Renewable Energy Terms

P-N Junction—Boundary area in a semiconductor

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Derivation: "P" and "N" stand for "positive" and "negative"; "junction" (from Latin iungere, *to join) describes the interface between two different layers in a semiconductor device.*

Photovoltaic (PV) cells convert sunlight into electricity. It seems like magic when you put a cell, panel, or array into the sunshine and watch the meter showing voltage and amperage, or watch a motor or light swing into action. But this magic is not hard for physicists to explain and describe. Making it understandable to mere mortals (that includes me) is another thing, but I'll give it a try....

The heart of a PV panel is what's called the P-N junction. The name sounds mysterious, but it just stands for "positive-negative junction." The cell has two layers of silicon. Each layer is prepared differently, with impurities, or "dopants" added to give it specific characteristics.

The "P" or positive layer has tiny (and very exact) amounts of boron, indium, gallium, or other substances added to the silicon. These substances give the layer a positive charge. Physicists would say that the layer is short on electrons. The bonds between the silicon and the dopant material would be strongest if there were one more electron in the outer shell of the dopant.

The "N" or negative layer has tiny (and very exact) amounts of phosphorus, arsenic, or other materials added. This gives the layer a negative charge—the layer is long on electrons. The bonds between the silicon and the dopant here have an extra electron each. So there are free electrons roaming around this layer.

These two layers are actually built into the same piece of silicon in a PV cell. The two oppositely charged layers instantly try to balance out their charges. The result is that a permanent electrical field is set up across the junction (the area where the two layers meet). This field encourages electrons to move across the junction, but discourages them from crossing back. In electronics, this is called a diode, and when it conducts electricity if illuminated by light, it's called a photodiode.

Why don't all the (negative) electrons and (positive) holes, or lack of electrons, in the two layers balance each other out? Only a certain number of electrons make it across. Eventually they're stopped by the electric field that the exodus of other electrons has created.

When light particles (photons) hit the cell, they bump electrons loose from their bonds. Some of these "slide down" the P-N junction, which is often described as a "slope" or "gradient." In a PV cell, wires are attached to a grid on the surface of the cell (the "N" side) and to the back of the cell (the "P" side). These form a circuit that takes advantage of the junction's tendency to shunt electrons one way and not the other.

The light does all the work by jostling electrons out of their bonds so they're free to roam around. The P-N junction in the solar cell simply "herds" the electrons in the right direction so they can do useful work.

Still confused? Well, join the club. Check out Chris Greacen's more detailed explanation in *HP23,* or go to www.nrel.gov/research/pv/docs/pvpaper.html for an even more lengthy explanation. Or just continue to believe in the magic...

Access

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