What is MPPT?

MPPT or Maximum Power Point Tracking is the system used by advanced charge controllers to extract the maximum possible amount of power from your PV module. To understand this we have to briefly touch on some simple electric principles.

First our units

- Volts, (V) are a unit of measure of the force or pressure, volts symbol is always V
- Amps (A) are a unit of measure of the current or flow, Symbol is A or I
- Watts (W) are a unit of measure for electric power, or amount of work done, symbol is always W, though often seen as kW, which is a kilowatt, or 1000 watts.

Now a bit on Ohms law to glue the above together:

Ohms law, in its simplest is volts (V) multiplied by Amps (A) equals Watts, or:
A x V = W

So if we look on the back of a solar panel that specification makes a lot more sense.

Electrical Performance under Standard Test Conditions (STC)	
Maximum Power (Pmax)	130W
Maximum Power Voltage (Vmpp)	17.6
Maximum Current Current (Impp)	7.39
Open Circuit Voltage (Vov)	21.9
Short Circuit Current (Isc)	8.02

The above panel is rated at 130 Watts, so in one hour under Standard Test Conditions, this panel can produce 130 Watts. This is obtained by multiplying the Maximum Volts (17.6) by the Maximum Current (7.39)

=> Vmpp x Impp = Watts

=> 17.6 x 7.39 = 130 Watts.

- Why 130 Watts does NOT equal 130 watts
- Where did my Watts go?
- So what happens when you hook up this 130 watt panel to your battery? Unfortunately, what happens is not 130 watts.

OK, so we know that if the panel can produce the maximum voltage at the maximum current we will get every ounce of power from the panel, so what is stopping us, where else does the power go.

Several things can work against you including temperature, cable sizes and shade, but for now we are going to look at the battery voltage. If your system has a display you will be able to tell the voltage of your battery, Batteries are not intelligent, the more discharged they become, the less voltage they can absorb, I have included a voltage chart for a typical 12v battery below.

PERCENTAGE OF CHARGE	(V) AT REST	(V) CHARGING	(V) UNDER LOAD
100%	12.73	14.75	12.50
90%	12.62	13.75	12.40
80%	12.50	13.45	12.30
70%	12.37	13.30	12.25
60%	12.24	13.20	12.15
50%	12.10	13.10	12.00
40%	11.96	12.95	11.90
30%	11.81	12.75	11.70
20%	11.66	12.55	11.50
10%	11.51	12.25	11.25

From the above table you can see that a 50% charged battery will require a charge voltage of 13.1 Volts. So assuming the panel can deliver the maximum current, the most we can put into the battery in terms of watts is:

=> 13.1 (V) x 7.39(A) = 96.8 Watts, you lost 25%

That 33 watts is not going anywhere, it just is not being produced because there is a poor match between the panel and the battery. With a very low battery, say 11.5 volts, it's even worse - you could be losing as much as 35% (11.5 volts x 7.39 amps = 85 watts. You lost 45 watts.

So, why not make panels that put out a lower voltage and higher current?
The second energy killer is heat, the hotter a panel gets the less voltage it puts out, so our 17.6 volt panel on a very hot day might only put out 15v, so if we started with a 15v panel, on a hot day it would not put out enough to fully charge the battery.

So now we have the MPPT 'intelligent' charge controllers

MPPT or is algorithm that included in charge controllers used for extracting maximum available power from PV module under certain conditions. The voltage at which PV module can produce maximum power is called 'maximum power point' (or peak power voltage). Maximum power varies with solar radiation, ambient temperature and solar cell temperature.

Typical PV module produces power with maximum power voltage of around 17 V when measured at a cell temperature of 25°C, it can drop to around 15 V on a very hot day and it can also rise to 18 V on a very cold day.

Basics of Maximum Power Point Tracking (MPPT) Solar Charge Controller

Maximum Power Point Tracking - this is electronic tracking, and has nothing to do with moving the panels. Instead, the controller looks at the output of the panels, and compares it to the battery voltage. It then figures out what is the best power that the panel can put out to charge the battery. It takes this and converts it to best voltage to get maximum AMPS into the battery. (Remember, it is Amps into the battery that counts). Most modern MPPT's are around 92-97% efficient in the conversion. You typically get a 20 to 45% power gain in winter and 10-15% in summer. Actual gain can vary widely depending weather, temperature, battery state of charge, and other factors.

How MPPT works?

MPPT or maximum power point tracking can optimise the power going into your battery. Assume your battery is low, at around 11.3 volts. A MPPT takes that 17.6 volts at 7.39 amps and converts it, so that what the battery gets is no longer 7.39 amps at 17.6 volts, but 10.16 amps at about 12.3 volts. Now you still have almost 130 watts, and everyone is happy.

To compare:

	Volts (V)	Amps (A)	Watts (W)
Outback FM60 MPPT	**12.3**	**10.16**	**125 Watts**
Normal Charge Controller	12.3	7.39	91 Watts

MPPT is most effective under these conditions:

- Cold weather, cloudy or hazy days: Normally, PV module works better at cold temperatures and MPPT is utilized to extract maximum power available from them.
- When battery is deeply discharged: MPPT can extract more current and charge the battery if the state of charge in the battery is lowers.

MPPT is DC to DC converter which operates by taking DC input from PV module, changing it to AC and converting it back to a different DC voltage and current to exactly match the PV module to the battery.

The main advantages of the MPPT charge controller are:

- Extracting the maximum power from PV module; it forces PV module to operate at voltage close to maximum power point to draw maximum available power.
- MPPT solar charge controller allows users to use PV module with a higher voltage output than operating voltage of battery system. For example, if PV module has to be placed far away from charge controller and battery, its wire size must be very large to reduce voltage drop. With a MPPT solar charge controller, users can wire PV module for 24, 48 or up to 140V (depending on charge controller and PV modules) and bring power into 12 or 24 V battery system. This means it reduces the wire size needed while retaining full output of PV module.

- MPPT solar charge controller reduces complexity of system while output of system is high efficiency. Additionally, it can be applied to use with more energy sources. Since PV output power is used to control DC-DC converter directly.
- MPPT solar charge controller can be applied to other renewable energy sources such as small water turbines, wind-power turbines, etc.

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