

pennsylvania
STATE OF INDEPENDENCE



Solar Energy Systems

A Guide for Pennsylvania Municipal Officials

Here comes the Sun!

12/1/2009

Governor's Solar Working Group

Table of Contents

Introduction	3
Solar Working Group	3
The Pennsylvania Alternative Energy Investment Fund – Act #1	4
How Solar Works	5
How Much Solar Systems Cost.....	9
How Net Metering Works.....	10
Alternative Energy Certificates	11
Interconnection.....	11
Fire and Safety	12
Model Solar Ordinance for Pennsylvania Municipalities.....	12
Permits	14
Inspections	15
Criteria for DEP Approved Solar Installers	15
Frequently Asked Questions	16
Glossary of Commonly Used Terms	20

Introduction

This guide is a primer for local government officials, code officials, engineers and solicitors on Solar Energy Systems. With the passage of the Pennsylvania Alternative Energy Investment Fund and the growth of alternative energy technologies, solar energy systems will become more commonplace in municipalities across the Commonwealth. Solar energy is unique in several ways.

- **Location** Solar projects can be located anywhere but are more viable where there is more sunshine. The potential for solar in Pennsylvania is relatively consistent across the Commonwealth although it is higher in the Philadelphia region than the Pittsburgh region which receives about 9% more solar radiation on an annual basis than Pittsburgh.
- **Size** Solar projects come in all sizes. Municipalities will see solar projects proposed on residential, commercial, industrial, agricultural, institutional and utility scale.
- **Ownership** Solar project ownership is diverse. From residential to utility scale, the owner of the solar energy system can vary from property owner equity to a fully leased project.
- **Technology** Solar technology is rapidly changing. Solar technology is wide ranging including: modules and collectors mounted to rooftops, building integrated roofing and glazing, ground mounted pole and racks systems, as well as solar farms with modules ground mounted on the hillsides.

The solar industry will create new business and jobs and change the appearance of homes, businesses and landscapes throughout Pennsylvania communities. The goal of this guide is to assist local municipalities with integrating solar energy systems into existing government functions including the insurance of public health and safety, regulation of land use and enforcement of general codes and construction standards.

This guide applies to solar energy systems regardless of size or purpose (i.e. residential, commercial, etc.). It is neither a technical nor economic guide for designing or installing a solar system. Rather, it introduces solar energy system technology while addressing relevant issues and local government's role in facilitating and regulating solar energy systems in existing construction. (This guide will be updated periodically and available on line.)

Solar Working Group

The Solar Working Group, convened by the Governor's Office and Department of Environmental Protection (DEP), is charged with developing solar energy for adoption into local ordinances in Pennsylvania's municipalities. One of the tasks identified by the group is to provide timely information to local officials, residents and businesses. As such, this guide provides an overview of solar energy systems for a range of Pennsylvania communities.

The Pennsylvania Alternative Energy Investment Fund – Act #1

The time has come to power homes and businesses with solar technologies. Soon, thousands of individuals, businesses and communities will rely on the planet's most abundant natural resource—the sun—for some of their power needs. Solar energy is a renewable alternative to conventional power plants that burn fossil fuels and release emissions including greenhouse gases contributing to climate change.

The State of Pennsylvania is fostering solar power to create jobs, promote business development and stimulate energy independence, as well as reduce the environmental impacts from electricity generation and fossil fuel usage. Each of the 67 counties in Pennsylvania can benefit from advancement of solar power. The Pennsylvania Alternative Energy Investment Fund provides the following funding for our solar energy future:

- \$100 million through the **PA Sunshine Solar Program** to provide loans, grants and rebates that cover up to 35 percent of the costs residential consumers and small businesses incur from installing solar energy technology. It is important to note that these rebate levels are established by DEP and will change over time.
- \$80 million in grants and loans for economic development projects in the solar sector. These solar grants are administered by the Commonwealth Finance Authority. As of this printing, approximately \$30 million has been allocated to a variety of Pennsylvania solar projects

Through these avenues, the Pennsylvania Alternative Energy Investment Fund will advance clean, reliable and renewable energy from the sun and maintain the Commonwealth's leadership in energy production and environmental stewardship.

Each municipality has the opportunity to be a solar friendly community while simultaneously ensuring that solar energy systems are properly installed.

Here comes the Sun!



How Solar Works

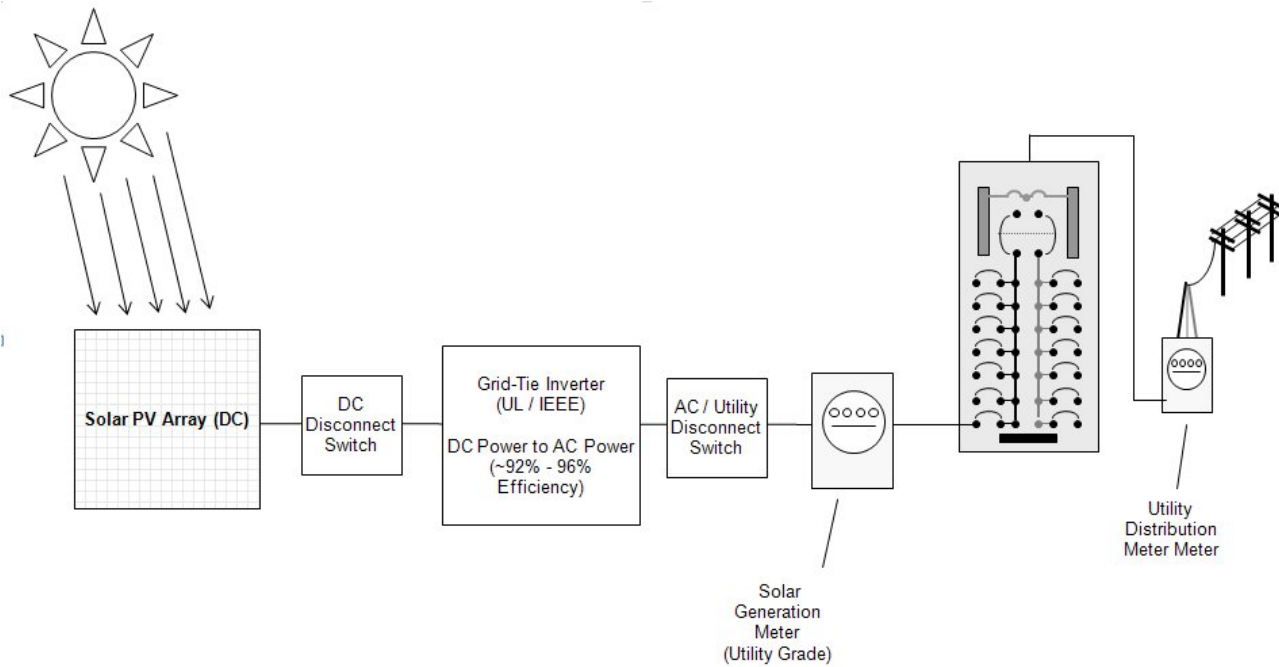
There are two major forms of solar energy technology: photovoltaic (PV) systems and solar thermal systems.

Solar Photovoltaic

Solar photovoltaic (PV) cells convert sunlight into electricity, powering everything from lamps to electronic devices and even electric cars. Contrary to popular belief, solar systems do not need strong sunlight to function properly and can be used effectively throughout Pennsylvania. Of course, stronger sun combined with days of sunlight increase system performance; however, solar PV can produce electricity even on cloudy days. The amount of solar energy or irradiance that shines on a building or area over a period of time is defined as insolation, which is included in weather data that is available for several cities in Pennsylvania. In order to estimate the annual electricity production of the solar PV system, it is important to know certain technical specifications of the solar PV system, the amount of annual insolation at the site, the orientation of the solar PV modules, and the shading impacts at the site from nearby obstructions. Shading impacts have a much greater effect on system performance than orientation of the solar PV modules, so conducting thorough shading analysis is important. Using solar shading assessment tools, such as using the Solar Pathfinder or the Solmetric Solar Eye have proven very effective for determining these impacts. Solar companies listed on DEP's website will be able to analyze these factors and provide advice on what a site is adequate for solar.

In solar PV systems, a flow of direct current (DC) electricity is produced when sunlight strikes an array of solar modules. Appliances and machinery, however, operate on alternating current (AC), such as the electricity supplied by a utility. The DC energy produced by the modules is, therefore, fed into an inverter that converts DC power into AC power and feeds into the main electrical panel that powers a home or business.

The majority of solar PV systems are grid-tied. This means they are directly connected to the power grid and do not require battery storage. Solar PV will not operate during a power outage unless it has battery backup. Solar electrical energy can provide power to a home or business, reducing the amount of power required from the utility; when the solar PV system power generation exceeds the power needs at the home or the business, then the surplus power automatically back feeds into the grid. A special utility meter will record the "net" power coming in from the utility and the surplus power flowing out from the solar PV system. The following depicts a simple one line diagram of a solar PV system interconnected to the grid.



Solar PV system can be installed on a roof, integrated into the building or roof structure or ground mounted on poles or racks. Tracking systems on poles enable the modules to follow the sun during the course of the day to increase overall output of the solar PV system.

The solar PV array capacity is rated in watts or kW (1 kW = 1,000 watts) in DC power output based on Standard Testing Conditions (STC), and is simply the sum of all the individual solar PV modules in the array. For example, 25 solar PV modules each rated at 200 watts DC make up a total solar PV system array size of 5 kW. The inverter, which converts the DC to AC power, also has a rated capacity in watts or kW, but it is based on the AC power output. Often the inverter AC capacity is numerically close to the DC array capacity, but in general, it should not be more than +/- 20% of the DC rated capacity. For example, the 5 kW DC rated solar PV array could have an inverter capacity rated between 4 kW to 6.3 kW AC. Regardless of the size of the solar PV array, the inverter will limit its output to a small percentage above the inverter AC rated capacity. The utility companies are interested in the inverter AC capacity more than the solar PV array DC capacity because it's the inverter that is interconnected into the utility grid.

Solar Thermal

Solar thermal systems use solar energy to typically heat a fluid, such as water or an antifreeze solution, or heat a gas, such as air. Solar thermal systems are most commonly utilized for heating residential hot water systems, though they are also used for space heating, spas or swimming pools, and even space cooling. Another type of solar thermal system technology utilizes concentrating solar power (CSP) to reach extremely high fluid temperatures in utility scale solar thermal plants to generate electricity. However, these large, central solar thermal power stations have been developed in the western U.S. and outside the country, where they work best with high beam solar radiation (compared to diffuse solar radiation) and are not considered commercially viable in the eastern U.S.

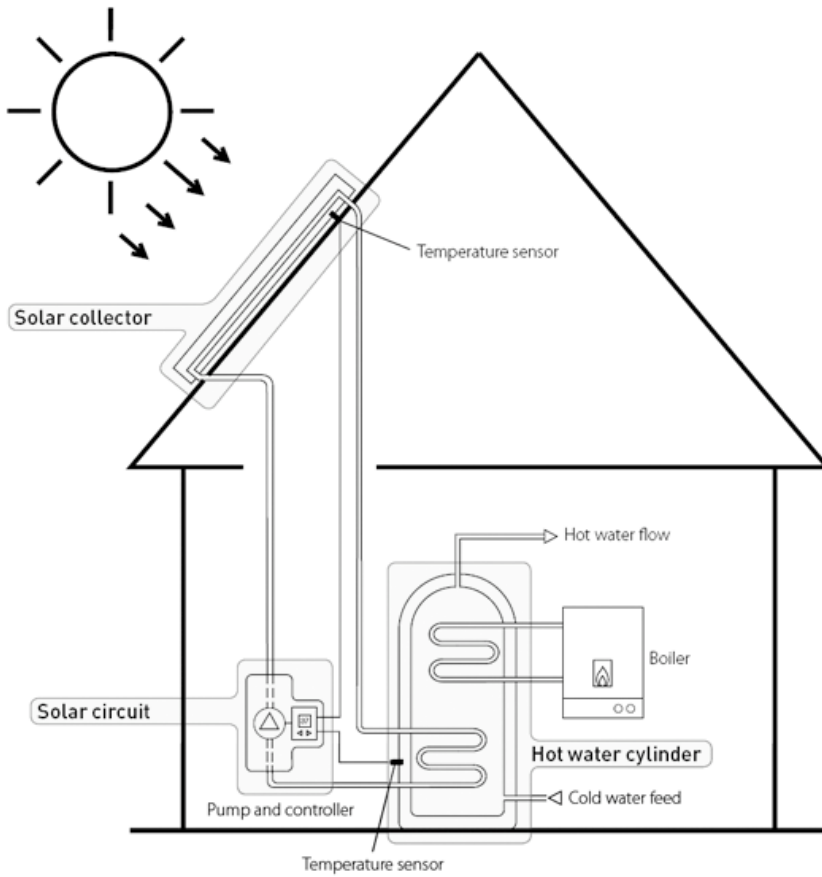
Solar water heating systems collect solar radiation from a flat plate collector or evacuated tubes. Most systems transfer the heat to a safe antifreeze solution, which is pumped into a solar heat storage tank to store each day's hot water supply. This is used as preheated water before using conventional energy to finish heating the water to a set temperature. Often solar thermal energy meets almost all the residential hot water needs in the summer months, requiring very little conventional energy for backup.

Solar water heating systems are most commonly roof mounted, but can also be installed on the side of a building or ground mounted on racks. A single 4' by 8' solar panel can potentially heat 20 gallons of water from 56 °F to 113 °F in 1 hour. In the summer, two solar panels with a storage tank can supply hot water for a family of five. Pools use unglazed collectors to circulate pool water directly and can increase temperature by 10 or 15 degrees depending on size of pool and other factors.

Active solar space heating systems are generally the most complicated type of the different solar thermal systems discussed above, except for the concentrating solar power plant. Depending on the type of solar heating system, it may use water or antifreeze, pipes, pumps and water storage tanks; or, it may use air, fans, air ducts and thermal mass storage in the form of rocks, concrete, water, or special paraffin or salts. Unfortunately, the down side to active solar space heating systems is that they are only useful during the cold months when heat is needed. However, it may be possible to utilize this technology to provide some space cooling relief through careful design.

It is important to note, however, that of all the solar thermal technologies described above, the Pennsylvania Sunshine Program only pays out rebates for solar water heating systems.

The following shows a simple closed-loop solar water heating system.



How Much Solar Systems Cost

PV Systems

Incentives offered through the Pennsylvania Sunshine Solar Program will reduce the purchase cost of a PV system by a maximum of 35%. Currently, the rebates are generally available to pay \$2.25 per watt of DC capacity up to 10 kW for a residential solar PV system. Additionally, the federal Investment Tax Credit (ITC) allows for a 30% credit on federal income tax returns based on the entire installation cost, not just the incremental cost after the rebate. The cost of a PV system depends on a number of factors, including system size, equipment options and labor costs. Installed cost typically range from \$7 to \$9 per watt or more. For a 4 kW residential system, unsubsidized cost is estimated to be between \$28,000 to \$40,000 however, state rebates, tax credits, and the financial benefits from net metering and solar renewable energy credits will **significantly** bring down those costs. The PA Sunshine Program covers residential solar PV systems rated between 1 kW and 10 kW..

Commercial solar PV systems can range anywhere from 3 kW and above. PA Sunshine will pay rebates for solar PV systems rated between 3 kW and 200 kW, though rebate amounts depend on the system size. As a result, site and financing costs are wide-ranging and highly variable.

The rebate levels decline over time based on the accumulated blocks of solar PV capacity installed; refer to the PA Sunshine Program website (www.depweb.state.pa.us/pasunshine) for further information or current status of the rebate level.

It is worth noting that the price for solar PV modules has tumbled about 20% or more during 2009 which will make solar PV systems more cost effective.

Solar Water Heating

Incentives offered through the Pennsylvania Sunshine Solar Program for a residential system will reduce the purchase cost of a solar water heating system by matching 25% of the installation cost up to \$2,000 or capped at 35% of the total project cost, whichever is less. For small commercial systems, the dollar cap amount is \$20,000, or capped at 35% of the total project cost, whichever is less. The rebate levels decline over time based on based on the number of solar thermal systems installed. Refer to the PA Sunshine Program website (www.depweb.state.pa.us/pasunshine) for the all current rebate levels.

In addition to the PA Sunshine Solar Program rebate, the federal Investment Tax Credit (ITC) allows for a 30% credit, up to \$2,000, on federal income tax returns.

Residential solar water heating systems are typically sized to provide 60% to 75% of annual domestic hot water needs. The majority of these systems install 64 or 80 square feet of collectors or evacuated tubes to match desired demand. Installed cost typically range from \$100 to \$175 per square foot of collector Area. For a 64 square foot collector with an 80-gallon storage tank, the unsubsidized cost is estimated to range between \$6,000 and \$11,000. As with PV systems, state rebates and tax credits will help **significantly** offset these costs.

Commercial solar thermal systems are custom engineered systems that provide heat for hot water systems, space heating, processing heat or even air conditioning through absorption chillers and desiccant cooling systems. The installation costs of these systems are wide-ranging and highly variable.

Solar Pool Heating

Solar pool heating systems are economical and provide free heat for pool heating after the initial investment. Outdoor solar pool heating systems are typically sized at 50% of the overall pool area. The solar collectors are unglazed and lay directly on a roof or on ground mounted racks. When the pool requires heating, pool water is simply diverted to the collectors using the existing filter pump. Indoor pools, operating year round, are similar to commercial solar hot water systems and utilize closed loop design and antifreeze heat transfer fluids. While the installation cost of solar pool heating systems is dependent on various factors, costs generally range from \$4,000 to \$7,000. Solar pool heating or spa heating systems are not eligible for rebates under the PA. Sunshine Solar Program.

How Net Metering Works

Net metering is a mechanism that provides a simplified approach for interconnecting and metering on-site renewable generating facilities, such as a solar PV system. It allows customers to use excess solar electric generation to offset utility-purchased electricity on a monthly or annual basis.

As a solar PV system starts generating electricity, it first goes to meeting the on-site electric demand at the home or business, slowing down the power being supplied by the grid. It is very common that later on in the day the solar PV system may produce more power than what is needed at the site, , at which point the

“excess” electricity will automatically back feed through the bi-directional utility meter and onto the utility grid (Note: PECO Energy does not have bi-directional meters at this time and therefore requires two meters, one to be wired in reverse, to record this information; PECO Energy provides a reimbursement for the second meter installation cost). At the end of a month, if a customer uses more electricity than a solar system generates, the customer is charged for the difference on the customers’ utility bill. However, if the customer generates more electricity than is needed during a given month, the excess is carried forward at full retail value towards the following month's bill. If the solar PV system generates more annual electricity than the annual electric usage by the home or business, then the customer receives payment for the annual surplus based on the ‘*Price to Compare*’ for electric generation and transmission.

Note that PA state law and PA. PUC regulation requires all investor owned utilities to follow the net metering rules, but electric cooperatives and municipalities are not included in this requirement. Some electric cooperatives and municipalities do have net metering in their territories but they may differ from the regulated utilities.

Pennsylvania's net metering statewide regulation also includes Virtual Meter Aggregation, which allows one account holder with several accounts (meters) within a 2 mile radius, take full credit from surplus generation from a single on-site renewable generation system (i.e., solar PV system) interconnected to one account and apply it across all other accounts. This applies to farms, campuses, apartment complexes, houses, etc.

Alternative Energy Certificates

An Alternative Energy Certificate (AEC) is a tradable environmental commodity representing proof that 1 MWh (1,000 kWh) of electricity was generated from an eligible renewable energy resource. A solar AEC, also known as a solar renewable energy credit or SREC, certifies that the electricity was produced from a solar energy system, and is issued once a solar facility has generated 1 MWh of solar electricity through either estimated or actual metered production.

As an economic mechanism of Pennsylvania's Alternative Energy Portfolio Standard (AEPS), utilities can buy and sell SRECs on the market in order to fulfill their solar share requirements stipulated under the AEPS. SRECs are also designed to provide incentives for renewable energy marketers, private businesses and individuals to invest in the development of the solar energy industry in Pennsylvania.

SRECs are sold separately from generated power, and can be traded by individual entities or aggregated and sold through agreements with agents commonly known as "aggregators". Like any commodity, the price of SRECs is a function of supply and demand like most commodities. Even though the price of an SREC is set in the marketplace, some states place a cap on those prices.

The state of Pennsylvania currently utilizes the PJM-GATS credit registry to accurately and efficiently issue SRECs. Their website is www.pjm-eis.com.

Interconnection

Interconnection refers to interfacing a grid-tied solar PV system, or any other grid-tied generator, to the electric distribution company (i.e., grid). This configuration allows the solar PV system to operate in parallel with the grid. For small systems, the point of interconnection is through a circuit breaker on the main electric service panel, or it could be a supply tap on the service lines just before the main electric service panel.

A solar installer or electrician will work to interconnect a solar PV system by submitting an interconnection application and appropriate fees to the electric distribution company. There are four levels of interconnection under the Public Utility Commission's interconnection rules. Level 1 is the simplest and least expensive application and applies to certified inverter based systems up to and including 10 kW in size. Level 2, 3 and 4 are more detailed and expensive applications and apply to generating systems greater than 10 kW up and including 2 MW systems. The PUC's Final Rules can be easily located on their website at www.puc.state.pa.us; under the electricity tab, click on "alternative energy" and scroll down to "interconnection" where there is the link to utility contacts for interconnection, agreement forms, application fees and the PUC's Final Rules (September 15, 2006).

Fire and Safety

All solar PV system components should have a UL or equivalent listing. Many quality solar products are manufactured in other countries that may have more established solar programs. There are several standards like UL that also meet OSHA and other fire and safety standards such as ETL and SE, which provide similar assurances as UL.

Developing guidance for the risk of fire is important to increase public safety for all structures equipped with solar energy systems. There is particular concern regarding roof-mounted solar systems, which can create limitations for firefighters to access, maneuver and specifically penetrate the roof to ventilate and suppress a building fire. Solar arrays are difficult and dangerous to cut through and time-consuming to move, therefore, in the face of a fire, solar systems can pose risks including shock and trip hazards.

States like California under their Office of the State Fire Marshal developed installation fire safety guidelines for PV solar systems. Guidelines like these could be applied in Pennsylvania and include

1. Marking – The guidelines specify that high-contrast, reflective and consistent wording should be used for all solar related conduit, electrical panels and disconnects.
2. Access, pathways and smoke-ventilation space – The fire marshal recommends that providing a 3-foot setback from the edges of roofline from gutter to ridge ensures that firefighters and access the roof in a quick and safe manner. A 3-foot setback along the roof's ridgeline is also recommended to provide the available space if there is a need to penetrate the roof to create ventilation.
3. Conduit runs – Chain saws are often employed to create vertical ventilation for fire suppression. Therefore, it is recommended that conduit runs should be kept 10-inches below roof decking to minimize the chance of being cut into.

Additional information on California's fire and safety guidelines can be obtained through:
<http://www.osfm.fire.ca.gov/training/pdf/photovoltaics/solarphotovoltaicguideline.pdf>

Model Solar Ordinance for Pennsylvania Municipalities

As part of the Governor's Solar Working Group, a model Solar Energy Systems Ordinance was developed for municipalities to amend into Pennsylvania local zoning ordinances. The purpose of the Solar Energy Systems Ordinance is to promote the use of solar energy and to provide for land planning, installation and construction of these systems subject to reasonable conditions that will protect the public health, safety and welfare of the community.

As solar energy systems become increasingly commonplace in local communities, the solar ordinance can provide significant legal structure for ensuring that the integration of solar systems into new and existing building construction and land development aligns with the regulations, goals and expectations of a specific municipality.

The model ordinance serves as framework for addressing the needs and concerns of solar energy systems. Consulting with a municipal solicitor is essential for ensuring that the model ordinance is appropriately tailored and incorporated into individual Zoning Ordinances.

Solar Energy Systems Ordinance

The Zoning Ordinance of _____ {municipality}, Ordinance No. _____, is amended by adding the following:

Section 1. Title:

This Chapter shall be known as the Solar Energy Systems Ordinance for _____{municipality}.

Section 2. Purpose:

The purpose of this Chapter is to promote the use of Solar Energy and to provide for the land planning, installation and construction of Solar Energy Systems in _____ {municipality} subject to reasonable conditions that will protect the public health, safety and welfare.

Section 3. Classification:

- A. Solar Energy Systems shall be allowed in any zoning district and may be installed upon receipt of the necessary construction, electrical and/or mechanical permit(s). This ordinance applies to Solar Energy Systems to be installed and constructed for residential or commercial use.
- B. Solar Energy Systems that are the primary use of a lot are governed by other sections of this zoning ordinance or the Land Planning Subdivision and Land Development Ordinance.

Section 4. Definitions:

"Solar Energy System" means any solar collector or other solar energy device, or any structural design feature, mounted on a building or on the ground, and whose primary purpose is to provide for the collection, storage and distribution of solar energy for space heating or cooling, for water heating or for electricity.

"Solar Energy" means radiant energy (direct, diffuse, and reflected) received from the sun.

Section 5. Applicability:

- A. This ordinance applies to Solar Energy Systems to be installed and constructed after the effective date of the ordinance, and all applications for Solar Energy Systems on existing structures or property.
- B. Solar Energy Systems constructed prior to the effective date of this ordinance shall not be required to meet the requirements of this ordinance.
- C. Any upgrades, modifications or changes that materially alter the size or placement of an existing Solar Energy System shall comply with the provisions of this Chapter.

Section 6. Design and Installation:

- A. To the extent applicable, the Solar Energy System shall comply with the Pennsylvania Uniform Construction Code, Act 45 of 1999 as amended and the regulations adopted by the Department of Labor and Industry.
- B. The design of the Solar Energy System shall conform to applicable industry standards.

Section 7. Setbacks and Height Restrictions:

- A. Solar Energy Systems may be installed as long as it meets the requirements of this Chapter and all other applicable construction codes.
- B. Ground-mounted Solar Energy System
 - 1. Solar Energy System must comply with all setback and height requirements for the zoning district where the Solar Energy System is installed.
 - 2. All exterior electrical and/or plumbing lines must be buried below the surface of the ground and be placed in a conduit.
 - 3. A ground-mounted Solar Energy System must comply with the accessory structure restrictions contained in the zoning district where the ground-mounted Solar Energy System is installed.
- C. Roof mounted Solar Energy System.
 - 1. A Solar Energy System shall conform to the height regulations of the zoning district where the Solar Energy System is installed.
- D. Waivers
 - 1. Upon request, the governing body may grant waivers of the setback or height requirements, provided that the waiver will not present any undue hardships on the adjoining property.
 - 2. The governing body shall take into consideration the support or opposition of adjacent property owners in granting waivers of setback or height requirements.

Section 8. Effective Date:

This ordinance shall take effect _____.

Permits

Permit fees will vary across the state.

The permitting process offers a valuable opportunity to ensure that solar energy systems are meeting baseline requirements, such as the National Electrical Code. A system installer can use the permitting process to inform the municipality about the solar system and demonstrate that installation will meet fire, safety and electrical standards.

Municipalities may want to request solar installers to include a list of the proposed equipment to be used, specifications, a site plan, and one-line wiring diagram as part of the permit process. The more information that is provided upfront, the easier it is for the installer to communicate with the local inspector and more cost effective to change the system design before any hardware is purchased and installed.

Inspections

Under the PA Sunshine Solar Program rules, DEP will perform inspections of at least 10 percent of all installations. A code official and/or electrical inspector will typically perform the electrical inspection for compliance with the National Electric Code (NEC) along with any required building inspections. If the solar system is grid-connected, the local utility company may also require inspection prior to activating the system or require documentation from the solar installer.

To ensure that a solar energy system passes inspection and is properly installed, contracting with an approved installer is critical to ensure consumer protection. In administering the PA Sunshine Solar Program, DEP has developed an approved list of solar system installers.

Criteria for DEP Approved Solar Installers

Whether or not a home or business is applying to the PA Sunshine, DEP's installer requirements serve as valuable guidance for selecting an installer.

An approved PV or solar thermal installer is one who meets or exceeds one of the following requirements:

1. Is certified by the North American Board of Certified Energy Practitioners (NABCEP).
2. Has completed an Interstate Renewable Energy Council (IREC) Institute for Sustainable Power Quality (ISPQ) accredited PV training program or a PV manufacturer's training program and successfully installed a minimum of three PV systems.

In addition to meeting the criteria, DEP requires that installers:

1. Be in good standing as evidenced by favorable reports from three customer references and no negative reports from the Better Business Bureau.
2. Up to date Commercial General Liability Insurance with bodily injury and property damage combined single limit of liability of at least \$1,000,000 for any occurrence.
3. Carry Workers Compensation Insurance for all employees of the company.

Frequently Asked Questions

Q. *Why should I go Solar?*

A. There are many reasons, here are just a few:

- Solar energy finance experts suggest that every 1,000 Watts of power from PV modules could add resale value to your home.
- Solar systems are extremely reliable, able to produce clean energy from the sun for at least 25 years.
- Dramatically reduce your carbon footprint, help your community clean its air, help provide grid stability and reliability as well as reduce our dependence on foreign energy sources.
- Incentives are now at their highest level in Pennsylvania and will decline as more systems are installed.
- Once the cost of the system is paid, the energy it generates is free. Solar energy is, therefore, a hedge against increasing energy costs.
- There are federal tax credits that many consumers can take advantage of to further lower the cost of a system at this time.

Q. *How much money will I save on my electric bill?*

A. The potential savings from a solar system depends on several factors, including your current utility rate structure and your usage, the size of the solar system and the amount of sunshine your system receives. A certified solar installer should be able to provide you with an estimate.

Q. *What size solar system do I need?*

A. Several factors will influence the size of your solar system. Determining your present electricity need is the first step in sizing your solar system and determining your budget. Completing an energy efficiency audit of your home or business and integrating energy efficiency measures before you decide to install solar may affect the size of the system you install. In addition, making improvements to the energy efficiency of your home or business will improve the comfort level of your home or building while reducing energy bills.

Residential solar PV systems are typically 2 to 5 kW (DC) in size, but many systems up to 10 kW or more are also being installed. Within Pennsylvania, the legal size limitation for a Residential solar PV system is 50 kW per electric account or point of interconnection at the utility meter. In Pennsylvania, a solar PV system will conservatively produce on average 1,000 kWh (AC) of electricity per year for each 1 kW (DC) installed in a fixed orientation. However, it is very possible to generate over 1,200 kWh per year if the solar PV array has optimum orientation, has no shading impacts or is a tracking system which follows the path of the sun throughout the day. The size of a typical solar PV module is roughly 3 or 4 feet wide by over 5 feet high, with a rated capacity ranging from 150 watts to over 300 watts. The solar array may conservatively take up about 100 square feet of roof area per 1 kW of DC capacity, but depending on the efficiency of the solar PV modules, the area can range from 150 square feet down to 60 square feet per kW of DC capacity.

Therefore, given the average Pennsylvania residential household consumes about 10,000 kWh of electricity per year; the size of a solar PV system to meet all of the annual usage would range from about 8 kW to 10 kW in DC capacity.

Q. *Are PV systems reliable?*

A. Yes. Stationary PV systems have no moving parts; therefore, there is nothing mechanical that will deteriorate. They operate silently, and require no fuel, filters or other costly parts or maintenance. The most common solar modules are constructed of silicon cells (similar to a computer chip) embedded inside a protective layer, such as sturdy tempered glass. They are made to withstand hot, direct sunlight and harsh weather conditions, such as snow and hail storms, and will continue to work as long as sunlight falls on the surface. They do need to be cleaned periodically to ensure maximum performance—dust and dirt can reduce a system's performance. Solar systems usually have an expected life of up to 25 years. Systems receiving incentives under the Pennsylvania Sunshine Program are required to have at least a 10-year equipment warranty.

Q. *Which solar technologies are covered under the Pennsylvania Sunshine Program?*

A. Incentives are available for solar photovoltaic (PV) technologies (roof-mounted, ground-mounted and building-integrated PV), and solar thermal systems. In addition, customers may be eligible for incentives under the Solar Water Heating Pilot Program. Please see the useful link section for additional information.

Q. *What applications will not be covered under the rebate program?*

A. Solar systems for swimming pools and spas will not be covered under any of PA's solar rebates or grant programs. In addition, generally, non-grid tied systems that run on batteries will only be considered for a rebate under certain circumstances. Contact DEP before installing to see if the system qualifies.

Also it will be important that your installer is familiar with all the guidelines in order to qualify for a rebate.

Q. *How long do solar systems last?*

A. PV solar panels are usually warranted for 25 years and some systems last even longer.

Q. *How long does a solar thermal system last?*

A. Three year warranties are fairly standard for solar thermal systems. Under the PA Sunshine Program, 10-year warranties are required for solar thermal collectors.

Q. *How much are application fees?*

A. DEP application fees are \$100 per application for residential applications and \$150 for commercial applications. These fees are non-refundable..

Q. *How can I check on the status of my application?*

A. Your installer can provide you with regular updates regarding the status of your application. You can also review details of your application online at <http://csi.powerclerk.com>.

Q. *How long will the application process take?*

A. The Pennsylvania Sunshine Program Administrators target less than 30 days to confirm both residential and non-residential reservation requests. To help ensure your application is processed quickly, please take a

minute to review your documents before filing them with the Department of Environmental Protection to ensure it is complete.

Q. *Must I go on a time-of-use (TOU) rate as a condition of participating in the Pennsylvania Sunshine Program?*

A. Pennsylvania Sunshine Program applicants are not currently required to use TOU rates unless required by other terms of their service. However, many customers benefit from TOU rates because solar production in the middle of the day generates electricity during peak periods when TOU customers rates are the highest. Customers should ask their solar installer and utility if TOU is available and is beneficial.

Q. *When I get my solar system installed, will I be off the grid?*

A. No. The Pennsylvania Sunshine Program provides incentives only for grid-tied solar systems. When a system produces more power than the customer is using, the excess flows into the grid. When the customer's electricity use is more than the solar system produces, the customer automatically gets power from the grid.

Q. *Do I need a battery backup for my solar electric generating system?*

A. A battery backup for your solar system is unnecessary when your system is connected to your utility's electric grid. The grid serves as a backup during times when your system is not producing electricity, for example, at night and on very cloudy days.

Q. *What happens during a power outage?*

A. Your solar electric system is designed to shutdown immediately in a power outage for safety reasons, unless it includes a battery storage system.

Q. *Can my city, homeowners association or neighbor prohibit me from installing solar on my roof?*

A. Check with your township for specific rules that apply in your community. In particular, some homeowners associations have rules governing property that may restrict solar.

Q. *Is the power produced by the solar system any different from the utility power? Will it hurt my home appliances or business equipment?*

A. No. The electricity generated by your solar system is no different from electricity delivered by your local utility. The solar system connects directly to your utility module or circuit breaker box, so it interfaces seamlessly with your utility power.

Q. *Does a solar PV system have to meet local building codes?*

A. Yes. You will probably need to obtain a permit from the municipality, or city. You may be required to purchase a building permit and/or electrical permit before you can begin installation. Most solar installers should be able to assist you with local permitting issues.

Q. *Can I install a solar PV system myself?*

A. Not and receive a rebate from the Pennsylvania Sunshine Program.

Q. *Where can I get more information?*

A. There are so many solar sites on the web too numerous to mention here but here are a few key sites:

Pennsylvania Public Utility Commission - <http://www.puc.state.pa.us>

Pennsylvania Department of Environmental Protection – <http://www.depweb.state.pa.us/>

Clean Power Markets, Inc. – <http://www.cleanpowermarkets.com/>

The Solar Alliance – <http://www.solaralliance.org/>

Mid-Atlantic Solar Energy Industries Association – <http://www.mseia.net/>

Solar Energy Industries Associate – <http://www.seia.org/>

PJM Environmental Information Services, Inc. – <http://www.pjm-eis.com/>

United States Department of Energy – <http://www.energy.gov/>

Pennsylvania Commonwealth Finance Authority – <http://www.newpa/commonwealth-financing-authority>

Glossary of Commonly Used Terms

A

Alternating Current (AC): Alternating current is an electric current whose direction reverses cyclically, as opposed to direct current (DC), whose direction remains constant. AC is the form of electricity that is delivered to your home or business. Solar photovoltaic (PV) systems produce DC power, which must be converted to AC by an inverter.

Array: Any number of electrically connected photovoltaic (PV) modules providing a single electrical output.

Azimuth: Azimuth is the horizontal angular distance between the vertical plane containing a point in the sky and true south. All references to azimuth within the Pennsylvania Sunshine Program, unless expressly stated otherwise, refer to true, not magnetic, azimuth.

B

Building Integrated Photovoltaic (BIPV): BIPV technologies form part of the structure to which they are affixed. Typically integrated into the roofing system, BIPV products can provide architectural interest and/or a very unobtrusive installation.

C

Capacity Factor: The capacity factor for an electricity generating unit is the ratio of the energy produced during a given time period, measured in kilowatt-hours (kWh), to the energy the unit could have produced if it had been operating at its rated capacity during that period :

$$\text{Capacity factor} = \frac{\text{Actual Solar PV System Generation (kWh)}}{\text{Rated generating capacity (kW) x period (in hours)}}$$

Capacity Rating: The rating given to a PV system by its manufacturer denoting the load the system is able to meet or supply when operating at full capacity. For a solar PV system, this will occur when the system is in direct sunlight with no shade.

Conversion Efficiency: The amount of the sun's energy that a solar cell can convert into electricity; the balance is lost as heat or reflected light.

D

Direct Current (DC): Solar PV systems produce electricity in direct current (DC), which is defined as the continuous flow of electricity through a conductor. In DC, electricity always flows in the same direction, which

distinguishes it from alternating current (AC). Solar PV systems produce DC power, which must be converted to AC by an inverter in order to power household appliances.

I

Insolation: The amount of solar energy that shines on a building or area, equivalent to energy and usually expressed in annual kilowatt-hours per square meter.

Interconnection Agreement: A legal document between the customer and their electric utility authorizing the connection of the customer's solar system to the utility's grid. This agreement is required prior to receiving a Pennsylvania Sunshine Program incentive payment, unless it is an approved off-grid application.

Interval Data Recorder (IDR): An Interval Data Recorder is a metering device that stores data on energy production, usually in hourly or 15-minute intervals.

Inverter: A device that converts direct current (DC) electricity produced by a solar system into the alternating current (AC) electricity that can be used in a home or building. Some energy is lost when this conversion takes place.

Inverter Efficiency: The AC power output of the inverter divided by the DC power input. Inverter efficiency is lowest when operating at low loads; thus, it is important to select inverter(s) of the proper size relative to the PV array. Grid tied inverters typically have a rated efficiency ranging between 92% and 96%.

K

Kilowatt (kW): A unit of electrical power equal to 1,000 Watts, which constitutes the basic unit of electrical demand. The Watt is a metric measurement of power (not energy) and is the rate (not the duration) at which electricity is used. 1,000 kW is equal to 1 megawatt (MW).

Kilowatt-Hour (kWh): A unit of electrical energy, equivalent to the use of 1 kilowatt of electricity for one full hour. Utilities measure customers' electric energy usage on the basis of kilowatt-hours, and electricity rates are most commonly expressed in cents per kilowatt-hour..

L

Load: The amount of power carried by a utility system or the amount of power consumed by an electric customer at a specific time. Base load is the minimum constant level of electricity required by utility customers; peak load is the amount of electricity required at the time of greatest demand.

M

Megawatt (MW): Unit of electric power equal to 1,000 kW, or 1 million Watts.

Meter: A device used to measure and record the amount of electricity used or generated by a consumer.

Modules: A module is the smallest protected assembly of interconnected PV cells. Applicable modules are typically rated between 150 Watts and over 300 Watts.

N

Net Metering Agreement: An agreement with the local utility that allows customers to receive a credit at the retail price of electricity for surplus electricity generated by certain renewable energy systems. Under net metering, the electric meter runs backward as a customer's solar system generates surplus electricity.

O

Orientation: A term used to describe the direction that the surface of a solar module faces. The two components of orientation are the tilt angle (the angle of inclination a module makes from the horizontal) and the azimuth (based on true South, not magnetic North/South).

P

Photovoltaic (PV): The technology that uses a semiconductor to convert light directly into electricity.

Power Conversion Efficiency: The ratio of output power to input power of the inverter

Power Purchase Agreements (PPA): A contract to purchase energy. PPAs are usually established between a power plant and a purchaser of electrical energy, such as a utility. A PPA may be a contract written between a building owner that wants to use solar energy and a third-party developer who will install, maintain and own the PV system used to generate the electricity on the building's structure, then sell the solar energy produced by the system to the building owner at a pre-determined rate.

Program Administrator (PA): Program Administrator refers to Department of Environmental Protection (DEP), who performs administration of the PA Sunshine Solar Program under the auspices of the Commonwealth Finance Authority (CFA).

R

Renewable Energy Credits (RECs): Renewable energy certificates (RECs), also known in Pennsylvania as alternative energy credits (AECs) represent the environmental attributes of the power produced from renewable energy projects. By installing a renewable energy system (such as solar), you become the owner of these environmental attributes, or RECs. They have value in the marketplace. Ask your solar installer about how to sell your credits which, in most cases, will help reduce the cost of your system.

S

Silicon: A chemical element (Si) that is the most common semi-conductor material used to make solar PV cells.

Solar Irradiance: Radiant energy emitted by the sun, particularly electromagnetic energy.

Solar Pathfinder: A device used in PV site assessment for charting the sun's path through the sky for all months of the year, calibrated by the hours of the day. Also provides other critical, detailed site data.

Solar Thermal: The process of concentrating sunlight on a relatively small area to create the high temperatures needed to vaporize water or other fluids to drive a turbine for generation of electric power, heat water for domestic or industrial hot water, or space conditioning (heating or cooling). Pennsylvania Sunshine Program is the first state in the country to have a state-wide rebate program for solar hot water systems. .

System Installer: Installers need to be approved in order to participate in the PA Sunshine Program. A list of approved installers can be found on the DEP website. Installers need to meet certain criteria before being listed.

Solar Renewable Energy Credits (SRECs): Alternative energy credits (AECs) or renewable energy credits (RECs) which are specifically generated from a solar electric or solar thermal system.

T

Time-of-Use (TOU) Meter: An electric meter that measures and records the times when a customer consumes or generates electricity, during utility defined on-peak and off-peak periods. This type of meter is used for customers who are on time-of-use rates.

Time-of-Use (TOU) Rates: Electricity prices that vary depending on the time period in which the energy is consumed or produced. In a time-of-use rate structure, higher prices are charged during utility peak-load times. Such rates can provide an incentive for consumers to curb power use during peak times. Solar PV modules tend to produce power during peak times, so they have high value when used in conjunction with time-of-use rates.

Tracker or Tracking Array: A number of PV modules mounted such that they track the movement of the sun across the sky to maximize energy production, either with a single-axis or dual-axis mechanism.

W

Warranty: In the Pennsylvania Sunshine Program, the solar PV systems must have a 5 year labor warranty, including 5 year and 20 year equipment warranties for the inverters and PV modules, respectively. For the solar thermal systems, the labor warranty must be 3 years, and the equipment warranty for the solar panels must be 10 years.

Watt: A unit of measurement of electric power, named after physics pioneer James Watt.

Watt-hour (Wh): A unit of energy measurement, equal to one Watt of power used for one hour.