Yield impact when oversizing the module array current

Whitepaper

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Business Unit Solar Energy

Yield impact when oversizing the module array current

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1 Introduction

Thanks to their flexible design, all Fronius inverters offer the possibility to oversize the maximum power of the PV array to at least 150%. The oversizing limit is always stated in the datasheet, as shown in the example below.

		Symo GEN24 Plus								
		6.0			8.0			10.0		
		MPPT1	MPPT2	Total	MPPT1	MPPT2	Total	MPPT1	MPPT2	Total
Max. PV generator output	Wpeak	7,500	6,500	9,000	10,000	7,000	12,000	12,500	7,500	15,000

Figure 1: Excerpt data sheet Fronius Symo GEN24 Plus

Oversizing refers to when the PV array has a higher peak capacity than the inverter. One reason to oversize the array is the fact that the theoretical peak power of PV modules is often not achieved in reality.

1.1 Oversizing the current of the PV generator

In practical scenarios, it is possible for the maximum power point (MPP) current of a PV array ($I_{mpp,pv\ array}$) to surpass the maximum input current capacity of the inverter or of each maximum power point tracker (MPPT) ($I_{dc,max}$). This is referred to as "current oversizing," which occurs when the $I_{mpp,}$of the PV array exceeds the $I_{dc\ max}$ of the inverter.

The concept of current oversizing is similar to that of power oversizing. When the PV array is oversized in terms of power, the resulting limitation is managed by adjusting the operational point, leading to higher voltage and lower current. Similarly, in cases of current oversizing, if the current generated by the array ($I_{mpp,pv\ array}$) increases beyond the maximum input current capacity of the inverter ($I_{dc\ max}$), the DC current will be restricted to the inverter's maximum input current ($I_{dc\ max}$), and consequently, the operational point will be shifted to a higher voltage.

In a case where there is both PV array oversizing and current oversizing, the operational point has already been shifted to a higher voltage due to power limitations. Therefore, further shifting might not be necessary, as the current is already reduced (owing to power limitations), resulting in no additional yield losses.

The key takeaway is that when power is limited, the current is inherently limited as well. If current is already oversized, its impact may become negligible.
Fronius inverters demonstrate notable resilience in managing high power and MPP current levels from the PV array.

2 When will there be additional yield losses?

Let's take as an example a Symo GEN 24 10.0 Plus inverter where the PV array is oversized with an additional 30%, so the inverter ratio (IR) = 130%. This inverter has $I_{dc\ max}$ = 25/12.5A, respectively, on each MPPT. In this example, the PV modules have $I_{mpp,stc}$ = 13A. Two strings are connected to the inverter: one string on MPPT1 and one string on MPPT2. It is visible that on MPPT2 $I_{mpp,stc}$(13A) > $I_{dc\ max}$(12.5A), so this means that there might be additional losses due to the current oversizing.

The current sizing ratio (SR_I) → $SR_I = \frac{I_{mpp,stc}}{I_{dc,max}} = \frac{13A}{12.5A} * 100\% = 104\%$. When it comes to power and current oversizing, Fronius has done additional analysis of how this affects the performance of our inverters. We also analyzed how the PV arrays perform in summer, when there might be higher temperatures that lead to voltage drop and higher irradiation, which means that there might be full current ($I_{mpp,stc}$). We defined a Δ buffer = 15%. This means → $SR_{I-THRESHOLD} = IR - \Delta = 130\% - 15\% = 115\%$. As long as the SR_I is lower than $SR_{I-THRESHOLD}$ there will not be any additional yield losses because of current oversizing. There could be additional yield losses if the SR_I is higher than the IR_Δ.

	$SR_{I-THRESHOLD} < SR_I < SR_{I-THRESHOLD}$
Additional yield losses	$yes < SR_I < no$

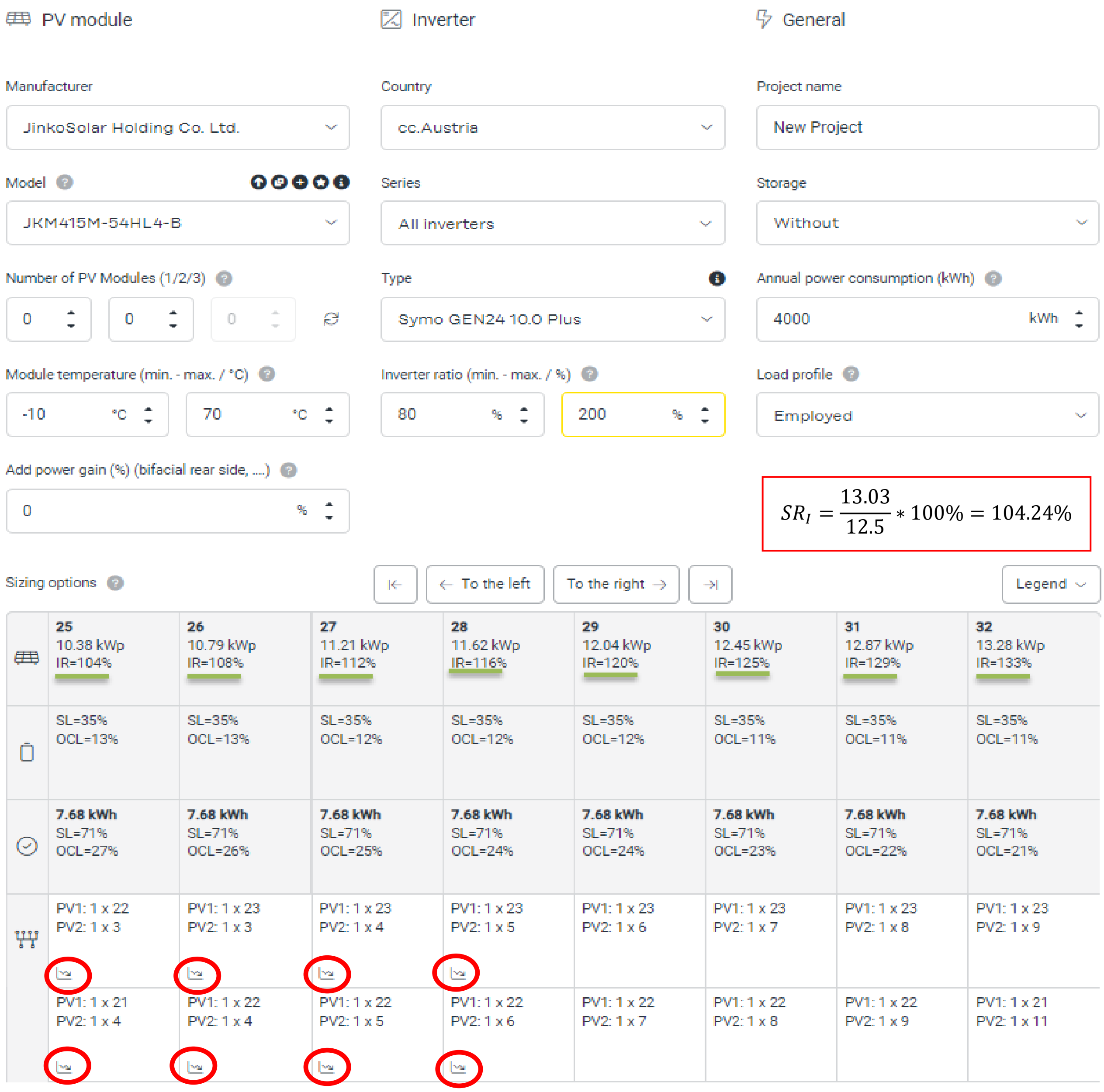

Figure 2: Example from Solar.creator and signalization where there are additional yield losses.

Figure 2 presents an example from the Solar.creator with the sign for additional yield losses circled in red → Loss of yield. This sign indicates which system could have minor additional yield losses and on which MPPT.

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3 How high are the losses?

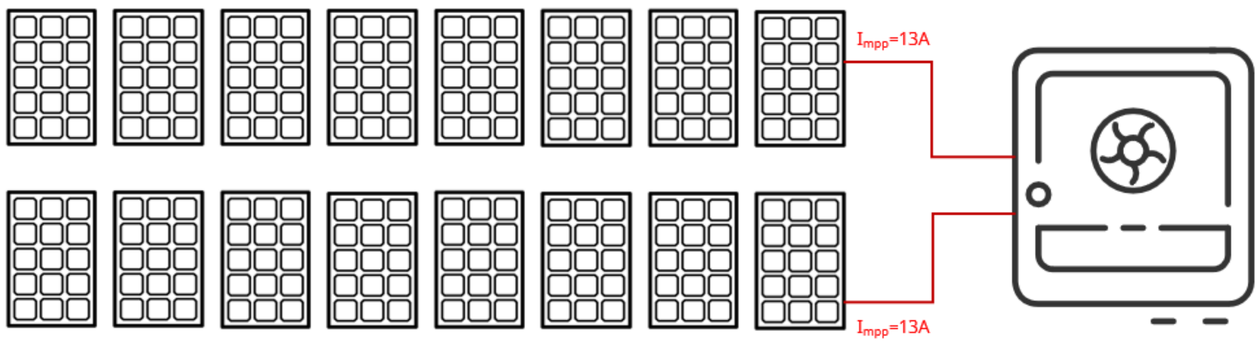

Figure 3: Example of Symo GEN24 10.0 Plus connected to modules with higher $I_{mpp.}$

Figure 3 presents an example of Symo GEN24 10.0 Plus connected with 2 strings with I_{mpp} = 13A each. One string is connected on MPPT1, which has $I_{dc\ max}$ = 25A, and the other string is connected to MPPT2, which has $I_{dc\ max}$ = 12.5A. In this case, the PV generator current on MPPT2 is oversized by 4% of the maximum input current of the inverter ($I_{dc\ max}$ = 12.5A) and the SR_I = 104%.

But even on a very sunny site with ideal weather conditions, this design **reduces the annual yield by less than 0.2%.** *(Please check the whitepaper "Economic system design with Fronius GEN24 Plus and high current PV-modules [1]" on our official website, where you can find the analysis of the annual yield.)*
This example refers to a system without power oversizing. With power oversizing IR ≥ SR_I + Δ ≥ 104% + 15% ≥ 119%, we might not have even this 0.2% additional yield loss due to current oversizing.

In reality, the overall performance of a PV generator varies throughout the day with varying irradiance, temperature, and other factors including the position of the sun, the season and the orientation of the roof. Direct irradiation on the PV generator of more than 900 W/m^2 occurs relatively rarely; correspondingly, the maximum input current of the inverter ($I_{dc,max}$) is hardly ever exceeded. Even on PV systems that have oversized array, this happens only on very rare occasions.

4 Reminder

The $I_{sc\ pv}$ is the maximum short circuit current (I_{sc} at STC) and it is an important current used in designing the maximum string current. According to IEC 60364-7-712 $I_{sc\ pv}$ = $I_{sc\ max}$ ≥ I_{sc} (STC) x 1.25. The PV generator's I_{sc} must not exceed the value ($I_{sc\ pv}$) of the inverter's MPPT.
The maximum short circuit current is always stated in our datasheet for each of the MPPTs.

		Symo GEN24 Plus					
		6.0		8.0		10.0	
		MPPT1	MPPT2	MPPT1	MPPT2	MPPT1	MPPT2
Max. array short circuit current ($I_{SC\ pv}$) [1]	A	40	20	40	20	40	20

[1] *$I_{SC\ pv}$ = $I_{SC\ max}$ >= I_{SC} (STC) x 1,25 according to e.g. IEC 60364-7-712, NEC 2020, AS/NZS 5033:2021.*

Figure 4: Excerpt datasheet Fronius Symo GEN24 Plus

[1]https://www.fronius.com/~/downloads/Solar%20Energy/Whitepaper/SE_WP_GEN24_and_high_current_modules_EN.pdf