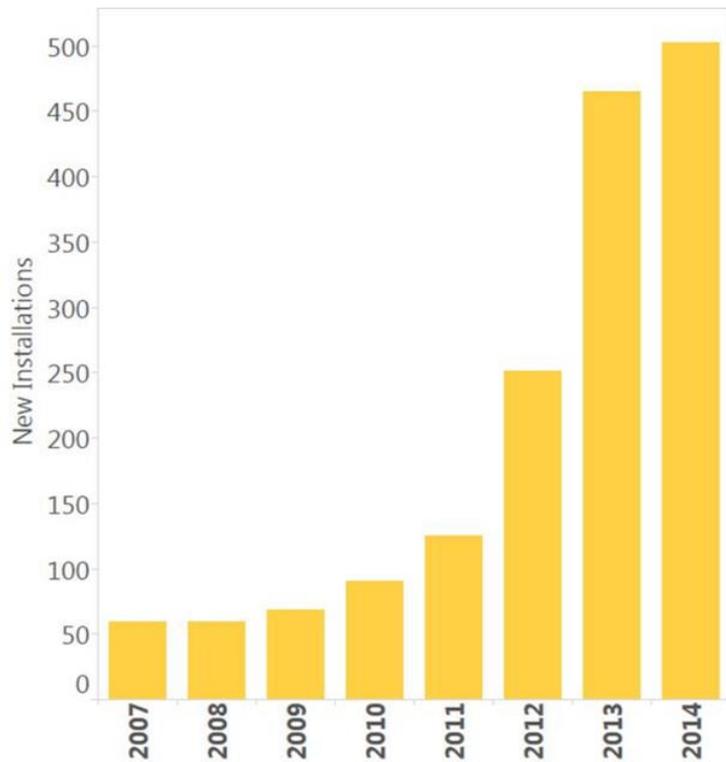


been certified by the WA Department of Revenue (DOR) and have met City Light incentive eligibility requirements, will receive a pre-filled application form once per year from City Light. The annual application documents the system's generation based on City Light production meter readings and provides the calculated annual incentive credit. In order to receive the incentive credit the application must be signed and returned to City Light no later than the provided deadline. All incentives are first applied as a credit on the associated City Light account no later than the state deadline of December 15th. Customers may request that the incentive credit be paid in the form of a check by indicating this preference on the annual application or contacting City Light Incentive staff via phone or e-mail. The Utility is reimbursed for the incentive payments by a credit on their state taxes.

The program authorizes utilities to pay the following for the electricity produced by PV systems:

- \$0.15 /kWh for systems with no “Made in Washington” components
- \$0.18 /kWh for systems with “Made in Washington” inverters
- \$0.36 /kWh for systems with “Made in Washington” panels
- \$0.54 /kWh for systems with “Made in Washington” panels and inverters

Incentives are capped at \$5,000 per year, per tax registration number assigned to a customer, and expire June 30, 2020.



Resources

Washington State Legislation – Renewable Energy Production Incentive-
WAC 458-20-273

apps.leg.wa.gov/WAC/default.aspx?cite=458-20-273

Washington State Department of Revenue registration form:

dor.wa.gov/docs/forms/misc/renewenersystcertinvstrecincprgm.pdf

Maintenance & Resale

Regular Maintenance

There is very little maintenance required on a PV system with no moving parts. Some system owners wash their panels, but in the Northwest, our climate tends to take care of this chore. You may want to brush off the panels if they tend to collect leaves, but other than that, your system should operate as



Photo Credit: Seattle City Light

designed with no intervention. You can also keep track of your production by reading your production meter or checking the inverter display.

Resale Value

The effect of a solar system on the appraised value of your home can be hard to predict, but according to a study by ICF Consulting, every \$1,000 reduction in annual energy bills increases a home's resale value by \$10,000 to \$25,000. However, homes are generally valued in comparison to similarly sized and aged homes around them, and if there aren't many solar homes in your neighborhood, the appraiser may not have a bar to measure against.ⁱⁱⁱ The market for solar homes continues to grow as energy costs increase along with an increased interest in sustainable building.

Choosing an Installer

As with any construction project, best practices include asking these basic questions of a potential contractor:

- Do they have a business license?
- Are they licensed for the work you want them to do (mechanical, electrical, structural, etc.)?



Photo Credit: Puget Sound Solar

- How long have they been in business?
- How many solar electric systems have they installed?
- Will they provide references?
- Have they attended manufacturer, trade association, or other training on solar electric installations?

In comparing bids, you should consider warranty service, installed system price (equipment plus installation), system size, permit costs, and predicted energy output.

It's a good idea to check the Washington Labor and Industries website to learn more about the listed contractor, licensing status, violations, etc.

lni.wa.gov/TradesLicensing/Contractors/HireCon/

The North American Board of Certified Energy Practitioners (NABCEP) runs a quality credentialing and certification program for renewable energy professionals. In order to be NABCEP certified, a practitioner must meet installation experience requirements, sign a code of ethics and pass a four- hour exam. Look for the NABCEP seal on contractors' websites. More information about NABCEP and a list of certified installers can be found at their web site; nabcep.org

Installation and Incentive Checklist: 9 Steps to Solar Power

#1 System Selection

Contact installers, schedule site evaluations, and choose your system design. Use the "Find Solar Installers" link at seattle.gov/light/solar to find installers that have installed at least three PV systems in Seattle City Light's service territory.

#2 Interconnection Application

The following interconnection application documents are required (most solar installers will provide these for you):

- ✓ Interconnection Application & Agreement – Level 1 (for inverter-based generating systems – 100 kW or less)
- ✓ "One-line" electrical diagram of the proposed generating system
- ✓ Inverter specification sheet
- ✓ Application for Electric Service — required for production meter service and to participate in the WA state production incentive program (includes a new meter fee; check payable to Seattle City Light).

Complete and submit these forms prior to installation along with the production meter installation fee (or indicate on the Interconnection Application that it is okay to bill this

fee to your City Light account). City Light Electric Service Representatives (ESRs) at your local (North or South) Service Centers are available to work with you or your installer to review your application submittals and to advise you regarding meter installations and fees.

Your application will be reviewed and Interconnection Agreement signed with a copy and welcome letter sent to you for your records.

Your ESR may visit your site prior to installation to mark the appropriate location for a production meter socket (socket to be installed by your installer; meter to be installed by City Light).

Submit Interconnection Applications to:

Seattle City Light
Attn: Intake Desk
1300 N. 97th St
Seattle WA, 98103

#3 Electrical Permit

The person installing the system, typically your solar contractor, must obtain an electrical permit (specifically an Electrical Permit Application: No Plan Review). Zoning, setback requirements, roof height, and exposure may impact your installation. Contact their Local Jurisdictional Authority (LJA) for land-use and electrical permit information if you have questions about your particular property.

#4 Installation

Install your solar electric system, including your production meter socket. City Light may have marked the ideal location for the production meter socket (for ease of meter reading). If you or your contractor have any questions about the marked location, please call your Electrical Service Representative. Meter bases should be labeled in accordance with City Light signage requirements as detailed in the Requirements for Electrical Service Connections (Chapter 14: Customer Generation).

#5 Electrical Inspection

Once installation is complete, call the Department of Planning & Development (or your local electrical permitting office if you are outside of Seattle) for an electrical inspection. New construction requires both a cover and final inspection—existing structures require only a final inspection.

After passing the electrical inspection, you must notify your ESR, who you can locate on via our service maps located at:

seattle.gov/light/electricservice or by contacting the appropriate service center.

#6 Metering

Notify your Electrical Service Representative that your system has passed final electrical inspection. Once City Light confirms your system was installed according to plan and has pass the final electrical inspection, a meter technician will be scheduled to replace your existing billing meter with a new net capable meter which is designed to register reverse power and install your production meter (only required if you plan to apply for production incentives). If you are not planning to apply for production incentives, this is your last step.

#7 Washington State System Certification

To be eligible for state production incentives, you must complete the WA Department of Revenue (DOR) Renewable Energy System Cost Recovery Certification form and submit it directly to the DOR as directed on the form. It is suggested to submit this form via a trackable method such as e-mail, fax or certified mail. DOR will assign you a Tax Registration Number (if you do not already have one), provide your approved incentive rate, sign the form, and return the form to you along with a cover letter. The DOR will send provide notification to City Light that you have been approved to participate in the incentive program as long as you have provided permission to do so on the certification form. If you did not provide permission for the DOR to share this information with City Light than you are responsible for submitting a copy of the approval letter and certification form to City Light no later than August 1st following your initial incentive year.

You can obtain the DOR Renewable Energy System Cost Recovery Certification form, visit seattle.gov/light/solar and click on "Install Solar" on left sidebar.

#8 Apply for Federal Tax Credits

Individuals and businesses that install solar electric systems are eligible for a federal tax credit of 30% of the system cost (the total of installation and materials), which expires 12/31/16. Individuals use Residential Energy Credits IRS Form 5695 and businesses use the Investment Credit IRS Form 3468.

Updated forms can be found on the IRS website, irs.gov.

#9 Annual Incentive Payments

To monitor your production and calculate your incentive, City Light will read your production meter on the same schedule as your existing billing meter.

Around August following the end of each incentive year, City Light will send you an annual incentive application which provides a statement of the kilowatt-hours (kWh) produced by your solar electric system during the previous incentive year and the calculated incentive payment amount. Annual production will be based on a combination of pre-metered production (first time customers only), actual production meter reads and year-end estimates (as needed). Customers are asked to send a picture or notation of their City Light production meter read on June 30th of each year (all customers) and their inverter (new customers only – to help determine the pre-metered production).

The annual incentive application must be signed and returned no later than the provided due date in order to guarantee you will receive an incentive. The incentive is automatically approved once a signed copy of the annual incentive application is received by City Light. If you do not agree with information on the annual incentive application you may request and adjustment and the administrator will work with you for an agreed upon resolution.

All incentive payments are first credited to the associated City Light account no later than the state deadline of December 15th of each year, and will apply to current and future charges until either the credit runs out or a check is requested. Checks may be requested on the annual incentive application or by calling or e-mailing the administrator.

First time incentive payment applications must ensure all City Light eligibility requirements are met no later than August 1st following their initial incentive year. Eligibility requirements can be located online at:

seattle.gov/light/solarenergy/incentiveRequirement.asp.

As a renewable energy generator, you must maintain all records of energy production and incentive payments received for a period of five years. City Light or DOR may review these records with five working days' notice.

Additional Resources

For solar questions not answered by this guide please contact Seattle City Light's Energy Advisor at (206) 684-3800 or by email at SCLEnergyAdvisor@seattle.gov.

For questions directly related to annual incentive payments and/or the incentive program eligibility requirements please contact the Solar Incentive Program at (206) 684-5516 or by email at SCL_SolarInentive@seattle.gov.



Photo Credit: Martha Rose

If you want to do additional research, here are some resources you may find useful:

- U.S. Department of Energy Solar Energy Technologies Program—a consumer resource covering solar basics, applications, and, research and development at the national level. energy.gov/eere/solarpoweringamerica/solar-powering-america-home
- Solar Washington—the local chapter of the American Solar Energy Society, providing events, newsletter and links posted on the web solarwashington.org

Solar Works in Seattle!

We hope you decide to join the many Seattle area residents who are taking advantage of a local renewable resource to generate their own clean, green power.

Seattle City Light is a publicly owned utility dedicated to exceeding our customers' expectations in producing and delivering low cost, reliable power in an environmentally responsible and safe way. We are committed to delivering the best customer service experience of any utility in the nation.

ⁱ Historic Summary provided by Solar Oregon,

http://www.solaroregon.org/learn/solar_electric/history-of-pv, accessed February 25, 2009.

ⁱⁱ Google SketchUp is one tool that may help you model the impacts of shading. Learn more at <http://sketchup.google.com/>.

ⁱⁱⁱ <http://www.realtor.org/rmodaily.nsf/0/1aab2c6905430c9f8625730c0058fd32?OpenDocument>, accessed January 2, 2009.