

Photovoltaics

What are photovoltaics?

Photovoltaics (PV) are the direct conversion of sunlight to electrical energy. All other electrical energy sources use sunlight energy indirectly. For example, hydropower uses water evaporated by sunlight. Coal and other fossil fuels begin as living plants and animals that grow utilizing sunlight in addition to air, water and food.

Behind the scenes of a PV solar cell

PV solar cells are thin wafers of silicon, similar to computer chips only much bigger. Within a PV silicon cell, sunlight is converted into electric energy when the sunlight knocks loose electrons from silicon atoms. The freed electrons flow from the solar cells to a load or battery, where the energy is stored. (See Diagram 1.) Approximately 10 - 15 percent of the energy that strikes the solar cell is converted to electricity.

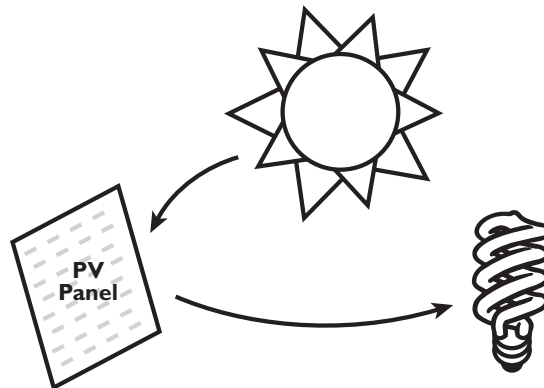


Diagram 1

PV panels come in many configurations including panels, roof shingles, and metal roofs. Integrated shingles and metal roofs are usually installed during construction of the building. Panels, which are mounted off the roof, can be retrofitted to an existing structure. Panels are also installed on ground mounted racks.

From DC to AC

PV cells produce direct current (DC) energy. Because most residential and commercial electrical equipment is AC (alternating current), this DC energy needs to be converted. An inverter is used to produce AC power from the DC generated PV cells. The AC power produced can also be provided to a utility.

Utility utilization

Providing AC energy to a utility is accomplished through the use of a net meter that allows electrical energy to flow both to and from the electric utility. Small generators use net metering to reduce the utility connection cost. Net metering replaces the more complex and costly interconnection requirements needed by large electrical generators. It also eliminates the costly engineering analysis required by large generators.

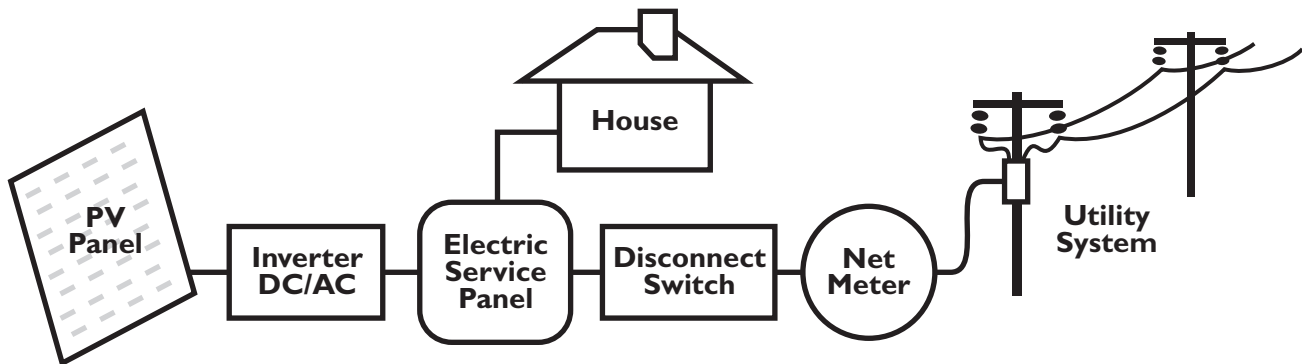


Diagram 2

PV equipment and installation requirements

Our net metering schedules require PV customers to meet the equipment and installation requirements of the Institute of Electrical and Electronic Engineers (IEEE), Underwriters Laboratories (UL), and the National Electric Code. IEEE 929 addresses the safety, equipment protection, and power quality of the PV system. UL 1741 provides the requirements of the inverters. The National Electric Code covers installation requirements of the PV system.

IEEE 929 ensures the safety of lineman, customers, and utility equipment. It also sets power quality ranges:

- voltage - 106 - 132 volts
- frequency - 59.3 - 60.5 Hz.

Outside these ranges the customer's unit disconnects from the utility system.

IEEE 929 – safety first!

IEEE 929 requires the PV unit to disconnect from the utility system during a power outage. The PV system can reconnect to the utility system only after power has been restored for at least 5 minutes. Operating an electrical system during an outage is called “islanding.” Personal injury can occur if the “island generator” feeds a utility system that is being repaired and assumed disconnected from all energy sources.

The need for standard interconnection requirements for small to medium PV systems was the driving force behind IEEE 929. With IEEE 929 in place, inverter designers can produce standardized equipment, thus lowering PV system costs. Before IEEE 929, many utilities required 200W and larger customer generators to comply with the expensive interconnection requirements established for very large (>100MW) generators. These large steam or engine driven generators can cause severe disturbances to a utility grid if not controlled by utility requirements, whereas a small PV inverter, properly designed, can almost instantly disconnect itself from the grid.

UL 1741 overview

UL 1741 is the manufacturing and testing standard for static inverters used for PV systems. This standard is for construction, safety, and performance requirements. These requirements include:

- Construction - Enclosure, controls, disconnects, overcurrent protection
- Protection against injury - mounting, guards, utility disconnect
- Performances - output power, utility compatibility, rain and sprinkler tests

Installed PV systems need to meet IEEE 929 and UL 1741 standards. Local building code officials also insure that the installation meets local and national electrical code requirements.

References

Installation of PV systems ranges from \$6,000 to \$10,000/kW. One kW of panel can generate 1,200-1,800 kWh/yr depending on panels, inverters, and location. The following references can be used to better evaluate PV applications, costs, and performance.

Panels

Astropower	www.astropower.com
BP Solar	www.bpsolar.com
United Solar	www.uni-solar.com

Inverters

Omnion	www.omnion.com
Trace	www.traceengineering.com
Advanced Energy	www.advancedenergy.com

Other

Nat. Renewable Energy Lab.	www.nrel.gov/clean_energy
Sandia Labs	www.sandia.gov/pv

For more information

Contact your account manager, or call 1-888-221-7070. You can find the tariff for your state on our web site, www.pacificpower.net, click on Customer Service then click Regulatory Information.