

# Ultra Low Energy (ULE) Suwanee River Administration Building: Mastering Solar Energy Systems

Just about the entire roof area on the south side of the high performance home is stocked with solar panels, 40 photo-voltaic and one solar water to be exact. The system is designed to turn the utility meter backwards during the day. The system is on the south side because this gets the most direct solar exposure year round. Here is how it works:

## Photo-voltaic (PV) panels

PV panels turn a portion of the sunlight (photo) they receive into electricity (voltaic). PV or solar cells are made up of silicon wafers, one layer “doped” with a substance that tends to give up electrons when excited by incoming photons (solar energy units) and another layer doped with a substance that tends to take on excited electrons (the silicon crystal base is a great background for this exchange of electrons because silicon atoms tend to loosely share lots of electrons in this crystal structure). And whenever you create a flow of electrons, you get electricity.

The tricks to making solar cells for everyday use have been developing the technology to mass produce cells (even before “mass” demand exists), developing the technology to boost how much sunlight they can convert into electrical current, and developing the technology to support safe and efficient integration into existing electrical systems.

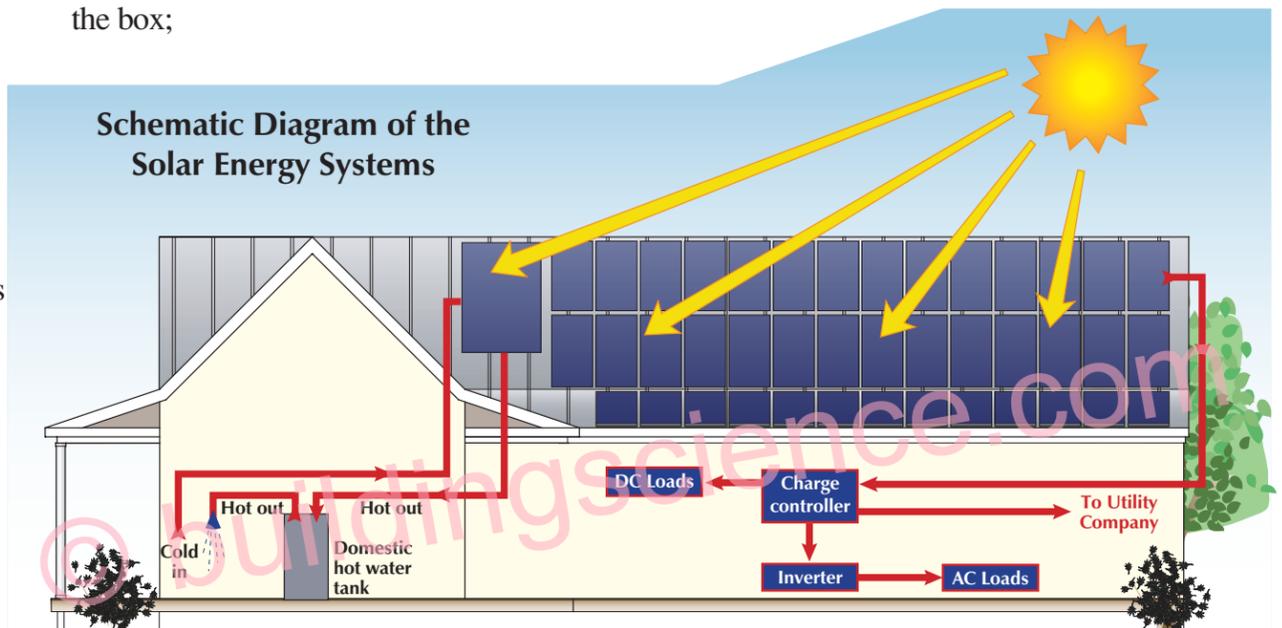
The ULE PV system has two other important major components besides the array of forty panels—an inverter and a controller. A long time ago, for a variety of reasons related to materials, safety, and transmission issues, we decided to run buildings, including homes, on alternating current (AC). But the PV panels produce direct current (DC). The inverter changes the DC into AC current compatible with household electrical systems. The last component, the controller, controls the flow of energy from the panels, to the house, and to and from the utility power lines. An important part of the controller’s job is to prevent current from entering the line when utility linemen have interrupted the utility supply for line maintenance or repair.

The size or capacity of PV systems is generally expressed in terms of **watts** or **kilowatts** generated under peak or ideal conditions. The ULE PV system is capable of generating about 10 watts per square foot of panel, for a total of 4,000 watts or 4 kilowatts. Given the efficiency of the high performance building envelope, its HVAC system, and appliances, 4kW should just about meet the total electrical demand over the course of an entire year, depending on the patterns and nature of use by its occupants. And here is the really neat part — managing energy use is pretty much all that is needed—the PV system is virtually maintenance-free during its 20+ years of expected operation.

**Solar water panel** All solar water heaters have the following components:

- an open-faced roof-mounted box with a dark, highly absorptive inside surface;
- a glass top face that permits sunlight to pass into the box but is relatively reflective to the heat energy into which the sunlight is converted inside the box (like a greenhouse);
- highly conductive piping inside the box, filled with a fluid that can pick up a significant portion of the heat energy trapped in the box;

track record in the field. This 4 by 8 panel has been custom-made to be oriented up and down the shed roof of the dormer window on the south elevation of the roof. The hot water from the roof panel circulates to the standard 50-gallon storage tank of the electric water heater, basically keeping the electric elements of the water heater off or working less. The ULE occupant will only know the panel is working by looking at the paltry electric bill.



- insulated piping that carries the heated fluid down into the building, for hot water use or heat exchange to water for use.

There are two ways of classifying the major differences among solar water systems—active versus passive and closed-loop versus open-loop. Active systems all have pumps controlled by a thermostat that move fluid through the system. Passive systems have **no pumps**; they rely upon either thermo-siphoning or density differences brought on by temperature to move fluid through the system. Closed-loop systems have two loops—one loop goes to the solar collector and contains a fluid (generally a water-antifreeze mix) that transfers heat well but has a very low freezing point. This fluid exchanges its heat content with potable water in a separate loop. Open-loop systems have only one loop of potable water.

Generally, active and closed-loop systems have **significantly higher efficiencies** and can be used in climates with freezing conditions. Many passive and/or open-loop systems are only appropriate for areas with no or only occasional mild freeze conditions. Passive and open-loop systems are less complicated and hence less expensive. But open-loop systems are very dependent on high-quality water for efficient operation and reasonable service life. Closed-loop systems must have either a drain-back or warm water trickle feature to deal with freeze conditions, but much depends on the specific installation and length of exposed transfer piping.

The CopperSun system is a passive open-loop system—no pumps, no moving parts, no valves, no controller. This is a very simple yet sophisticated solar water system with a good

This solar most of the hot water needs for a family of four, **depending** on weather and the hot water use of the occupants. Anyone can save money with this solar water system, but here is the way to be a real winner: match your hot water use to late afternoon peak solar production. And, of course, the same holds true to use of electricity (see **Mastering Power Demands**).

The CopperSun is designed for temperate climates with limited freeze potential. It is rated for 20° F for an 18 hour period. The two freeze protection systems required by the Solar Rating Certification Corporation are the high mass 4-inch tubes and the drain down system for rare times in the Atlanta climate when conditions could exceed the rated conditions.

Many PV systems have batteries for storing electricity when PV supply is greater than household demand. PV battery systems are currently still very expensive and not particularly long-lived. While batteries are nearly essential for off-the-grid systems, they are not a part of ULE building’s grid-tied system. Many off-the-grid PV systems also have a back-up generator, which runs to supply household demand for extensive periods of bad weather and/or to periodically top off the battery charge.