



PPL Electric Utilities

Renewable Generation: Making the Connection

A guide for customer-owned
electricity generation projects



Welcome to the world of renewable energy.

At PPL Electric Utilities, we know that renewable energy sources such as wind and solar power play a role in supplying the energy needs of the communities where we live and work.

With increasing 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.

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

This booklet provides helpful information for those seeking to install and operate renewable energy equipment, and for connecting electrical equipment to the PPL Electric Utilities electricity distribution system.

Financial compensation for excess generation also is addressed.

As always, safety is our top priority. The rules and regulations governing the connection of renewable energy equipment are meant to ensure your safety and the safety and protection of PPL Electric Utilities' infrastructure.

Residential customers with questions can call us at **1-800-342-5775** or email us at **renewableenergyapplications@pplweb.com**.

Commercial or industrial customers can call us at **1-888-220-9991, select Option 4**, or email us at **businessaccounts@pplweb.com**.

Thank you,
PPL Electric Utilities

Renewable energy options



- Solar thermal energy for domestic hot water heating and space conditioning



- Solar (photo-voltaic) energy for producing electricity



- Wind energy for producing electricity

Potential benefits

- Saving on household operational costs
- Reducing your electric bill
- Selling power back to the utility or alternative generation supplier
- Helping to protect the environment through a reduced carbon footprint



SOLAR HOT WATER SYSTEMS

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

Installation Requirements

- Look for systems that have SRCC Certified Collector and Water Heating Ratings and Warranties.
- Solar water heating collectors can be mounted on a roof or on the ground. Ask your installer for guidance.
- 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 seasons.
- The area where the collectors are mounted should not be shaded by trees, buildings or other objects.

PROS	CONS
Low Cost Installation Short Investment Payback	Operation. The system will operate only when sufficient sunlight is available. Seasonal Output. Production of hot water is highest during summer, spring and fall.

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 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. (See Table Below)

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

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 percent. If unknown, a burn efficiency of 80 percent could be used. Older heating systems and those that have not been maintained 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 percent.

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 (gallons of water to be heated X 8.33) X Change in temperature = BTUs

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

Step 3: BTUs ÷ 3,413 (electric water heater) = kWh

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

Step 4: (kWh) X (cost per kWh) = savings

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

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





SOLAR (PHOTOVOLTAIC) GENERATION SYSTEMS

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

Installation Requirements

- Photovoltaic panels can be mounted on a roof or on the ground. Ask your installer for guidance.
- A UL or IEEE certified inverter is required for interconnection to the grid.
- 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	CONS
<p>Systems Connected to the Power Grid. (PPL Electric Utilities has to approve the system.) If the system is equipped with the proper inverter, surplus generation could be sold back to the utility or alternate supplier.</p> <p>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.)</p>	<p>Operation. The system will operate only when sufficient sunlight is available.</p> <p>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. Ask installers about other technologies that might be right for you.</p> <p>Power During Electrical Outages. Systems that are grid-connected will be isolated from the grid if an electrical outage occurs. This isolation is incorporated as a safety feature to protect your equipment from overloading and protect the safety of electric service personnel.</p>

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 3.5 per day in northeastern Pennsylvania) by the kilowatt-hour output of the system. This number represents the maximum potential of a properly installed system in a location that has ideal solar conditions. Actual output may vary depending on site factors.

$$(\text{Number of sun hours}) \times (\text{System output in kWh}) = \text{Total kWh}$$

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.





WIND GENERATION SYSTEMS

Wind generation uses wind power to generate electricity.

Installation Requirements

- Wind turbines often require a pole or tower mounts, which would be an added expense. Guy wires may be required for additional support.
- A UL or IEEE certified inverter is required for interconnection to the grid.

PROS	CONS
<p>Systems Connected to the Power Grid. (PPL Electric Utilities has to approve the system.) If the system is equipped with the proper inverter, surplus generation could be sold back to the utility or alternate supplier.</p> <p>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.</p>	<p>Large Systems. Require special pole mounts or towers that add to installation costs.</p> <p>System Output. The electrical output of the system varies by wind speed and will operate only when sufficient wind is available.</p> <p>Power During Electrical Outages. Systems that are grid-connected will be isolated from the grid if an electrical outage occurs. This isolation is incorporated as a safety feature to protect your equipment from overloading and protect the safety of electric service personnel</p>

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. Actual output may vary depending on site conditions.

(Wind Speed) X (kWh Output at Speed) X (Hours of Operation) = Total kWh
Wind studies using a wind speed recorder should be made at site location.



THINGS TO CONSIDER ABOUT SOLAR AND WIND ENERGY

- 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.
- 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 deliver electricity to its grid. Applications are available at: <http://www.pplelectric.com/interconnectionforms>
- 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.
- The rated outputs of solar and wind energy systems are supplied by equipment manufacturers. A 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 greater 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:

SOLAR

- 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

WIND

- For wind generation systems, the average wind speed at site location
- Height of tower or pole
- Wind barriers such as trees or buildings



Interconnection Application Process

If you are a PPL Electric Utilities customer and are interested in connecting a small generator – such as a windmill, solar project, bio-digester or other facility – to PPL Electric Utilities' transmission or distribution system, you must follow several steps and meet certain requirements.

These requirements are designed to ensure that your facility meets PPL Electric Utilities' standards for safety and will not diminish the reliability of our electric distribution system. They're also intended to help ensure that equipment, both ours and yours, is compatible.

Interconnection requirements differ for residential and business customers, so please call for details. Information, forms and resources can be found at www.pplelectric.com/interconnectionforms.

Reading your meter with customer-owned generation

Once you apply for interconnection, you may require a different style meter. Your new meter will have a digital display instead of five dials, making it easier for you to read your meter. It also will allow more flexibility to track your account information online.

Below the numbers on the display are two horizontal bars that move either from left to right or from right to left. These bars simulate the rotating disk found on the dial-style meters. The direction the bars move indicates the direction electricity is flowing.

If the bars are moving left to right, you are receiving electricity from the grid. If the bars are moving right to left, you are supplying electricity to the PPL Electric Utilities system. The speed of the bars is determined by the rate of electricity flowing through the meter.

Videos on reading your meter can be found at www.pplelectric.com. Just type **video center** into the **How Can We Help You?** search box.

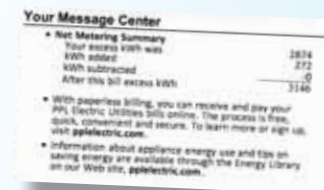
Net Metering

Net metering is the term for measuring the amount of electricity you produce against what you use in a given month. If your system produces more than you use, you will receive a credit for that power that will carry forward. PPL Electric Utilities does not record your total generation output, only the surplus, if one exists.

Those with customer-owned generation will see a net metering summary on their monthly bills (see right). Certain bill rates, such as Residential Thermal Storage (RTS), do not qualify for net metering.

The net metering summary shown here shows the customer carried over 2,874 kWh excess from prior bill periods. The generation produced during the current bill period exceeded their use by 272 kWh and was added to their accumulated excess, or bank.

What is virtual net metering? Virtual net metering involves calculating the net electricity usage at a property that might have more than one meter/account at an address, including the meter used to track customer-owned generation. For more information, residential customers can call **1-800-342-5775** or email us at renewableenergyapplications@pplweb.com. Business customers can call **1-888-220-9991, Option 4**, or email businessaccounts@pplweb.com.



Compensation for excess generation

If you are eligible for net metering, the generation produced by your renewable energy system will be used to offset your electric usage in a month and help reduce your electric bill. If you generate more power than you consume in a billing month and are a PPL Electric Utilities default service customer, we will track or “bank” your excess generation. This banked power will be used in future monthly bills should you use more power than your system generates. If you still have power banked at the end of a year, you will be eligible for payments for that excess power.

Payments can be triggered at a variety of times.

You could receive payments:

- Annually in May
- Because of a change from default service with PPL Electric Utilities to an alternate generation supplier
- If you change your alternate generation supplier
- If you change from shopping to default service
- If there is a rate change
- If you request to stop service

Payments for customers on rate schedules RS and GS1 will be based on the Price to Compare in accordance with PUC regulations. Customers on rate schedules GS3 or LP4 may contact Business Accounts regarding compensation for excess generation. For more information, residential customers can call **1-800-342-5775** or email us at **renewableenergyapplications@pplweb.com**. Business customers can call **1-888-220-9991, Option 4**, or email **businessaccounts@pplweb.com**.

If you buy your generation supply from an alternate supplier, you won't be eligible for payment from PPL Electric Utilities during the settlement periods described above. You must contact your supplier to determine whether it will pay you for excess generation.

In addition, when you purchase your generation supply from an alternate supplier, PPL Electric Utilities will use your banked generation to offset only the Distribution portion of your bill in future months. Depending on your agreement with your supplier, this could result in a monthly bill which includes no or minimal usage charges from PPL while including full or partial usage charges from your supplier. You must contact your supplier to determine whether they will use your banked generation to offset the Price to Compare portion of your bill in future months.

We encourage all customers to explore their options for electricity supply. Be sure you are familiar with your contract with your supplier and understand the terms as they relate to payment for excess generation. The latest information on suppliers in Pennsylvania can be found at **www.PaPowerSwitch.com** or at **www.pplelectric.com** by selecting **Choose Your Supplier** from the **At Your Service** listings.

Be sure you are familiar with your contract with your supplier and understand the terms as they relate to payment for excess generation.

Renewable Energy Credits (REC)

Renewable energy credits, or renewable energy certificates, are part of the world of renewable generation and serve as a sort of currency for renewable energy markets. They represent the attributes of renewable electricity generation, things such as greenhouse gas reduction that are outside of the electricity itself.

RECs have a monetary value and can be bought and sold between buyers and sellers from generation to the final point of application or use at a facility.

The federal government and the Pennsylvania Public Utility Commission advise that consumers or organizations with on-site renewable electricity systems should be clear about who owns the RECs produced by their system.

Customer-owned generation checklist

Using the following checklist will help you follow the important steps necessary to complete the connection of your generation system to the PPL Electric Utilities grid.

- Contact PPL Electric Customer Service to request information on billing and compensation.
- Consult with a renewable systems contractor regarding system requirements (size, type, location, cost, etc.)
- Submit an Interconnection Application/Agreement along with required specifications and diagrams. If approved, you'll receive a confirmation letter.
- Have your contractor fill out necessary system forms for state, federal and other rebates and tax incentives.
- Contact PPL Electric Utilities to conduct a method of accommodation review.
- Complete and send in to PPL Electric the necessary tax forms (W-9).
- Have a certified electrician inspect and certify the system once installed and send in a cut-in card showing proof of the electrical inspection.
- Go to **www.pplelectric.com/interconnectionforms** for more information.
- Residential customers can call **1-800-342-5775** or email us at **renewableenergyapplications@pplweb.com**
- Business customers can call **1-888-220-9991, Option 4**, or email us at **businessaccounts@pplweb.com**

FREQUENTLY ASKED QUESTIONS

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

No. Systems that are connected to the power grid will be isolated from the grid if an outage occurs. This isolation 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 for additional cost.

Is the energy free?

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. Note: PPL Electric Utilities will not record your total generation output, only the surplus.

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. However, it is important that the generator is hooked up correctly following all rules and regulations. Contact PPL Electric Utilities with any questions.

Will I be paid for excess power?

Payments for customers on rate schedules RS and GS1 will be based on the Price to Compare in accordance with PUC regulations. Customers on rate schedules GS3 or LP4 may contact Business Accounts regarding compensation for excess generation.

How much will I be paid for excess power?

Between settlement periods, excess kilowatt hours produced are carried forward and applied at full retail value, kilowatt hour for kilowatt hours, to offset your usage.

At a settlement point (see page 11, Compensation for excess generation), your compensation will be dictated by whether you have selected an alternate generation supplier or rely on PPL Electric Utilities to buy power on your behalf.

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.) Demand charges may apply for GS-1 and GS-3 rate customers. 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: www.pplelectric.com/interconnectionforms.

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 the 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 for renewable energy systems?

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 and Efficiency 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.

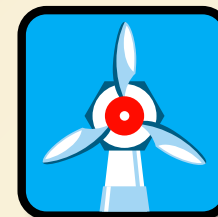
If the interconnection requires changes to our equipment or facilities, you may be responsible for our costs to design the changes and buy and install the necessary equipment.

May I sell power to my neighbor?

No. Only licensed electric generation suppliers subject to Pennsylvania Public Utility Commission regulations may sell power to a third party.

GLOSSARY OF TERMS

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 of usable solar radiation. In 1 hour under ideal conditions, 1 square meter receives the equivalent of approximately 1 kWh of solar energy. 3.5 hours per day is a good average to use in northeastern Pennsylvania.




ADDITIONAL RESOURCES

www.ases.org	American Solar Energy Society
www.awea.org	American Wind Energy Association
www.depweb.state.pa.us	PA Department of Environmental Protection
www.dsireusa.org	Database of State Incentives for Renewables and Efficiency
www.pasolar.org	Solar Energy in Pennsylvania
www.eere.energy.gov	U.S. Department of Energy - Energy Efficiency and Renewable Energy
www.nrel.gov	National Renewable Energy Laboratory
www.paaeps.com	Pennsylvania Alternative Energy Portfolio Standard Website
www.nrel.gov/rredc/pvwatts	Solar Production and Cost Savings Calculation (Federal)





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 This booklet is printed on recycled paper and is recyclable.

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