



ENERGY CONNECTIONS

CAN I MIX DIFFERENT SIZE SOLAR PANELS?

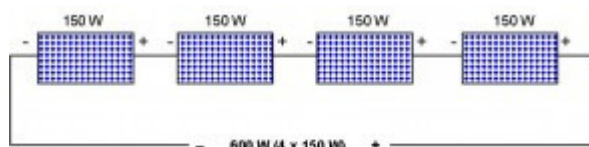
Mixing solar panels of various voltage or wattage, or produced by different manufacturers, is a frequently asked question by most DIYers.

Though mixing different solar panels is not recommended, it's not forbidden and things would be ok as long as each panel's electrical parameters (voltage, wattage, amps) are carefully considered.

When you intend to wire two panels produced by different vendors, the vendors actually are not the problem. The problem is in different electrical characteristics of the panels, together with different performance degradation.

Solar modules are connected in series to obtain higher output voltage. The maximum system voltage however must not be exceeded.

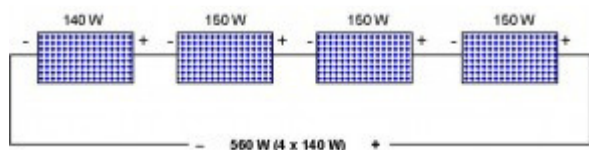
For modules connected in series total power is calculated as follows:



Mixing solar panels in series

Total connected power = $150W + 150W + 150W + 150W = 600W$

However if among modules connected in series a module has rated power lower than the other modules, due to lower rated current of this panel compared to the other modules belonging to this string, that module might drag the overall system output down:



Mixing different solar panels in series

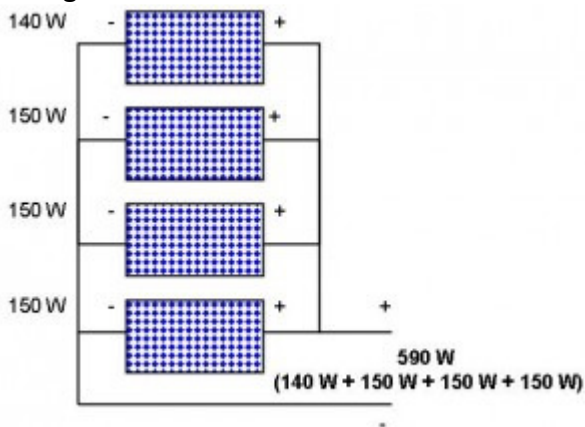
Solar modules are connected in parallel to obtain higher output current.

For PV modules connected in parallel total power is calculated as follows:

Mixing solar panels in parallel

$$\text{Total connected power} = 150W + 150W + 150W + 150W = 600W$$

Unlike connection in series, if among modules connected in parallel there is a module of power output lower than the output of the other modules, this might not affect seriously the total power output of the array, provided that this module has equal to the other modules rated voltage:



Mixing different solar panels in parallel

Maximum voltage on a string of modules must always be lower than maximum input DC voltage of the inverter.

When connecting different solar modules, it's not the different wattage, it's actually the current (for series connection) and voltage (for parallel connection) that could drag down the performance of the solar array composed of those modules.

Only solar panels of exact or similar current should be wired together in series. When you connect a 3A panel to a 3.5A panel, the overall current will be dragged down to 3A. Such a reduction in current will by all means lead to a reduction in power output and therefore loss in system performance.

Similarly only solar panels of exact or similar voltage should be wired together in parallel. When you connect a 15V panel to a 24 V panel, the overall voltage will be dragged down to 15 Volts. Such a reduction in voltage will lead to a reduction in power output and therefore loss in system performance.

Compared to voltage and current, wattage is not a significant concern. When you wire together a 60W panel to a 100W panel in series, the total connected power would be 160W, provided that the two panels are of equal current.

Here any difference in voltages is not important, voltages will just sum up and all you've got to

consider is that the total voltage should fall within the inverter voltage window.

If their current ratings are different however, you should be prepared to expected unpleasant surprises, since the overall current would be the lower of the two, which will means that you're not going to obtain a total of 160W but always less. How much less – depends on difference in rated currents.

Furthermore when you wire together a 60W panel to a 100W panel in parallel, the total connected power would be 160W, provided that the two panels are of equal voltage. Here any difference in currents is not important, currents with just sum up and all you've got to consider is that the total current should not exceed the maximum inverter input current.

If their voltage ratings are different however, you should be prepared to expected unpleasant surprises, since the overall voltage would be the lower of the two, which will means that you're not going to obtain a total of 160W but always less.

How much less – depends on difference in rated voltages.

Why it is not recommended to connect different solar panels?

- Apart from rated power, each panel has a power degrade percentage. This means solar panels' output degrade in a different way over time. Moreover the stated degradation not always coincides with what is written on a panel's nameplate. Therefore it's not easy to find an exact panel match of different solar vendors. 'Exact match' means both almost similar ratings and ratings degradation. For panels connected in series, voltage is additive while current is the same, provided however that all the panels have equal current rating. If among the panels connected in series there is a panel with rated current lower than the others, it will drag down the current passing through all the remaining panels. Therefore each of the remaining panels (with higher current rating) will underperform which means that will produce lower current (and power) than stated on its nameplate. In other words if two dissimilar modules are wired in series, the voltage is still additive, but the current will be equal to the current produced by the panel with the lowest current output in the series string.
- For panels connected in parallel, current is additive while voltage is the same. If among the panels connected in parallel there is a panel with rated voltage lower than the others, it will drag down the voltage on all the remaining panels. Therefore each of the

remaining panels (with higher current rating) will underperform which means that will produce lower voltage (and power) than stated on its nameplate.

- Mixing solar panels with different electrical characteristics is not recommended if you use an MPPT charge controller. Different wattages make impossible for the controller to find the optimal operating voltage and current, since they are different for each panel type.

The solution is simple: utilize panels that have similar electrical characteristics to the original panels.

Therefore, when connecting different solar panels, to minimize the losses:

- Connect only in series panels of the same brand and of the same current
- Connect only in series panels of the different brands and of the same current-this is your second option if for whatever reason you cannot find the same brand panels
- Connect in parallel panels of the same brand and of the same voltage
- Connect in parallel panels of different brands and of the same voltage-this is your second option if for whatever reason you cannot find the same brand panels
- Connecting different solar panels with the same array is not recommended since either the voltage or the current might get reduced. Therefore if you are planning to use dissimilar panels, try to pick the ones with similar voltage and current