Radiant Energy to Electricity

Solar energy can be used to produce electricity. Two ways to make electricity from solar energy are **photovoltaic** systems and systems using thermal energy.

Photovoltaic Systems

Photovoltaic comes from the words *photo,* meaning light, and *volt*, a measurement of electricity. **Photovoltaic cells** are also called PV cells or solar cells for short. Using PV cells to harness the sun's energy is a rapidly expanding science. The first practical PV cell was developed by Bell Telephone researchers. At first, PV cells were used primarily in space to power U.S. space satellites. Now PV cells are common in many different applications. You are probably familiar with photovoltaic cells. Solar-powered toys, calculators, and many lighted roadside signs all use solar cells to convert sunlight into electricity.

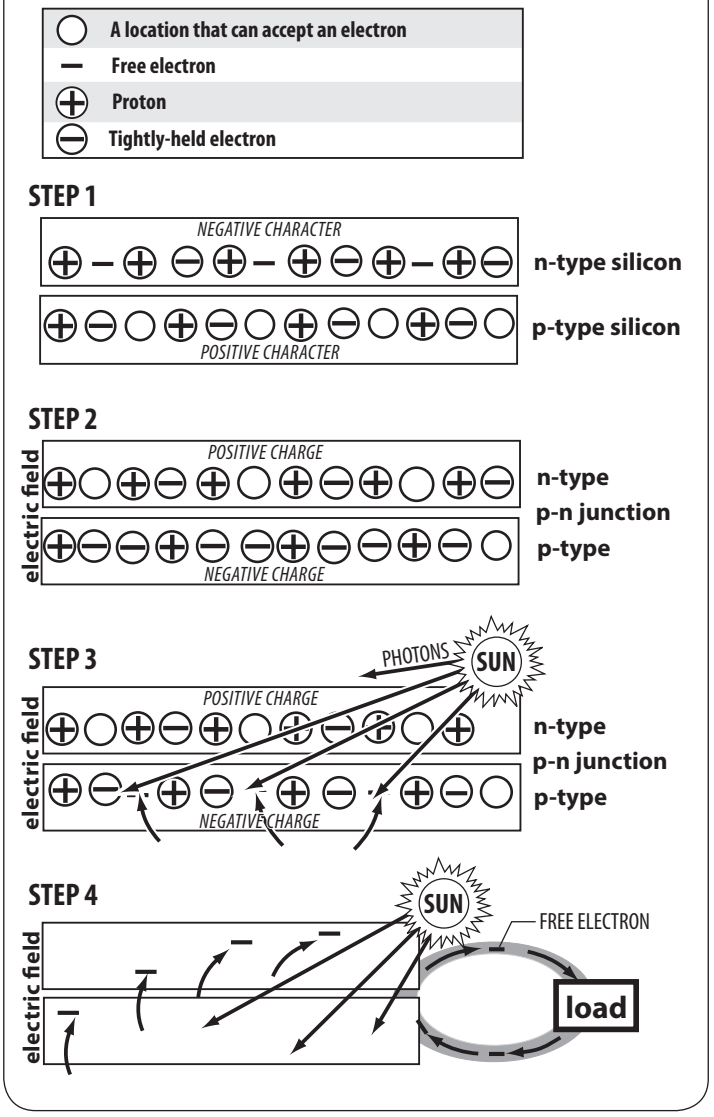
Solar cells are made of a thin wafer of **silicon**, one of the elements found in sand and the second most common element on Earth. The top of the wafer has a very small amount of phosphorous added to it. This gives the top of the wafer an extra amount of free, negatively charged electrons. This is called n-type silicon because it has a habit of giving up its electrons, a negative character. The bottom of the wafer has a small amount of boron added to it, which has a tendency to attract electrons. It is called p-type silicon because of its positive character. When both of these chemicals have been added to the silicon wafer, some of the free electrons from the n-type silicon flow to the p-type silicon and an electric field forms between the layers at the p-n junction. The p-type now has a negative charge because it gained electrons. The n-type has become positive because it lost electrons.

When the PV cell is placed in the sun, the radiant energy excites the free electrons. If a circuit is made by connecting the wafer's sides, electrons transfer their energy from atom to atom from the n-type through the wire to the p-type. The PV cell is producing electricity—the transfer of energy due to moving electrons. If a load such as a light bulb is placed along the wire forming a circuit, the electricity will do work as it flows to make the bulb light. The conversion of sunlight into electricity takes place silently and instantly. There are no mechanical parts to wear out, therefore photovoltaic systems last an extended period of time.

Photovoltaic systems can consist of small cells, like the ones that charge calculators, to systems that power individual homes, to large power plants powering many homes. The average size of a residential PV system installed is about 6.1 **kilowatts**. The average size of a **utility-scale** PV is about 4.3 **megawatts**. However, the sizes of residential, commercial, and utility-scale PV systems can vary greatly, depending on the space available for use.

New technologies are constantly being developed to make PV cells thinner and more flexible. There are now roofing shingles that are made of PV cells. Rather than putting panels on your roof, solar shingles can be used that match the conventional shingles for a more pleasing look. Scientists are developing PV cells that can be put into home windows and on thin, flexible film that can be attached to the outside of the home. There are even different types of solar paint!

From Silicon to Electricity



UTILITY-SCALE PHOTOVOLTAIC INSTALLATION

Image courtesy of Sacramento Municipal Utility District

A single PV cell does not generate much electricity. Many cells are connected to create panels that will produce enough usable electricity to power devices or be transported to consumers.