Using Your Solar Panel
I-V curve
Rated panel power is where the rectangular area created by multiplying the voltage and current is at a maximum.

MPPT (Max Power Point Tracking) charge controllers allow the panel voltage to stay where the panel power is maximized. Output voltage to the battery is converted to battery’s state of charge delivering more amperage.

\[ I_{\text{panel}} \times V_{\text{panel}} = I_{\text{battery}} \times V_{\text{battery}} \] (Green arrow)
Wasted Power

Stanard PWM charge controllers clamp the solar panel to battery voltage. The effect is reduced panel output.

A nominal 24V battery has a 26.4V full charge. If the battery is low, lets say 22V then the maximum charging wattage is 123W instead of the rated 200W of the panel.
IEC panel ratings

• All solar panels are rated to standard test conditions
• 1000 W/m\(^2\) solar irradiation
• 1.5 AM (Air Mass) or thickness of atmosphere that absorbs radiation netting a spectral response.
• 25\(^0\)C panel temperature (reasonable number for factory flash tests)
• Real world output will usually be less since all photovoltaic technologies have a temperature coefficient. In the case of CIGS modules power drops be 0.43%/\(^0\)C.
• If you’re in a cold environment output will increase with that being predominantly voltage driven.
What power can you expect?

- Tucson spring nets panel temperatures in the high 50°C range.
- Choosing 58°C as the figure you can do the math.
- % drop = (58-25) x .0043 or 14.2%. Multiply the rated output of 200W and you get a 28.4W loss or an effective output of 171.6W.
- Irradiance will be right around the 1000 W/m²
- The spectral response driven by air mass will be less that 1.5 but small enough difference that you won’t see a significant increase in output.
- Take the panel to Mt. Everest and that’s a different story. Cold temperatures low air mass and high irradiance will increase module performance dramatically.
Shading

• Solar cells are roughly 0.5 volts
• To get module voltages where they are useful, cells are connected in series
• Shading a cell not only eliminates the cell's ability to generate electricity but it reverses and starts absorbing power
• This characteristic results in 50% output loss with just a cell or 2 shaded.
• To maximize battery charging in the pits, make sure you don’t shade panels in any fashion.