A PV Solar System has four major components:

1) THE SOLAR PANEL: This is the component that receives photons from the sun and converts the photon energy into electricity. The panels are rated in Watts.

2) CHARGE CONTROLLER: This component insures that the storage batteries are not overcharged and damaged.

3) STORAGE BATTERIES: The batteries store our collected electricity until we use the energy to power our appliances. Our electricity is stored as the potential energy rated in Volts.

4) INVERTER: This component changes the current from our batteries, which is stored in direct current (DC), to an alternating current (AC) which is compatible with our household appliances.

Conversion of Sunlight to Electricity: Photovoltaic energy (PV) is the conversion of sunlight into electricity through a PV cell, commonly called a solar cell. A photovoltaic cell is a non-mechanical device usually made from silicon alloys.

Sunlight is composed of photons or particles of solar energy. These photons contain various amounts of energy corresponding to the different wavelengths of the solar spectrum. When photons strike a photovoltaic cell, they may be reflected, pass right through, or be absorbed. Only the absorbed photons provide energy to generate electricity. When enough sunlight (energy) is absorbed by the material (a semiconductor), electrons are dislodged from the material's atoms. Special treatment of the material surface during manufacturing makes the front surface of the cell more receptive to free electrons, so the electrons naturally migrate to the surface.

The output of a solar panel is usually stated in watts, and the wattage is determined by multiplying the rated voltage by the rated amperage. The formula for wattage is Volts times Amps equal Watts. So for our example, a 12 volt - 60 watt solar panel measuring about 20 X 44 inches has a rated voltage of 17.1 and 3.5 amps .

V X A = W
17.1 volts times 3.5 amps equals 60 watts**.**

Our solar panel rated as 60 watts exposed to 6 hours of peak sun will produce 360 watt hours of power per day. A typical home will require 4000 watts of DC generating power to produce sufficient kwh to cover annual electrical consumption. This equates to 67 - 20 X 44 inches solar panels from the example above.

Wiring the System:
Solar panels can be wired in series or parallel to increase voltage or amperage respectively, and they can be wired both in series and in parallel to increase both

volts and amps. Series wiring refers to connecting a positive terminal of one panel to the negative terminal of an adjacent panel. This connection will produce voltage as the sum of the two panels and the amperage will remain the same as the output panel. Two 12 volt and 3.5 amp panels wired in series will produce 24 volts at 3.5 amps.

Solar panels can be wired in parallel by connecting positive terminals to positive terminals and negative terminals to negative terminals. Two 12 volts and 3.5 amps panels wired in parallel will produce 12 volts and 7 amps.

A series/parallel wired system refers to doing both to the above. This wiring scheme would produce 24 volts and 7 amps from our two 12 volt and 3.5 amps panels.

Inverter:

An inverter is a device which changes DC power stored in a battery bank to standard 110 / 240 volts AC. Nearly all our lighting, appliances and motors are designed to use AC power. Inverters come in sine wave and modified sine wave output. Most 11o-volt devices can use the modified sine wave output. However, special devices that use lasers or silicon controlled rectifiers will require the pure sine inverter, which is more expensive.

Auto transfer switching is a common internal feature, which enables switching from one AC source to another and/or from utility power to inverter power for designated loads. Battery temperature compensation, internal relays to control loads, automatic remote generator starting and stopping, and many other programmable features are available.

Charge Controller:

A charge controller monitors the batteries' state of charge to insure that when the batteries need current when required and also insure that the batteries are not overcharged. Connecting a solar panel to the batteries without a charge controller seriously risks damaging the batteries and potentially causing a safety concern.

Charge controllers are rated based on the amount of amperage they can produce from a solar array. If a controller is rated at 20 amps, you can connect up to 20 amps of solar panel current output. Advanced charge controllers utilize Pulse-Width-Modulation, which insures the most efficient battery charging and extends the life of the batteries. Even more advanced controllers can include Maximum Power Point Tracking, which maximizes the amount of current going to the batteries by lowering the panel's output voltage.

Many advanced charge controllers offer Low Voltage Disconnect and Battery Temperature Compensation as optional features. The Low Voltage Disconnect allows the terminals to be voltage sensitive. If the battery voltage drops too far, the panels are disconnected, thus preventing damage to the batteries. The Battery Temperature Compensation adjusts the charge rate based on the temperature of the battery since batteries are sensitive to temperature variations above and below about 75 F degrees.

Batteries:
The batteries for our system should be Deep Cycle units, which are designed to be discharged and then recharged hundreds or thousands of times. Batteries are rated in Amp Hours (ah) and are usually rated at 20 or 100 hours. Amp Hours refer to the amount of current that can be supplied by the battery over the periods of hours. An example: a 350 ah battery could supply 17.5 continuous amps over a 20-hour period.

Like solar panels, batteries are wired in series and/or parallel to increase voltage to the desired level and increase amp hours. The capacity of the battery amp hour capacity requires careful sizing for the conditions under consideration. Longest periods of no sun or cloudy conditions, availability of generator or grid backup, or a standby generator with battery charger are among the conditions for consideration. The size of the battery bank will depend on the storage capacity required, the maximum discharge rate, the maximum charge rate, and the minimum temperature at which the batteries will be used.

Overall Design:
As with all electrical systems there are voltage losses as the electricity is carried across the wires, batteries and inverters and these losses are dependent on the efficiency of each component. These efficiency losses vary from component to component and from system to system and can be as high as 25 percent. A trained technician will be required to fine-tune the system for efficiency.