How solar energy becomes electricity

A small primer on how to make magic with our nearest star

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Sunlight hits a solar panel, magic happens and electricity comes out an attached wire.

Now, about that second step: Ben Brabson, professor emeritus in Indiana University's physics department, helped explain it to a nonscientist.

Let's start at the electricity end. Electricity is made of charged particles — electrons — flowing in a particular direction. So how does sunlight charge particles?

Solar panels are usually made of silicon, and when sunlight — energy packets from the sun, called photons — hits the panel, it knocks some electrons loose from each silicon atom's nucleus. But such excited free electrons aren't electricity. They need to flow in the same direction to produce a current.

"The trick here is to put together two layers of silicon that have too many electrons (n type for negative charge) or too few electrons (p type for positive charge)," Brabson explained. "That's why a real photovoltaic cell must have two layers of silicon, a top layer with excess electrons (n type) and a bottom layer with too few electrons (p type). The boundary between the two types of silicon is called the p-n junction (see the above diagram). At that boundary there is a preferred direction for the excited electrons! This preferred direction forces the excited electrons to move only in one direction and we have a current source — just like a battery."

That's about as elementarily as that "magic" step can be explained.

On a bright, sunny day, the sun shines approximately 1,000 watts of energy per square meter of the Earth's surface, and if we could collect all of that energy we could easily power every home and office on the planet for free.

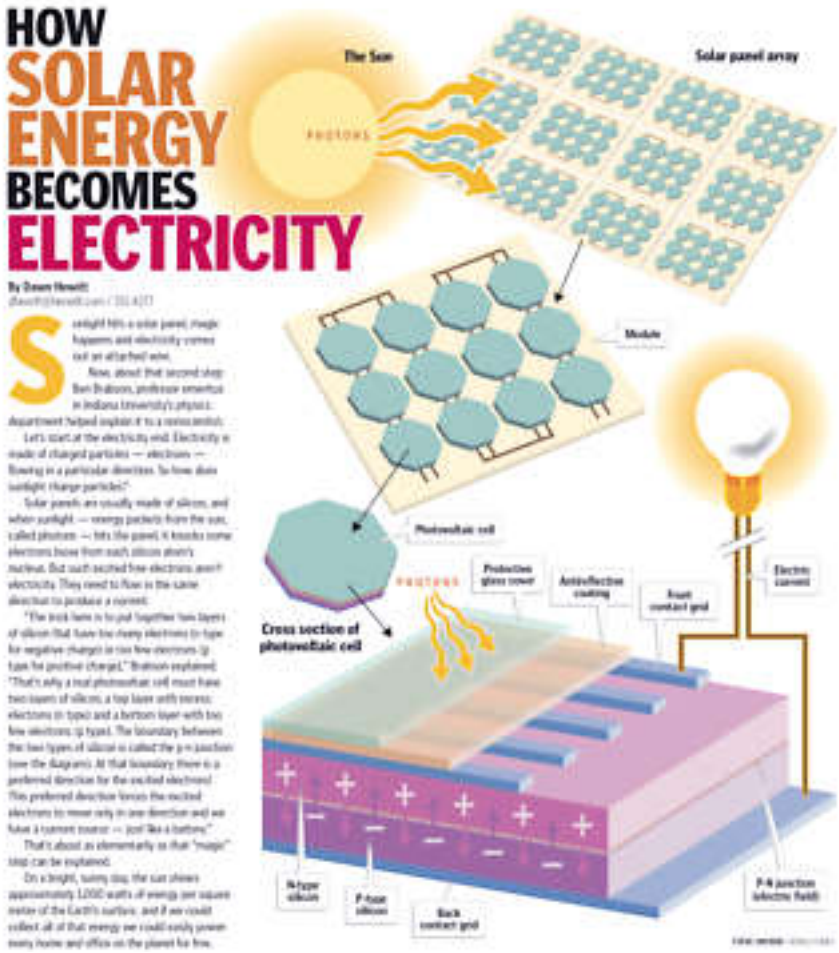
Photovoltaics: photo = light, voltaic = electricity

Middle Way's new way

Middle Way's New Wings Community Partnership project, now under construction in the old Coca Cola bottling plant on South Washington Street, is using the sun for both electricity production and water heating. They've installed photovoltaic panels that will generate electricity and a solar thermal system to heat water.

Contractor Mann Plumbing expects the building's 5-kilowatt solar generating capacity could reduce the big, old building's electric bills by 10 percent per year while it reduces greenhouse gas emissions. Inside the building is an inverter, which converts the DC to AC, and its digital readout shows both the amount of electricity being produced and the carbon dioxide that's not. The solar thermal system will supply hot water for the old building and its new neighbor, including six apartments, a commercial kitchen, a child-care center and Middle Way's legal and advocacy services offices. The two 120-gallon solar-heated hot water tanks are expected to supply 100 percent of buildings' hot water needs. The solar projects cost Middle Way $63,000 — $25,000 for the hot water system, and $39,000 for the electricity, but $25,000 of the funding came from a state Alternative Power and Energy grant. For residential use, a PV panel for an average house ranges from $15,000 to $40,000, according to Mann's solar installation expert Amie McCarty, but a 30 percent federal tax credit helps. The payback period depends upon price of electricity and how much is used. A solar water heating system for a typical residence costs from $6,000 to $8,000 and usually pays for itself in five to seven years.McCarty said.

Steve Snyder | Herald-Times



The silicon panels of Middle Way’s photovoltaic system lie flat on the roof of the South Washington Street building.Jeremy Hogan | Herald-Times

Amie McCarty of Mann Plumbing looks at part of a thermal solar water heating system installed on the roof of the former Coca Cola Bottling building, soon to house six apartments for Middle Way clients and a commercial kitchen.
Jeremy Hogan | Herald-Times