DC:AC Ratio

Why Is My PV Module Rating Larger Than My Inverter Rating?

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THIS COMMON QUESTION HAS A SIMPLE ANSWER

To maximize energy output at the lowest cost. In real world conditions, PV module output rarely produces power at the rated output due to thermal and lower light impacts. PV modules in general have a negative temperature coefficient meaning as the cell and module temperature goes up, the output power goes down. Module power ratings are done in laboratory conditions maintaining the module at 25 degrees Celsius (68ºF), much cooler than typical operating conditions. Furthermore, modules seldom experience incident sunlight at 1,000 W/m² test conditions either. Inverters tend to operate more efficiently when they are operating at or near their peak power output. Thus, the ideal pairing of an inverter and PV module is not as simple as matching the peak output power of each, but rather having an optimal ratio.

PV module and inverter selection are two of the most important decisions in PV system design. Ensuring that these components will work together is important from a technical, reliability, and economic perspective. Solaria and Enphase utilized their world-class engineering teams to pair IQ7+ with the PowerXT module to optimize system economics, considering the following points:

- Higher DC:AC ratios improve inverter utilization and the capacity factor reducing the overall dollar per watt system cost
- High DC:AC ratios (>1.3) are routinely used in utility scale applications to ensure maximum energy harvest from the inverters over time and the lowest cost of delivered energy
- For DC:AC ratios up to 1.4 the net energy yield is typically proportional to module power over a 1:1 matched module power rating without needing a higher power (i.e. more expensive) inverter
- DC losses in string inverter systems (including those with optimizers) are typically much higher than losses associated with AC-based microinverter systems
- Clipping losses in AC systems are typically very low (<0.1%) compared to other sources of losses, such as orientation factors, soiling, shading, and thermal losses.

Module STC (Wdc)	DC:AC Ratio	Capacity Factor	Year 1 Inverter Clipping loss (%)	Energy Yield Increase
295	1.00	0.257	0.0%	0%
365	1.24	0.309	0.0%	24%
400	1.36	0.317	0.6%	35%

Table 1: IQ 7+ - Phoenix, -0.4%/°C simple efficiency model, 5.6% *Ltotal*,180° azimuth, 25° tilt

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ENERGY INCREASE VS CLIPPING

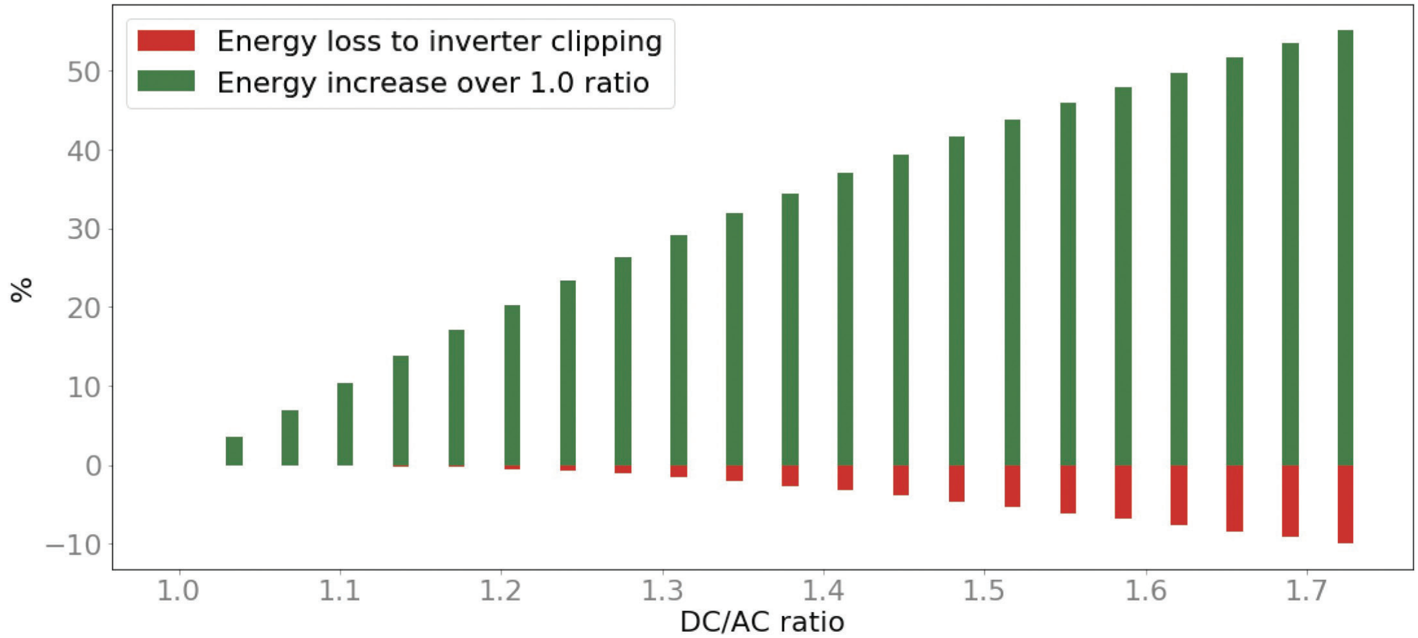

Figure 1: *Typical energy increase and clipping vs DC/AC ratio (Newark, NJ)*

As observed in **Figure 1**, increasing DC:AC ratio increases energy yield with minimal loss of energy harvest due to inverter clipping. However, the increased energy yield with DC:AC ratios greater than 1.0 is always much larger than the loss due to clipping, even at higher DC:AC ratios.

CONCLUSION

PV modules seldom produce power at their test condition power rating shown on the label. Standard installation practice calls for pairing PV modules with DC power ratings higher than the AC inverter power rating, also called the DC:AC ratio. In general, increasing the DC:AC ratio for most inverters increases inverter and system capacity factor and energy yield and improves system economics well beyond any minor impact imposed by clipping.

Reference:

For a more detailed account of this study please reference the Enphase Technical Brief, "*Why Is My PV Module Rating Larger Than My Inverter Rating?*" December 20, 2017. Values in **Table 1** are taken from, or interpolated from, Table 16 of that report.

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