**Solar Panel/solar cell**

* Solar panel consists of no.of individual solar cells connected in series to increase the voltage output.
* When sunlight hit the surface of the solar cell it can create 0.5V voltage output.
* Solar cells are extremely brittle.
* Connecting solar cells in series creates a resistance and the current is flowing through all the solar cells decreases the power output.
* To prevent these kind of situations diodes are used.
* Gives an DC output which is not stable. Output varies with the sunlight, panel power, temperature etc.

**MPPT Controller**

In charging batteries charging controllers are used and the best option is to use MPPT(Maximum power point tracking) charger controllers. Here there are usually two ways.

* Some uses switching converters
* Some uses PWM (Inefficient)

Battery

Solar panel

Buck-boost/PWM

The charger controller could create constant current, constant voltage and activate or deactivate a load with a relay. It must have a maximum current limit.

MPPT technique is commonly used with wind turbine and solar panel systems. This maximize the power extractions.

Since the output of a solar panel is unstable it cannot be directly connected to the load. Therefore, first need to charge a battery and get the output from the battery. To charge the battery MPPT controllers are used.

MPPT charge the battery, protect both battery and the panel from over currents, Enable and disable the load.

The input voltage and current to the battery is decided by the pulse width of the PWM signal.

**Battery charging stages**

There are three main stages of charging. First 80% of the battery is charged from constant current which is known as the bulk stage. Then the battery is charged from constant voltage which is known as Absorption stage. Finally, the floating stage. Here the controller reduces the voltage to another preset value and keeps the current flow to less than 1% of the battery capacity.