Solar Electricity

Re-Energy
Backgrounder

Solar Energy

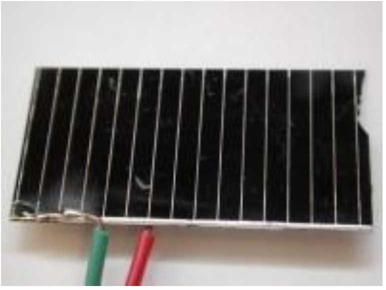
On planet Earth, sunlight is an incredibly important form of energy. Every day, the sun pours unimaginable amounts of energy into space. Some of it is in the form of infrared and ultraviolet light, but most of it is in the form of visible light. Some of this energy falls on the Earth, where it warms our planet's surface, drives ocean currents, rivers, and winds, and is used by plants to make food. Life on Earth depends totally on the sun.

The sun emits unimaginable amounts of energy into space every day, mostly in the form of visible light.
Photo courtesy of NASA

Photovoltaic Cells

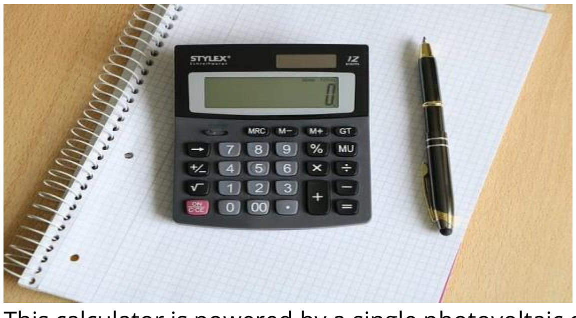
Visible light can be converted directly to electricity by a space-age technology called a photovoltaic cell, also called a solar cell. Most photovoltaic cells are made from a crystalline substance called silicon, one of the Earth's most common materials. Solar cells are typically made by slicing a large crystal of silicon into thin wafers and putting two separate wafers with different electrical properties together, along with wires to enable electrons to travel between layers.

When sunlight strikes the solar cell, electrons naturally travel from one layer to the other through the wire because of the different properties of the two silicon wafers.



A photovoltaic cell consists of a thin piece of specially coated silicon, with wires attached to capture the flow of electricity

A single cell can produce only very tiny amounts of electricity-barely enough to light up a small light bulb or power a calculator. Nonetheless, single photovoltaic cells are used in many small electronic appliances such as watches and calculators.



This calculator is powered by a single photovoltaic cell.
Photo courtesy of Pixabay

Photovoltaic Arrays

To capture and convert more energy from the sun, photovoltaic cells are linked to form photovoltaic arrays. An array is simply a large number of single cells connected by wires. Linked together in an array, solar cells can produce enough electricity to do some serious work! Many buildings generate most of their electrical needs from solar photovoltaic arrays, including the Toronto Healthy House, which gets 80% of its power from the sun.

Photovoltaic arrays are becoming a familiar sight along roadsides, on farms, and in the city, wherever portable electricity is needed. They are commonly used to provide power for portable construction signs, emergency telephones, and remote industrial facilities. They are also becoming popular as a way of supplying electricity for remote power applications such as homes and cabins that are located away from power lines, for sailboats, recreational vehicles, telecommunications facilities, oil and gas operations, and sometimes entire villages in tropical countries, for example.

Many single photovoltaic cells are connected by wires and mounted on a flat panel to form a photo-voltaic array - *Photo courtesy of Solar Futures International*

Storing Electricity

Solar panels make electricity in all kinds of conditions, from cloudy skies to full sunlight, in all seasons of the year. But they don't work at all during the nighttime! To make electricity available after sundown, the energy must be stored during the day for later use. The usual storage device is a rechargeable battery.

The batteries used with solar arrays must be able to discharge and recharge again many times. They contain special parts and chemicals not found in disposable batteries. They are also usually larger and more expensive than their disposal cousins.

Besides solar panels and rechargeable batteries, modern photovoltaic systems are usually equipped with some kind of electronic charge controller. The main job of the charger controller is to feed electricity from the solar panel to the battery in the most efficient manner and to prevent the solar panel from overcharging the battery. The charge controller also protects the solar panels from electrical damage.

In many cases, people need the electricity stored in the rechargeable batteries for use with normal household appliances. The problem is that most of the appliances require 110 volts of alternating current (110V AC), whereas the battery puts out only direct current (DC), usually at a much lower voltage. A device called a power inverter solves this problem by converting the battery's low voltage direct current to 110 volts of alternating current. Modern charge controlled often come equipped with their own built-in power inverters.

Solar Electricity in Everyday Use

Photovoltaic panels, like computers and other technologies, are getting cheaper and easier to buy. In fact, many people consider them a great alternative to gas-powered generators or connections to the regular electricity supply. Some countries, such as Japan, have encouraged businesses and communities to install solar panels on the roofs of new buildings to reduce the need for electricity from other sources.

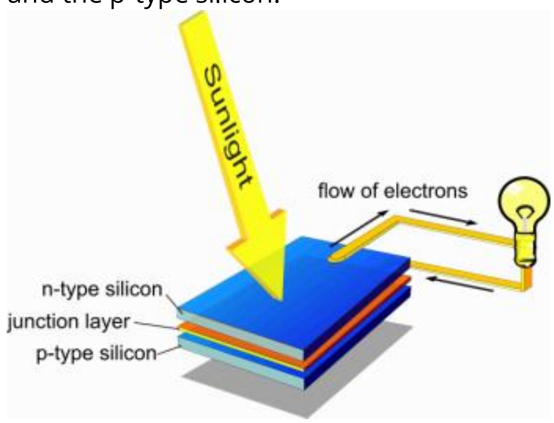
Many homes and businesses have both a connection to the commercial electrical supply system, often called the “electricity grid”. The solar panels can provide all or most of the building’s electrical supply during the day, and the grid supplies whatever other electricity may be needed during the night. In some cases, the panels make more electricity than is needed in the building, and the excess electricity is sold to the power company. This results in the power company sending the building owner a cheque instead of a bill for selling them the electricity!

Questions

1. List all the appliances in your home, school or neighborhood that have a photovoltaic cell or array on them.
2. What are the advantages of solar electricity over electricity made from fossil fuels, nuclear fuels, or hydroelectricity?
3. What are the problems or disadvantages of solar electricity?

How Photovoltaic Cells Work

Photovoltaic cells are marvels of sub-atomic physics. They are constructed by layering special materials called semiconductors into thin, flat sandwiches, called solar cells. There are three layers: the uppermost layer consists of “n-type silicon”, which can release negatively charged particles called electrons when stimulated by light. The lower layer is composed of “p-type silicon” and develops a positive charge when stimulated by light. The middle layer is called the “junction layer” and acts as an insulator between the n-type silicon and the p-type silicon.



A ray of light consists of a stream of photons, which are tiny packets of light energy moving along around 300,000 kilometers per second. When these energy packets strike the upper layer of a solar cell, they jar loose electrons, which builds a negative charge in the silicon layer. (HINT: which is why it is called the n-type silicon!) These electrons are attracted to the p-type silicon in the layer below, but are forced to travel through an electric circuit made of thin connecting wires. Electrons generated on the upper layers of several cells are gathered together to form an electric current, and are sent down a wire to a motor or some other appliance. Once they have done their work, the electrons are allowed to return to the lower layer of the solar cell, completing the circuit. The amount of electricity the panel can produce depends on the intensity of the light, the number of cells arranges on the panel, and how they are connected to each other.