GENERAL CONCEPTS OF RENEWABLE ENERGY

Solar Panels:

They use photovoltaic cells to generate DC electrical power using the sunlight. There are 2 common types of solar panels:

- **Amorphous:** they are great because they will work on sunny or cloudy days. Generally this type of solar panel takes more space per watt than crystalline solar panels so they are limited to smaller wattages.
- **Monocrystalline:** they are the most efficient, meaning you get more power per square inch. All crystalline solar panels work best in sunny conditions.

You can connect several same voltage solar panels of whatever power in parallel, to get more watts. Also, for some applications you can connect then in series to get higher voltages, as long as they are the same type, voltage and power level.

You can get more than the maximum recommended battery operating voltage from the solar panel. So a regulating device is needed to avoid overcharging the batteries. They are called Solar Panel Charge Controllers.

Solar Panel Charge Controllers:

Their main function is to open or regulate the current from the solar panel to the battery to avoid overcharging the battery. There are 2 common types of charge controller:

- **On/Off:** They disconnect the solar panel when the battery voltage rises to/above the maximum recommended value (Cut-out) and resumes the connection when the battery voltage drops to a lower level (Cut-in). As a consequence of that, the battery is not being charged all the time but after repeated small charge/discharge cycles. They are the most simple and affordable solution.

- **PWM "Pulse Width Modulation":** Always keep the battery on full voltage condition and there is not a Cut-in voltage. When in PWM regulation, the current from the solar panel tapers according to the battery's condition and recharging needs. Typically this top of the line and efficient controller comes with features like temperature compensation, settable and monitoring parameters, display and buttons panel, battery low voltage disconnect, and load short circuit/overload tripping.

Wind Turbine Generator:

This is another kind of generator that uses the wind speed to produce electrical power. It can be used together with solar panels to charge a common battery bank. In fact they complement each other since the wind turbine can work not only at daylight but at night as well.

Like the solar panels, the wind turbine can overcharge a battery bank, so a controller is needed. The controller can be built in the same turbine or be a separate indoor device that has to be located close to the battery bank. It performs the AC to DC conversion (rectifier) function.
The controller can slow down or stop the turbine rotor (shutdown), so it can perform the following additional functions:

- Battery Voltage Regulation
- Speed control
- Over temperature Control

Inverter:

This device is responsible to convert the DC power from the battery to the standard AC 120V 60Hz used at home. There are 2 common types of inverters:

- **Modified Sine wave:** it generates an AC output signal based on alternate pulses. It means more distortion. However it is more affordable than the True Sine Wave inverter, and can be used on most (but not all) appliances and devices.
- **True (pure) sine wave**: it generates the same sinusoidal AC power used at home from the utility company. It is recommended for some sensitive devices that require pure sine wave output, with almost no distortion. They represent the top of the line.

Most of them include setting and monitoring features and electronic protections.
The inverters sink a relative high amount of current from the battery bank in their DC Input. Therefore very thick wires with short lengths are required.

Batteries:

Their function is to storage the energy provided by the DC sources. For applications using inverters and other power electronic devices, deep cycle batteries (Gel or AGM) are recommended.

Adding batteries in parallel increases the total capacity rating of the battery bank.

For a specific load requirement, the bigger the battery capacity in Ah, the longer the run time and the charging time. On the other hand, the higher the average power you get from DC sources the shorter the charging time will be. As a result of that, for a required charging time, the higher the average source power the larger the battery capacity can be.

With this information and using standard battery charging and discharging tables or calculators (check the web), you can get the average battery charging and run time. So you can play with all the parameters in order to meet the requirements for your specific application.