PLTW Engineering

10-12/Solar Energy production

May 20, 2020

10-12/DE

Lesson: **5/20/2020**

Objective/Learning Target: Students will be able to explain how solar panel systems work and their applications.

Solar Energy Sources

Electrical energy can be generated from a variety of energy resources and can be transformed into almost any other form of energy.

Electric circuits are used to distribute energy quickly and conveniently to distant locations.

Solar Energy Sources

Each panel in a photovoltaic (PV) array contains photovoltaic cells, which are typically made of silicon crystals and directly convert sunlight into electrical energy.

When light particles called photons strike a cell, they get absorbed within the crystal. An electric field present in the crystal then separates electrons from positively charged "holes." Positive holes move to one side and electrons to the other, creating a voltage difference between the two regions of the crystal.

Solar Energy Sources

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This current then flows to the PV cell's output terminals.

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Solar Energy Sources

The direct current (DC) power generated by PV cells can be stored in batteries. But before it can be used, it must run through an inverter.

An inverter converts DC power into alternating current (AC) power, the form most lighting, motors, and appliances use to run.

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Solar Energy Sources

Photovoltaic energy can be used either near to where it's produced or distributed away from its source.

Systems can be connected to an electrical grid to serve broader areas, run independently of a grid to serve local needs, or combine with other electrical systems.

The amount of power generated depends on the quantity of photons reaching the cells, which vary according to the time of day, whether clouds are present, and seasonally.

Solar Case Study: Nellis Solar Power Plant

As of 2009, the Nellis Solar Power Plant -- located on Nellis Air Force Base in Nevada -- is the largest solar photovoltaic installation in North America.

Operational since 2007, the Nellis array contains approximately 70,000 solar panels and 6 million solar cells.

Solar Case Study: Nellis Solar Power Plant

It is capable of producing 14 megawatts of energy, which can generate 25 to 30 million kilowatt-hours of electricity annually. This can supply more than 25 percent of all electrical power used at the base, which is equivalent to the annual needs of about 2,200 homes.

Solar Case Study: Nellis Solar Power Plant

Each year, the Nellis PV array will keep 24,000 tons of carbon dioxide out of the atmosphere -- the amount that would be created if the 14 megawatts were coming from a coal-fired plant. That's the equivalent of removing 185,000 cars from the road.

Quiz yourself

1. Why did installing solar panels make both economical and ecological sense at Nellis Air Force Base?
2. What do photovoltaic arrays use to produce electricity? What are individual solar cells made from?
3. All technologies involve trade-offs. What are some of the pros and cons of generating electricity on a large scale using solar power?
4. Would a solar power system such as this one be practical where you live? Explain.
5. What device can turn DC voltage into AC voltage?

Helpful links

USA department of Energy Solar cell basics

Youtube video about solar cells and how they work