

RENEWABLE ENERGY OPTIONS

INTRODUCTION

With the increase in energy costs, customers are looking for ways to reduce or offset the operational costs of households and businesses through energy-efficiency improvements, technology and renewable energy.

Energy-efficiency improvements and technology may reduce energy consumption by reducing the energy requirements of the home, business and equipment.

Renewable energy offsets energy usage by the production of electricity or heat.

PPL Electric Utilities customers have a renewed interest in energy alternatives. In this document, we will discuss:

1. Solar energy for domestic hot water heating and space conditioning.
2. Solar (photovoltaic) energy for the production of electricity.
3. Wind energy for the production of electricity.

Potential benefits related to installing these options include:

- Saving on household operational costs.
- Reducing your electric bill.
- Selling power back to the utility.
- Helping to protect the environment.



DISCLAIMER:

This information is being provided to PPL Electric Utilities customers for informational purposes only. PPL Electric Utilities does not warrant or endorse the energy system or equipment of any particular manufacturer. PPL Electric Utilities does not guarantee that a particular third party system will in fact save energy.

SOLAR HOT WATER SYSTEMS

Solar hot water systems use the sun's energy to heat water for domestic hot water use.



Installation Cost

Average installed cost ranges from \$3,500 to \$7,000 for a system capable of providing ample hot water for a small family.*

* The average cost of the renewable energy systems in this document is based on customer and contractor feedback (2004 through 2008). System size, type and cost, mounting hardware, equipment location, and site conditions govern the actual cost of the installation.

Installation Requirements

- Look for systems that have SRCC (Certified Collector & Water Heating Ratings) & Warranties.
- A minimum 10'x15' of roof area is needed for mounting solar water heating collectors.
- Solar water heating collectors should be mounted on a roof. Ground mounting is an option.
- The roof should be structurally sound and have no more than one layer of shingles.
- The proposed area where the collector is to be located should face due south and receive the maximum amount of sunshine on a daily basis for both the winter and summer season.
- The area where the collectors are mounted should not be shaded by trees, building or other objects.

Pros

Low Cost Installation.

Short Investment Payback.

Cons

Operation. The system will operate only when sufficient sunlight is available.

Seasonal Output. Production of hot water is highest during summer, spring and fall.

Things to Consider

- Check with the local zoning office in your area for rules, regulations and possible permits that may be needed.
- The value and addition of solar panels may increase insurance costs.
- PPL Electric Utilities has to approve renewable electric generation systems and equipment that will be connected to the grid. Applications are available at:
<http://www.pplelectric.com/Business+Partners/Tools+and+Reference+Center/Customer-Owned+Generation/>
- Prior to making major equipment investments, you should have a qualified professional perform a site study, specific to the proposed mounting location for the system and identify and evaluate any conditions that may affect the system's ability to produce energy.

SOLAR (PHOTOVOLTAIC) GENERATION SYSTEMS



Solar (photovoltaic) energy systems use the sun's energy to produce electricity.

Installation Cost

The installed cost for the first kilowatt of generation ranges from \$7,000 to \$10,000.*

* The average cost of the renewable energy systems in this document is based on customer and contractor feedback (2004 through 2008). System size, type and cost, mounting hardware, equipment location, and site conditions govern the actual cost of the installation.

Installation Requirements

- A minimum 10'x15' of roof area is needed for mounting photovoltaic panels.
- Photovoltaic panels should be mounted on a roof. Ground mounting is an option.
- The roof should be structurally sound and have no more than one layer of shingles.
- The proposed area where the photovoltaic panels are to be located should face due south and receive the maximum amount of sunshine on a daily basis for both the winter and summer season.
- The area where the photovoltaic panels are mounted should not be shaded by trees, buildings, or other objects.

Pros

Systems Connect to the Power Grid. If the system is equipped with the proper inverter, surplus generation could be sold back to the utility. (PPL Electric Utilities has to approve the system.)

Stand-alone Systems. Ideal for providing power applications such as area lighting or power for use at remote locations. These systems have battery back-up and charging systems. (The power supplied by the system is the sole source of power to the device it powers.)

Cons

Operation. The system will operate only when sufficient sunlight is available.

System Output. The electrical output of the system is limited to the space available for the photovoltaic panels. The systems are usually roof-mounted but could also be ground-mounted if a suitable location is available. The amount of direct sunlight that is available on a daily basis (southern exposure) is most important. Photovoltaic roof shingles are a new technology that can be used in place of panels.

Power During Electrical Outages. Systems that are grid-connected will **NOT** supply power to the household if an electrical outage occurs. Non-supply of power during outages is incorporated as a safety feature to protect your equipment from overloading and protect the safety of electric service personnel.

Things to Consider

- Check with the local zoning office in your area for rules, regulations and possible permits that may be needed.
- The value and addition of solar panels may increase insurance costs.
- PPL Electric Utilities has to approve renewable electric generation systems and equipment that will be connected to the grid. Applications are available at:
<http://www.pplelectric.com/Business+Partners/Tools+and+Reference+Center/Customer-Owned+Generation/>
- The rated outputs of solar and wind energy systems are supplied by equipment manufacturers. Although the ratings are supplied, the output of any system is specific to your location and conditions.

WIND GENERATION SYSTEMS

Wind generation uses wind power to generate electricity.



Installation Cost

The installed cost for one kilowatt of generation is approximately \$4,000 to \$6,000.*

* The average cost of the renewable energy systems in this document is based on customer and contractor feedback (2004 through 2008). System size, type and cost, mounting hardware, equipment location, and site conditions govern the actual cost of the installation.

Installation Requirements

- Systems producing greater than 1 kilowatt of electricity should not be mounted on residential structures. Systems greater than 1 kilowatt may require a pole or tower mounts, which would be an added expense. Guy wires are often required for additional support.

Pros

Systems Connect to the Power Grid. If the system is equipped with the proper inverter, surplus generation could be sold back to the utility. (PPL Electric Utilities has to approve the system.)

Stand-alone Systems. Ideal for providing power applications such as area lighting or power for use at remote locations. These systems have battery back-up and charging systems.

Cons

System Output. The electrical output of the system varies by wind speed.

Large Systems. Require special pole mounts or towers that add to installation costs.

Power During Electrical Outages. Systems that are connected to the grid will **NOT** supply power to the household if an electrical outage occurs.

Things to Consider

- Check with the local zoning office in your area for rules, regulations and possible permits that may be needed.
- The value and addition of wind generation systems may increase insurance costs.
- PPL Electric Utilities has to approve renewable electric generation systems and equipment that will be connected to the power grid. Applications are available at:
<http://www.pplelectric.com/Business+Partners/Tools+and+Reference+Center/Customer-Owned+Generation/>
- The rated output of solar and wind energy systems are supplied by equipment manufacturers. Although the ratings are supplied, the system's output is specific to your site location and conditions.

CALCULATING INVESTMENT PAYBACK

Questions to Ask Before Making an Investment

- Will the energy production or energy savings the system provides pay for the investment in equipment, installation, and maintenance?
- Will lesser investments in energy conservation yield higher energy savings?
- What is the interest on the money you would use for the cost of the equipment or what is the interest rate you would have to pay if you financed the system?
- Will state, federal or other grants lower the installed cost of the equipment?

Investment payback results will vary based on the following factors:

- Sun's angle
- Atmospheric conditions
- Collector or photovoltaic panel tilt angle, orientation, and efficiency
- Shading
- Outside temperature
- For solar generation systems, power conversion losses (inverter and wiring loss)
- For solar water heating systems, pipe heat loss, collector supply/return piping, amount of thermal storage, and time and volume of usage
- For wind generation systems, the average wind speed at site location

Calculating the Electrical Output of Solar (Photovoltaic) Generation Systems

The potential kilowatt-hour output can be found by multiplying the number of sun hours per day in your geographic area (average of 5.5 per day in Northeastern Pennsylvania) by the kilowatt (or watt) output of the system. This number represents the system's maximum potential of a properly installed system in a location that has ideal solar conditions.

$$\text{(Number of Sun Hours)} \times \text{(System Output in kW)} = \text{Total kWh}$$

To properly evaluate the kilowatt-hour output of a solar (photovoltaic) generation system, the proposed location of the photovoltaic panels needs to be evaluated using a Solar Pathfinder. A pathfinder evaluation takes into consideration the site's geographic location, collector orientation and shading potential. The evaluation gives the number of sun hours available on a monthly basis for the entire year.

Calculating the Electrical Output of Wind Generation Systems

The electrical rating of a wind generation system is rated at the maximum kilowatt-hour the unit is capable of producing. To give an indication of the unit's potential for production of electricity the manufacturer provides the kilowatt-hours the unit produces using an average wind speed.

$$\text{(Wind Speed)} \times \text{(kW Output at Speed)} \times \text{(Hours of Operation)} = \text{Total kWh}$$

Wind studies using a wind speed recorder should be made at site location.

Calculating Savings Using Solar Hot Water Systems

Solar water heating collectors are rated in thousands of British Thermal Units, or BTUs, per panel per day, application, and climate. Consult the system manufacturers or distributors for system capacity.

Step 1: Calculate the change in temperature needed to heat the water.

$$\text{Desired Temperature of Water} - \text{Current Temperature of Water} = \text{Change in Temperature}$$

Step 2: Convert the volume and temperature of the water heated by the system to BTUs

$$(\text{Gallons of Water to be Heated} \times 8.33) \times \text{Change in Temperature} = \text{BTUs}$$

Step 3: Convert BTUs to the equivalent quantity of fuel or electricity that would have been needed to heat the water.

$$\text{BTUs} \div (\text{Usable BTUs Per Unit of Fuel}) = \text{Amount of Fuel}$$

(See Table Below)

Usable BTUs Per Unit of Fuel at 100% Efficiency	
Electricity	3,413 BTUs Per kWh
Fuel Oil	138,000 BTUs Per Gallon
Propane	91,000 BTUs Per Gallon 21,500 BTUs Per Pound
Natural Gas	1,028 BTUs Per CCF
Coal Anthracite	27,000,000 BTUs Per Ton

The usable heat output of fossil fueled heating and hot water heating systems has to be adjusted for the efficiency of the furnace or hot water heating system being used.

Space Conditioning (Heating): Usable heat for space conditioning should be factored by the burn efficiency of the heating unit. Electricity's burn efficiency is always rated at 100%. If unknown, a burn efficiency of 80% could be used. Older and unmaintained heating systems will have a lower efficiency.

Domestic Water Heating: Some furnaces provide domestic hot water by use of a heating coil within the boiler. When the furnace is used for hot water needs during summer months, water heating efficiency may be lower than 80%.

For all systems, stand-by heat loss and piping heat losses should be considered. The percentage of heat loss depends on distance from the heater to point of use, temperature of the area that the pipes pass through and amount of pipe insulation.

Example

A domestic solar water heating system heats an average of **80 gallons** of hot water per day from **45 degrees to 120 degrees**.

How many dollars per day would be saved on your electric bill?

Step 1: Calculate the Change in Temperature.

$$120 \text{ Degrees} - 45 \text{ Degrees} = 75$$

Step 2: Calculate the

$$(\text{Gallons of Water to be Heated} \times 8.33) \times \text{Change in Temperature} = \text{BTUs}$$

$$80 \times 8.33 \times 75 = 49,980 \text{ BTU}$$

$$\text{BTUs} \div 3,413 \text{ (Electric Water Heater)} = \text{kWh}$$

$$49,980 \div 3,413 = 14.64 \text{ KWH}$$

$$(\text{kWh}) \times (\text{Cost Per kWh}) = \text{Savings}$$

$$14.64 \times \$0.10 = \$ 1.46$$

\$1.46 per day would be saved on the cost to heat domestic hot water.

FREQUENTLY ASKED QUESTIONS

- **Will a photovoltaic system provide emergency power during a power outage?**

No. Systems that are connected to the power grid will not supply power to the household if an outage occurs. Non-supply of power during outages is incorporated as a safety feature to protect your equipment from overloading and to protect electric service personnel.

- **Could generation systems be modified to supply power during a power outage?**

System options for generation include “break before make” transfer switching and battery backup systems. These options are already incorporated on some units and could be added on some existing systems.

- **Is the energy free?**

Yes. After the initial investment for the system and installation is paid for, the energy produced, with the exception of maintenance costs, is free.

- **Will the system become outdated?**

New technologies could possibly increase the usable output and size of photovoltaic systems. Installing a renewable energy system may be a wise investment if it is installed correctly, works properly, and provides a reasonable investment payback.

- **How will PPL Electric Utilities know how much power I produced?**

If the system is producing more electricity than the household is using, the surplus power will make the meter run backwards. This is called net metering.

- **Can I connect a generator to PPL Electric Utilities’ delivery systems?**

Yes. As a customer of PPL Electric Utilities, you are allowed to generate your own power. It is important that the generator is hooked up correctly following all rules and regulations.

- **Will I be paid for excess power?**

Yes. If you qualify as an alternative energy generator under Pennsylvania Act 213, our meters will measure the amount of excess electricity you deliver to our system and you will be paid for that electricity.

- **How much will I be paid for excess power?**

We’ll pay you the full retail value of your generation. The actual amount will vary, depending on your rate class and market values for electricity.

- **Will I still get an electric bill if I generate my own power?**

Yes. You will continue to receive bill statements from us and will be responsible for the monthly minimum distribution charge that applies to your rate class (see PPL Electric Utilities’ Tariff). We need to have the same power lines, metering equipment and facilities in place to serve you – whether we’re needed as a backup source of supply or to take and distribute excess power that you produce. The minimum monthly charge, or customer charge, covers a portion of our costs to provide and maintain this equipment. Other charges may apply in certain circumstances.

- **How do I begin the interconnection process?**

Applications can be found on our “Customer-Owned Generation” page online at:

[\(http://www.pplelectric.com/Business+Partners/Tools+and+Reference+Center/Customer-Owned+Generation/\)](http://www.pplelectric.com/Business+Partners/Tools+and+Reference+Center/Customer-Owned+Generation/).

There is no application fee, but other charges may apply.

You can also call our all our Customer Services Department at 1-800-342-5775. Our hours are Monday through Friday, 8 a.m. to 5 p.m.

- **What is required for interconnection process?**

The interconnection, when complete, must not jeopardize the safety of our workers or the public, and must not compromise the reliability of the electric grid.

- **Are grants available from PPL Electric Utilities or other sources?**

PPL Electric Utilities does not provide any grants or incentives. For a good overview of state, local, utility, and federal incentives, check the Database of State Incentives for Renewables & Efficiency (DSIRE) at

<http://www.dsireusa.org/>.

- **Must I sign a contract?**

Yes. You must sign an interconnection agreement with PPL Electric Utilities. Additional service and construction agreements may be required for larger projects under the jurisdiction of PJM Interconnection.

- **Does PPL Electric Utilities provide generation equipment or installation services?**

We supply the metering equipment required for billing purposes. You are responsible for generation equipment and installation.

- **Will it cost me anything to connect?**

It may not cost anything to connect in the case of residential and small commercial equipment connected with a certified electrical inverter. However, there may be charges for our engineering and field staff to review, inspect and test the electrical protective equipment used to connect larger generators.

If the interconnection requires charges to our equipment or facilities, you may be responsible for our costs to design the changes and buy and install the necessary equipment.

- **May I sell power to my neighbor?**

No. Only licensed electric generation suppliers subject to PJM and Pennsylvania Public Utility Commission regulations may sell power through agreements with PPL Electric Utilities, PJM, or a third-party.

GLOSSARY OF TERMS AND ADDITIONAL RESOURCES

Term	Definition
Watt	A standard rating of electrical energy: 1,000 watts are in 1 kW. 1,000 watts used within 1 hour equals 1 kWh.
Inverter	A piece of equipment that converts the low-voltage direct current (DC) electricity produced by the system into 120 or 240 volts of alternating current (AC) electricity.
kWh (Kilowatt Hour)	Designates the amount of electrical energy used by an appliance or produced by a generation system within 1 hour. kWh is the standard unit of energy used for electric bill calculations.
kW (Kilowatt)	The flow rate of electrical energy measured in 1,000 watts (1 kW) units. kW is used to measure the demand component of electric bills. It can also be used to designate the electrical output of generation systems.
BTU (British Thermal Unit)	The amount of heat energy needed to heat 1 pound of water 1 degree Fahrenheit.
Sun Hours	The average number of hours per day when usable solar radiation. In 1 hour under ideal conditions, 1 square meter receives the equivalent of approximately 1 kWh of solar energy. 5.5 hours per day is a good average to use in Northeastern Pennsylvania.

www.awea.org

www.builditsolar.com

www.depweb.state.pa.us

<http://www.depweb.state.pa.us/energyindependent/site/default.asp>

www.dsireusa.org

<http://www.phillysolar.org/Solar%20Matrix.pdf>

www.findsolar.com

www.focusonenergy.com

www.homepower.com

<http://www.pasolar.org>

<http://energy.sourceguides.com>

www.eere.energy.gov

http://rredc.nrel.gov/solar/old_data/nsrdb/

American Wind Energy Association

Build It Solar

PA Department of Environmental Protection

PA Department of Environmental Protection – Energy Independence Strategy

Database of State Incentives for Renewables & Efficiency

Eastern-Central PA Solar Contractors

Find Solar

Focus on Energy

Home Power Magazine

Solar Energy in Pennsylvania

Renewable Energy Installation Businesses in Pennsylvania by Business Name

U.S. Department of Energy – Energy Efficiency and Renewable Energy

National Renewable Energy Laboratory (U.S. Solar Radiation Data)