Fishbeck, Thompson, Carr & Huber, Inc. FTC&H

Concepts

Winter 2015

Shining Light on Photovoltaics

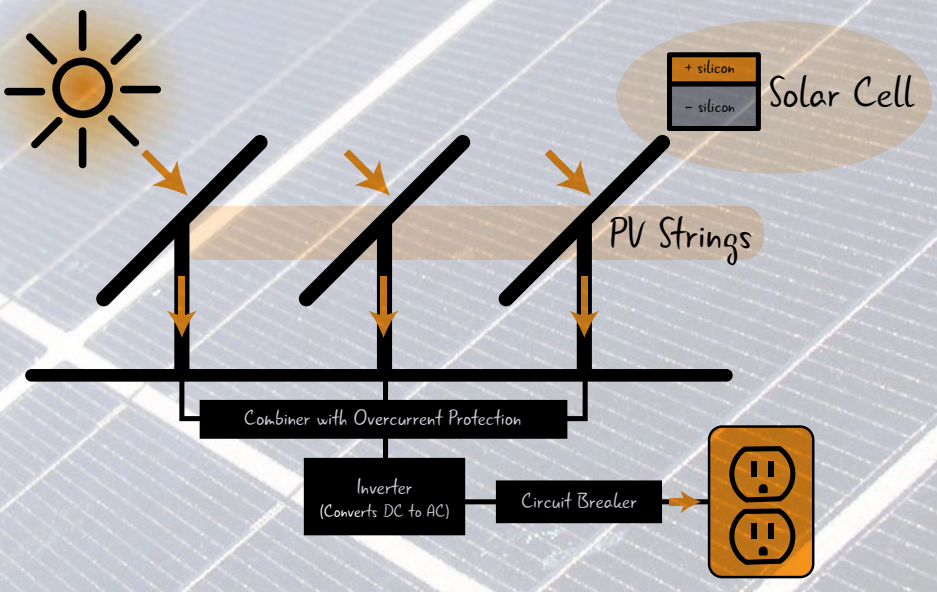
By now, we are all familiar with the concept of generating electricity from the sun. The notion is almost an afterthought when we have mobile access to GPS satellites and apps for seemingly anything the mind can imagine. The calculator on my desk, and perhaps on yours, is solar-powered. If your cell phone goes dead on a hiking trip, hook it up to any number of solar phone chargers available on the market and you're back in business. Even those GPS satellites are powered by the sun as they whirl through space 12,000 miles above Earth.

Though they have been around for over 50 years in one form or another, solar electricity-producing devices, referred to as photovoltaics or PV, use cutting-edge technology to produce clean and inexpensive energy. PV gets its name from the process of converting sunlight (photons) to direct current electricity (voltage), which is called the photovoltaic effect. Scientists from as far back as the late 1800s experimented with the idea; and in the mid-1950s, researchers at Bell Telephone discovered that silicon emitted an electric charge when exposed to sunlight. Today, thousands get the electricity they need to power their homes and businesses from individual solar PV systems.

PV Building Blocks

The basic building block for a PV system is the solar cell, which is typically made up of a thin layer of positively charged silicon on top of a thicker layer of negatively charged silicon. An electrical field is created at the intersection where the two layers meet. When the cell is exposed to sunlight, the PV effect results in voltage being produced and current flowing across the field.

Groups of PV cells are electrically configured into modules, strings, and arrays, which can be used to charge batteries, operate motors, and power various electrical loads. With the appropriate power conversion equipment, PV systems can produce alternating current (AC) to power conventional appliances and operate in parallel with, and interconnected to, the utility grid. A PV system can have multiple arrays; and it is because of this modularity that PV systems can be designed to meet almost any electrical requirement, no matter how large or small.



Free Source of Energy

Although a PV array produces power when exposed to sunlight, a number of other components are required to properly control, convert, distribute, and store the energy produced by the array. This balance of system equipment translates to high installation costs, which may cause consumers to balk at the idea of their own PV system.

Consumers who choose a PV system find the initial cost is counterbalanced over time by the very energy the system generates. Once the economic value of the system is fully realized – meaning the energy generated by the PV system has paid for its installation costs – any power the system provides is free for the system owner. This is especially valuable as global energy markets show increasing volatility. Many PV system owners expect energy costs to rise, and a PV system is one way to manage, even reduce, their energy costs in the future.

Surface Area Requirements

In addition to high initial costs, another potential limiting factor affecting PV systems is the large surface area required for a typical system. Solar panel modules for private homes and businesses usually hold about 50 cells. A typical home will use about 10 to 20 solar panels (2.5 to 5.0 kW). The panels are mounted at a fixed angle (42.9 degrees in Michigan) facing south, or they can be mounted on a tracking device that follows the sun, allowing them to capture the most sunlight. Of course, when mounted on a home, the system's appearance is an important consideration. Owners may give up some performance to allow a lower tilt angle so the panels align with the slope of their roof, or to maximize the number of modules in a designated footprint. PV modules installed with a steeper tilt angle may shade one another and require a greater distance between rows.

Some of the newest advancements in PV technology are aimed at reducing surface area requirements or making the solar cells themselves more adaptable to their environment. Thin-film solar cells are one innovation, using layers of semiconductor materials only a few micrometers thick. Because of their flexibility, thin-film solar cells can double as rooftop shingles and tiles, building facades, or the glazing for windows and skylights. As scientists and engineers continue to experiment with cutting-edge materials and newer applications, installation costs and large surface area requirements are expected to eventually come down.

Possible Concerns for Utilities

PV is an emerging technology, and is becoming more widely used. This can benefit public utilities by lessening peak demands on area power grids, reducing the potential for brown outs. However, utilities are not without some concerns when it comes to PV systems.

For instance, a utility:

- ☼ May view PV systems as the competition or a potential loss of revenue.
- ☼ May have concerns about the variable power output of PV systems (full sunshine to cloud cover).
- ☼ Must now keep track of all customer-owned PV systems connected to the power grid.
- ☼ Is concerned about power line worker safety.
- ☼ Wants the power grid to be stable.

To address the last three concerns, utility companies will require the customer considering PV to complete paperwork and pay for an interconnection study to ensure the utility can support their PV system and determine whether or not any utility modifications are needed. To ensure the safety of their power line workers, a utility will usually require special equipment to make sure the PV system does not energize a dead power line during a power outage. The utility will also make sure the PV system does not export power to the grid, unless it is intended to do so.

Bright Solar Future

Photovoltaic systems have a number of merits and unique advantages over conventional power-generating technologies. They can be designed for a variety of applications and power requirements, and are suitable in the private sector or as part of a robust local or national energy policy. PV systems have no moving parts, are modular, easily expandable, and even transportable in some cases. Energy independence and environmental compatibility are two attractive features of PV systems. The fuel (sunlight) is free, and no noise or pollution is created from operating PV systems.
In general, PV systems that are well designed and properly installed require minimal maintenance and provide long service lifetimes.

The future of solar technology is promising and there are undoubtedly innovations yet to come. The Department of Energy states the amount of energy produced by the sun that reaches Earth's surface in a one-hour period is capable of providing the energy needs of the entire world for one year. With the sun as their source, PV and solar power aim to tap that unlimited source of energy and become part of our global energy future.

For more information regarding solar energy, please contact Roger Maddox, PE at rmmaddox@ftch.com or Jim Rumping at jcrumping@ftch.com.