Economic system design with Fronius GEN24 Plus and high current PV-modules

White Paper

Version 2 / 2021

INTRODUCTION

Nowadays the amortization of a newly installed PV system depends on the initial investment as well as the self-consumption ratio. The feed-in limitations as well as non-existing feed-in tariffs resulted the max. efficiency rate becoming less important.

This paper addresses the question whether the max. DC current from the PV generator ($I_{pv,sc}$) can be much higher than the max. input current of the inverter ($I_{dc,max}$) and what kind of effect can be expected.

Even if the max. DC current is much higher than the max. input current of the inverter according to the data sheets, the yield losses are insignificant. The explanation for this is simple:

- **In relation to the entire operating time of a PV system, irradiation powers of more than 900 W/m² occur relatively rarely. As a result, the max. input current of the inverter is hardly never exceeded Even on a PV system with oversized array this happens on very rare occasions only.**

- **However, if the DC current is exceeding the max. input current of the inverter, the inverter will react by shifting the operating point (MPP). In fact the DC current will be restricted to the max. input current of the inverter and at the same time the voltage of the new operating point will increase. This behaviour compensates most of the initially assumed losses of current limitation.**

CURRENT OVERSIZING OF THE INVERTER RESPECTIVELY THE MPP-TRACKER

The DC inputs of inverter/MPP-trackers (MPPT) are characterized respectively limited by various different parameters. It is not uncommon that the max. MPP-current of the PV generator exceeds the max. input current of the inverter respectively the MPP-tracker when multiple strings are connected in parallel or PV modules with high DC currents are used. In that case, we talk about current oversizing. ($I_{mpp,stc}$ of PV-generator > $I_{cd,max}$ of inverter/MPPTs).

The Fronius inverters show an extremely high resilience regarding current and power oversizing. The current oversizing can be at least 50%, some types can handle even more (see data sheets “max. short-circuit current module” = $I_{pv,max}$). So the max. short-circuit current of the PV-generator ($I_{sc,stc}$) can be 50% over the $I_{dc,max}$ of the inverter without voiding the warranty or damaging the inverter.

Current oversizing does not necessarily lead to dramatic yield losses. This kind of system design actually makes economically sense because its losses are negligible.

/ **Example: Primo GEN24 Plus ($I_{DC,max}$ = 22 / 12A) with 2 module strings with an $I_{mpp,stc}$ = 13A each**
The PV current with 13A is therefore **8,3%** higher on MPPT 2 than the max. input current the inverter can accept ($I_{dc,max}$ MPPT2 = 12A). But even on a very sunny site (>1400 kWh / kWp*a) this design **reduces the annual yield** by **less than 0,2%.**

/ The same calculation for a Symo GEN24 10.0 Plus **($I_{DC,max}$ = 25 / 12,5A)** reduces the annual yield by only **0,1%.**

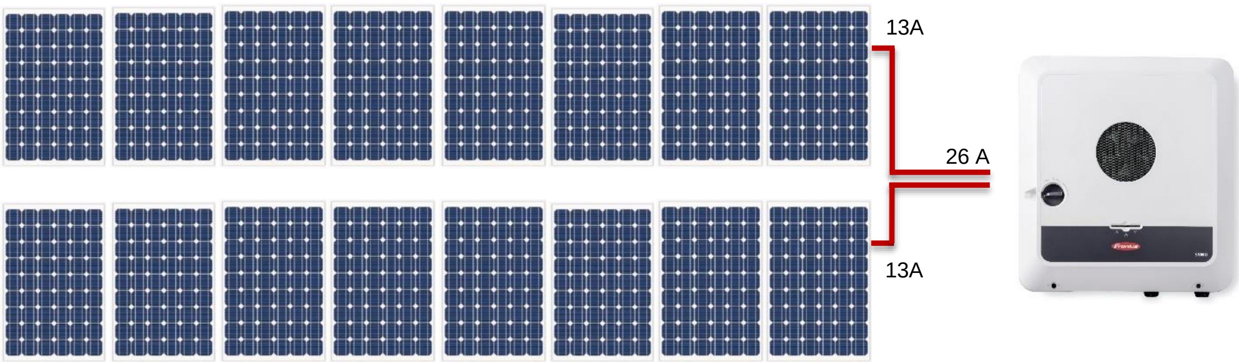

Figure 1; Installation of two parallel strings of 13A each, at a Fronius Symo/Primo GEN24 Plus

HOW TO EXPLAIN THESE EXCELLENT RESULTS?

1) Rarity of high irradiation directly on the module

In reality, a very high and direct radiation onto the PV array is quite rare (think of weather, time, roof orientation, position of the sun, seasons) compared to the standard test conditions (STC) which calculate with an irradiation of 1000 W/m². For this reason the theoretically producible electricity from a module data sheet is met only in rare cases. Which means that even though the current is limited there are hardly any losses in yield.

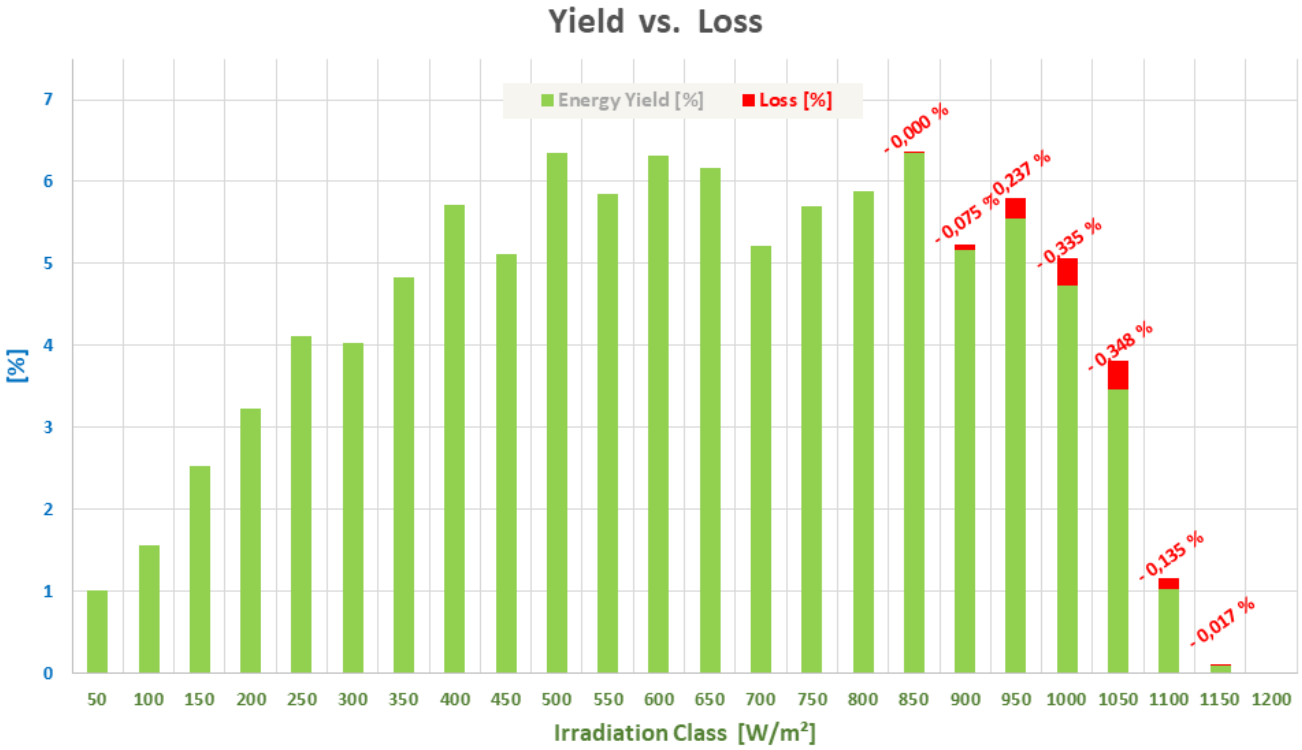

Figure 2; Yield per radiation category in one year (Melbourne (AUS), optimum orientation, annual yield of 1473 kWh/kWp), losses if $I_{MPP,STC}$ exceeds $I_{DC,max,inv}$ by 8,3%.

2) Shifting the operating point when the input current is reached

In case the current of the PV generator exceeds the maximum input current of the inverter the MPPT of the inverter will shift the maximum power point (MPP) towards the direction of open circuit voltage (higher voltage). This behaviour is similar to power derating due to limited export requirement.
Due to the higher input voltage the input power pulled from the inverter is increased and the losses can largely be compensated.

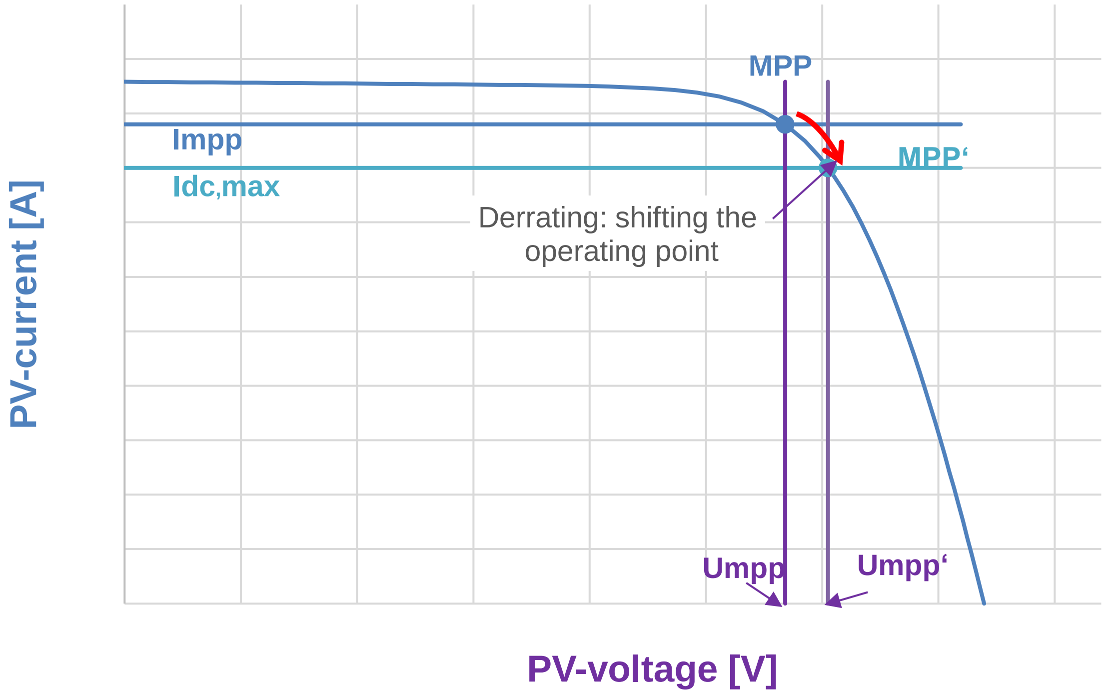

Figure 3: PV current limitation by shifting the operating point

3) Feed-in limitations in the markets

In addition to the above mentioned facts there are feed-in limitations in many markets e.g. the 60/70% regulation in Germany. Around midday the time of day when the current from the PV generator is the highest, many PV system owners aren't using much of their energy so that they end up with a very low self-consumption rate. Due to feed-in limitations PV systems have to limit feed-in power which makes yield losses even more negligible due to current limitation.

Note: max. short-circuit current $I_{pv,max}$

The so called $I_{pv\ max}$ is the max. short-circuit current (I_{sc} under STC). The PV generator's I_{sc} must not exceed the value ($I_{pv\ max}$) of the inverter's maximum power point tracker (MPPT). Just like there is a limit for the max. occurring voltage which is the $U_{dc\ max}$ (theoretically max. open circuit voltage with average radiation and low temperature) there is also a max. allowed current which must not be exceeded. Unlike with $U_{dc\ max}$ the I_{sc} occurs in case of a worst case scenario malfunction only. All relevant components in the inverter have to be able to withstand this possible short-circuit current. A DC disconnector - integrated in a Fronius SnapINverter - has to be able to cut off the short-circuit current safely.

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Solar Energy

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