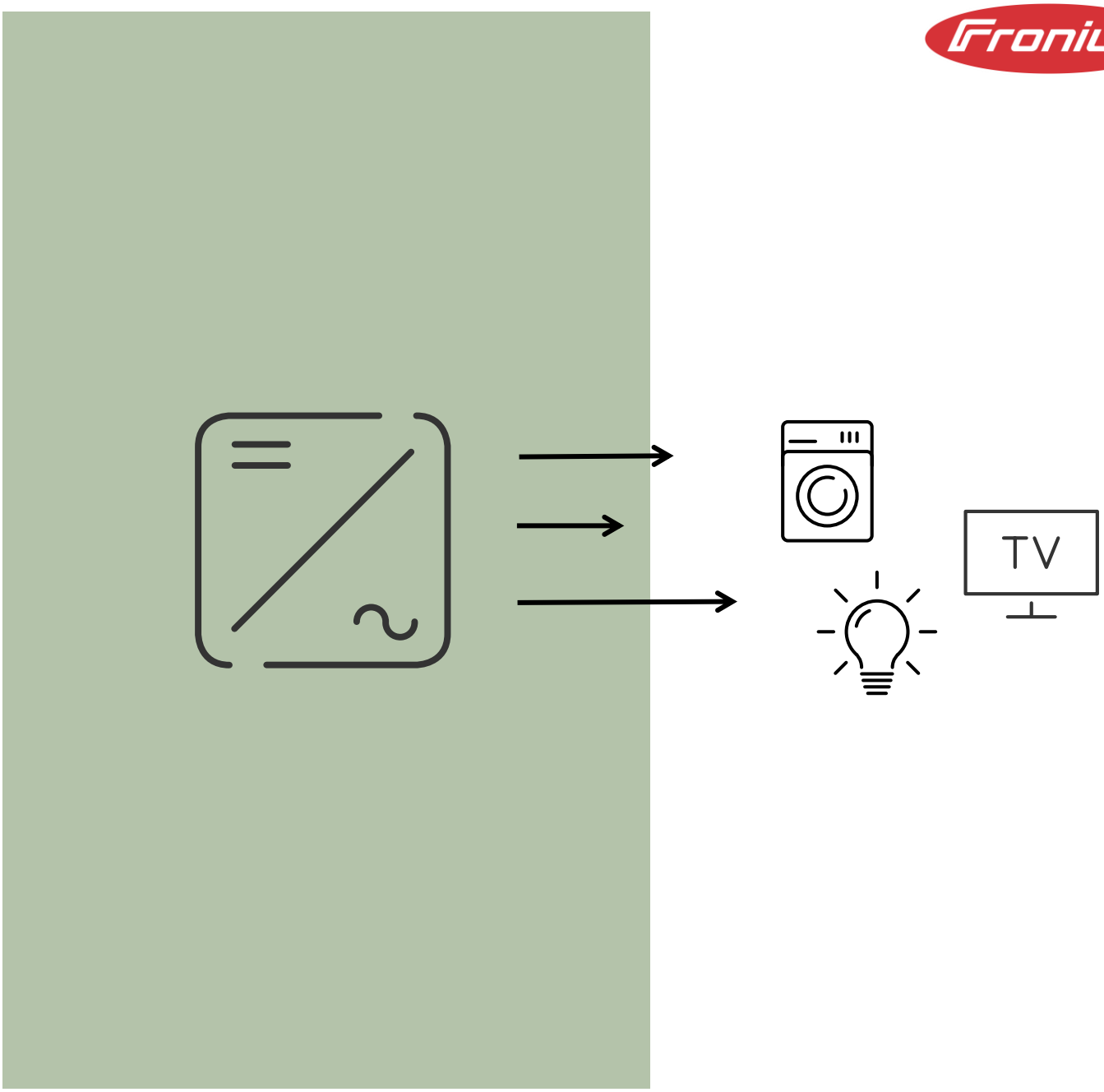


Asymmetric Generation (unbalanced power supply)

Application Guide

Version 20.09.2024

Business Unit Solar Energy

Table of contents

1 Area of application

In regions where three-phase electricity grids are prevalent, a notable challenge arises concerning billing at the grid feed-in point, in case billing is conducted precisely per phase. Despite inverters producing power symmetrically across all three phases, an inherent imbalance occurs in grid feed-in due to variations in household loads across phases. Consequently, even when sufficient PV energy is available, there's a risk of purchasing expensive electricity from the grid on one or two phases. Meanwhile, the surplus energy from the other phases is fed back into the grid but at a lower price, significantly diminishing the system's profitability.

In essence, this functionality presents a solution by substantially enhancing the profitability of PV systems in markets where phase-accurate billing is enforced.

⚠ **It's important to mention that the requirement for this functionality exists only in some markets, and therefore it should not be activated for every installation.**

2 Compatible inverters

The following three-phase inverters are compatible with the asymmetrical generation feature:

- All inverters from the Symo GEN24 and GEN24 Plus family
- Verto 25.0 – 33.3 inverters

It's essential to note that Tauro inverters are not capable of asymmetrical generation.

Furthermore, it is crucial to have a **Fronius Smart Meter** installed at the grid feed-in point to enable this functionality.

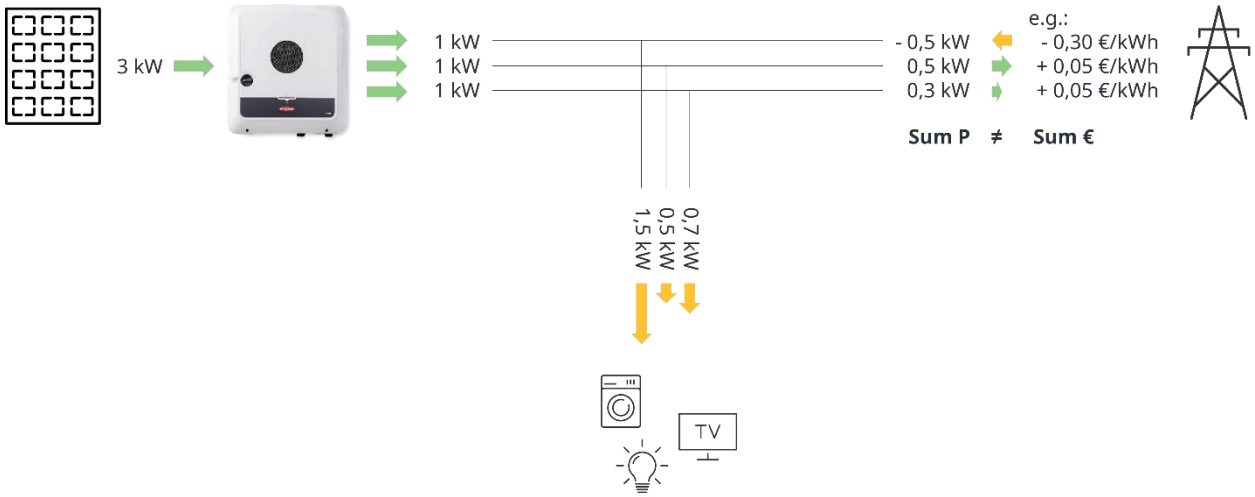
3 Functional description

This chapter describes the control behavior in different situations.

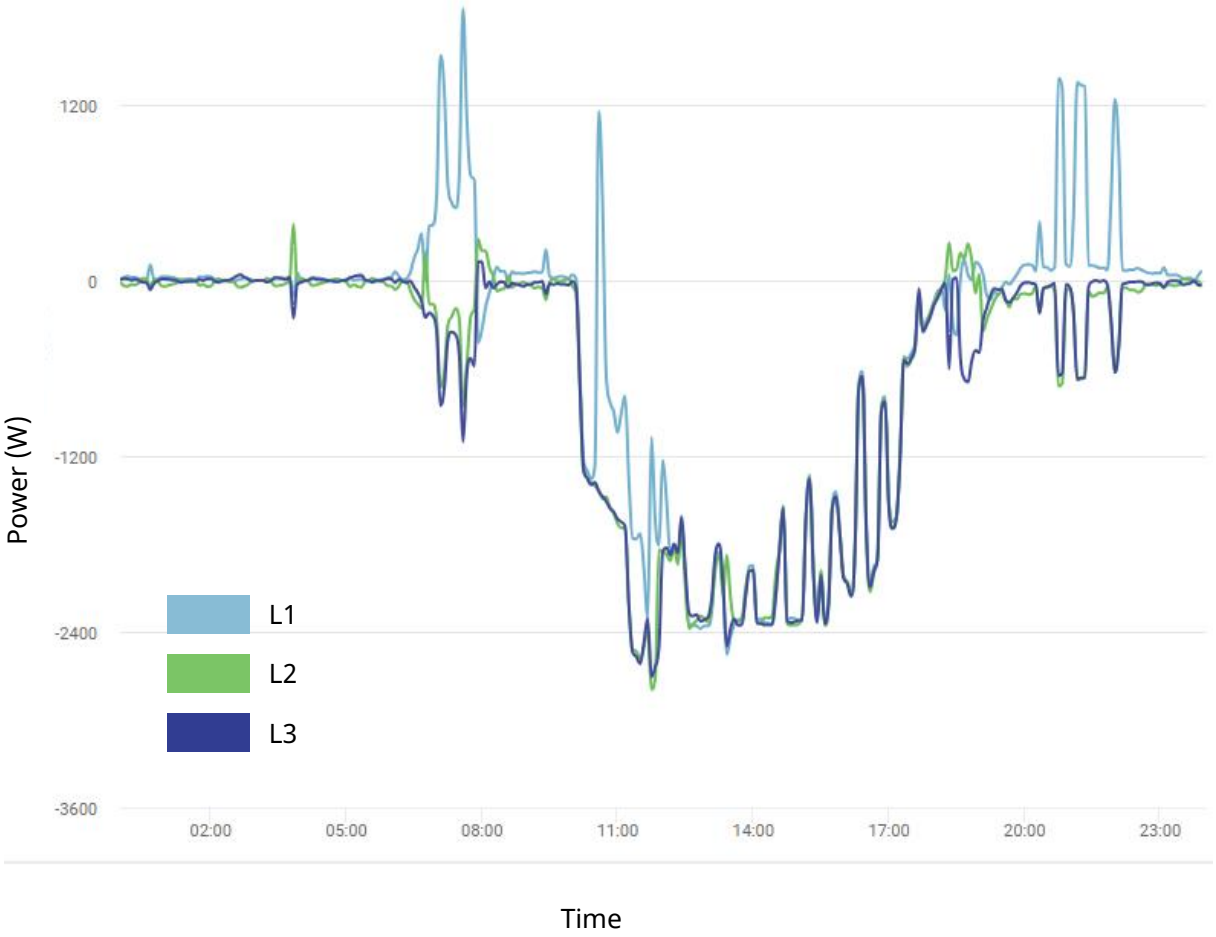
⚠ **Note: An important prerequisite for the proper operation of the function is that the phase alignment (L1, L2, L3) on the inverter and the Fronius Smart Meter match!**

3.1 Control behavior without power limitation requirements

In a scenario of symmetric generation of PV energy across the three phases, it is common for this generation not to align precisely with household consumption. Consequently, there may be instances of grid power consumption on certain phases, even when surplus PV energy could cover the entire household demand. The figure below illustrates a situation with symmetric generation.

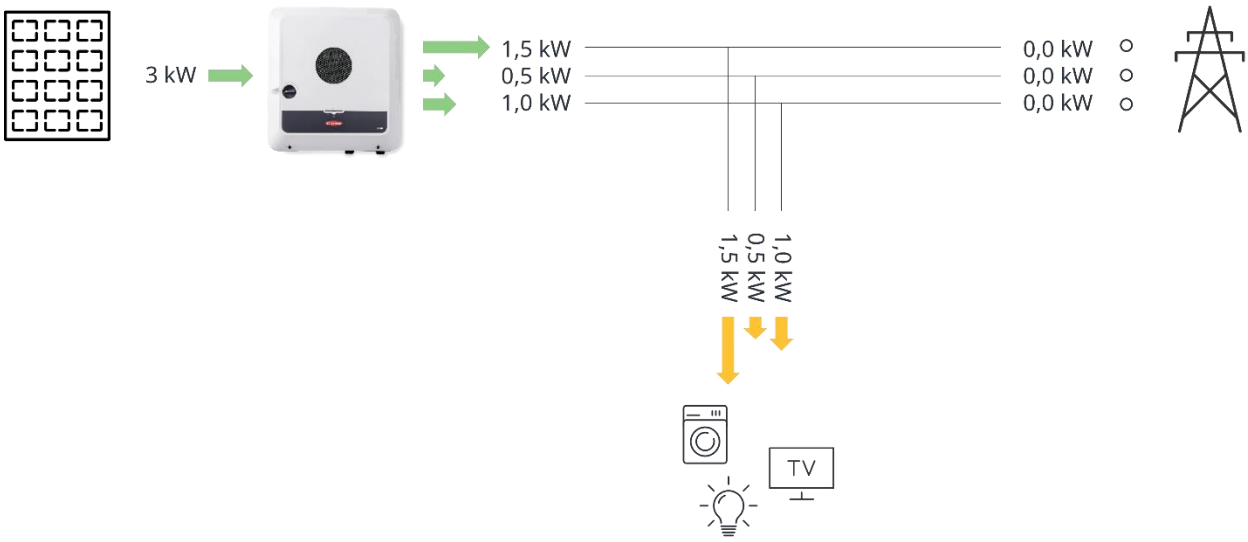


Example of Symo GEN24 10.0 Plus incl. Battery with symmetric generation and feed-in limitation of 7 kW: In night-hours, energy is exported to the grid on certain phases and consumed on other phases, while the sum of the energy flows remains zero. In day-hours, feed-in to the grid is limited with 7 kW in total, but exceeds 2,33 kW (33% of 7kW) on some phases as a result of household load asymmetry.



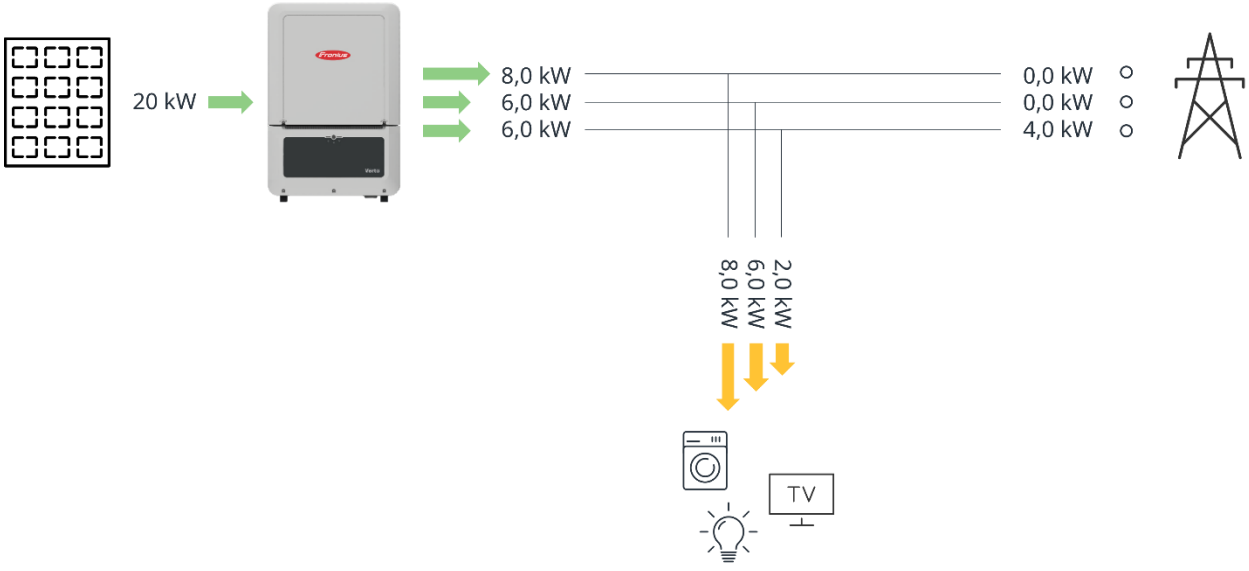
Now, the primary objective of function “asymmetric generation” is to prevent grid power consumption on any phase when surplus PV energy could adequately cover household consumption. This provides a

financial advantage by avoiding grid electricity purchases. The functional principle of asymmetrical generation is depicted in the figure below.



Example of Symo GEN24 10.0 Plus incl. battery with asymmetric generation and 2,33 kW feed-in limitation per phase: In night-hours, energy consumption from the grid is prevented efficiently and household loads are covered by the battery. In day-hours any feed-in to the grid is limited with 2,33 kW per phase (7 kW in total) and the inverter pushes its production towards this limit by compensating household loads with asymmetric generation.

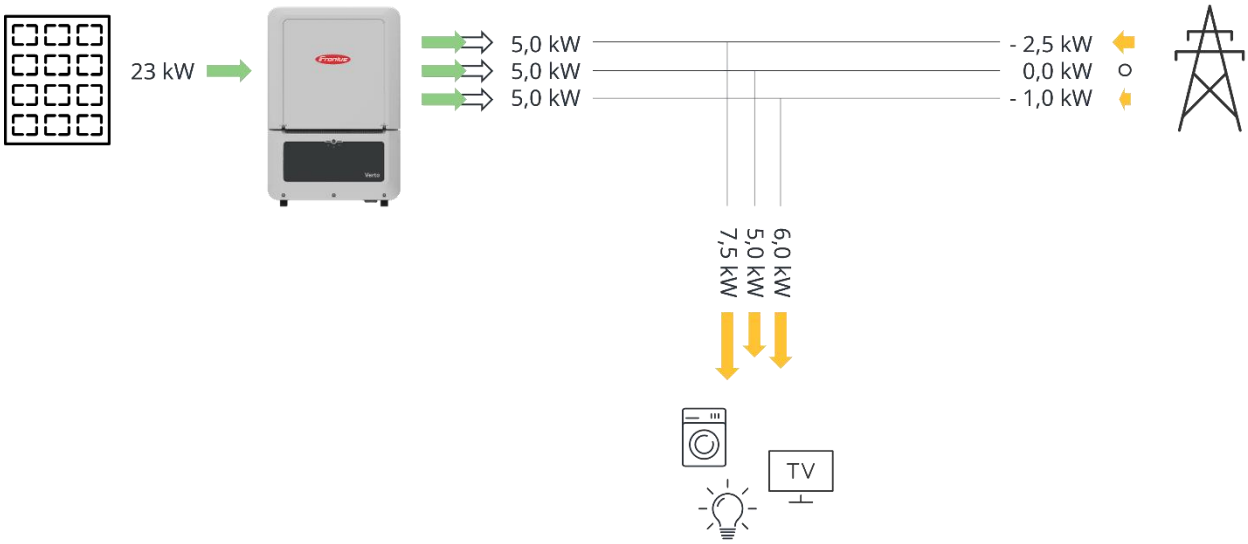
Further, in a scenario where the surplus PV energy exceeds the household energy demand but is not limited by a feed-in limitation, the secondary goal of the inverter is to restore symmetry at the inverter output as closely as possible. However, it's important to note that the aim is not to keep up symmetry at the grid transfer point. The following figure illustrates this scenario.



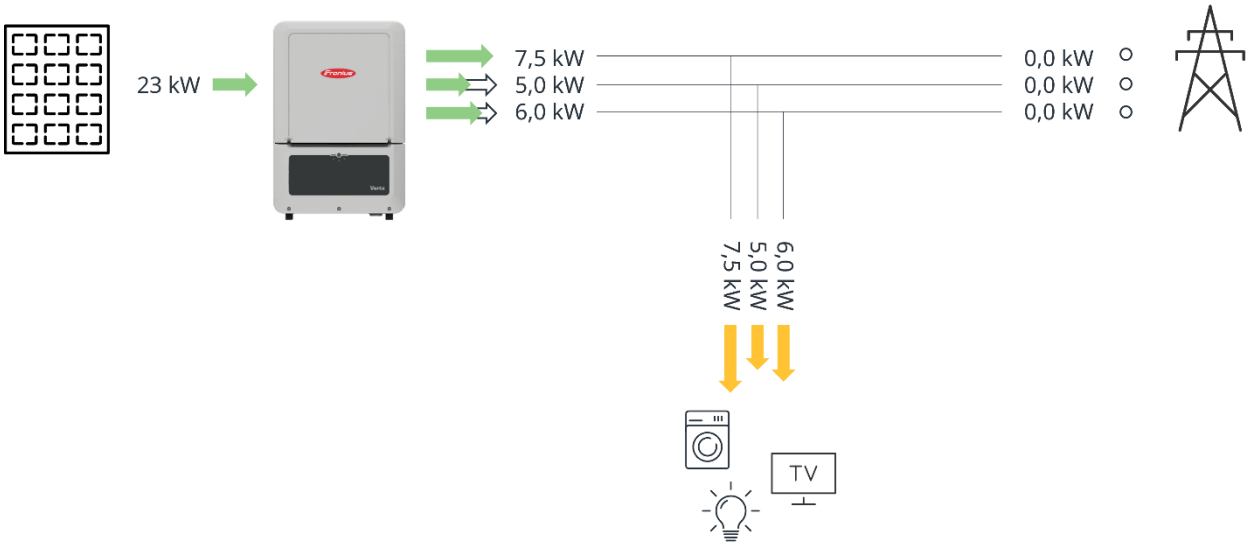
3.2 Control behavior with zero-feed-in requirements

In certain markets, there are strict zero-feed-in requirements, where no wattage is permitted to be fed into the grid at any phase. Conversely, in other countries, zero-feed-in regulations allow for individual phase feed-ins as long as the meter at the grid feed-in point remains balanced, meaning the total feed-in across phases must always sum to zero.

Traditionally, to ensure no physical feed-in occurs, Fronius inverters have limited the power output across all three phases to match the output of the weakest phase in the household. However, this approach often results in reduced energy yield since the system could potentially produce more energy. An example can be seen in the figure below:

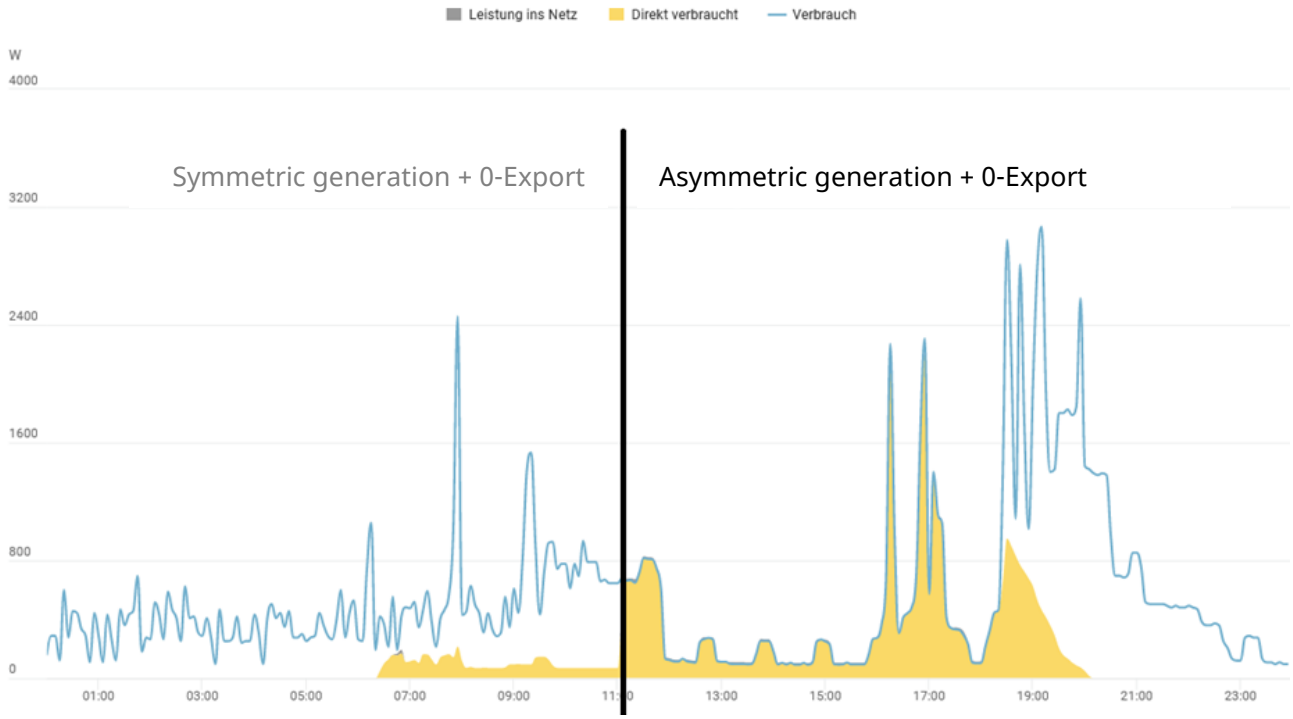


With the introduction of asymmetrical generation, it's now possible to precisely match the production to the demand on each phase while still ensuring zero physical feed-in.



This innovative approach not only optimizes energy production but also ensures compliance with zero-feed-in regulations. By dynamically adjusting the power output on each phase, the asymmetrical generation feature maximizes energy utilization while maintaining grid compliance.

As a result, the following energy flows can be observed in Fronius Solar.web:

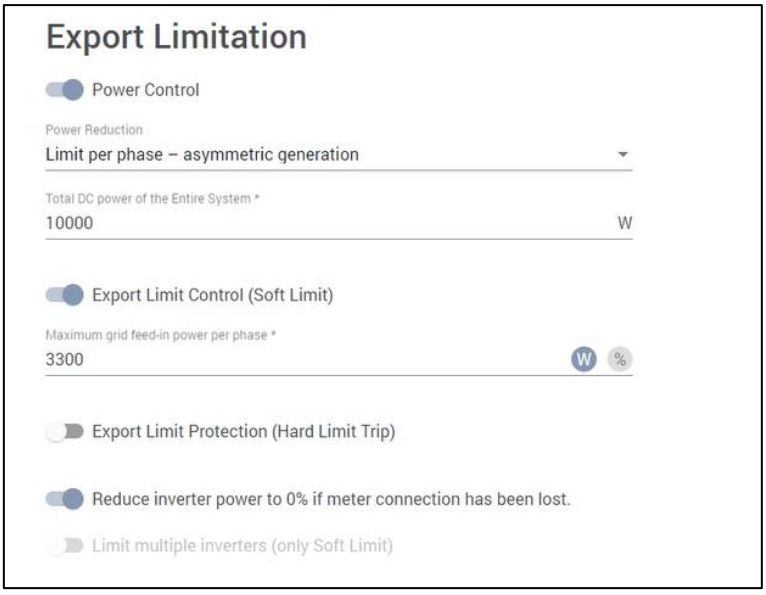


4 Activation in the user interface of the inverter

The first step is to connect to the user interface. This process is described in *How-To video: Connecting to the user interface of the GEN24/Tauro*[1] on YouTube. Please log in with your “Technician” password.

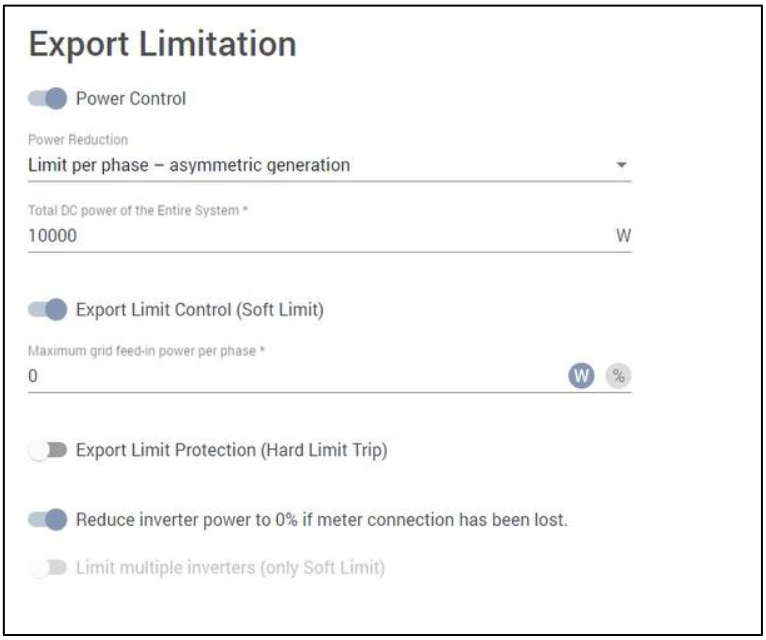
On the user interface, click "Safety & Grid Regulations" in the menu on the left and then "Export Limitation."

Activate the slider under "Power Control" and then select "Limit per Phase - Asymmetric Generation". Insert the total DC power of the entire system.
Further, it is necessary to activate "Export Limit Control" and to enter the "Maximum grid feed-in power per phase". Either via “soft” or “hard” limit depending on what is required.
If feed-in limitation is not required by the grid operator, but asymmetric generation is required for optimized phase exact self consumption, the “maximum grid feed-in power per phase” has to be set to the nominal power of the PV-system. (therefore, this limitation does not come into effect)



[1] https://youtu.be/pcwCZo-8dqc?si=MiNAjbqsNQe6JLjt

Example for “Asymmetric Generation” without effective grid feed-in limitation. In this case, the inverter will generate asymmetric power to reduce grid consumption, but won’t limit export to the grid.



Example for “Asymmetric Generation” with Zero-grid feed-in limitation. In this case, the inverter will generate asymmetric power to reduce grid consumption, and also avoid any power export to the grid.

5 Limitations

It's essential to acknowledge certain limitations:

- The Tauro inverter model is not supported for asymmetrical generation
- Operation in systems with Ohmpilot can lead to technical restrictions (load oscillation) and is therefore not supported
- When using the Fronius Verto 25.0 – 33.3 inverters, asymmetry is constrained to approximately 5.7 kW (25A). This is the max. difference between the phase with the highest load and the phase with the lowest load.
- The function only works when the neutral conductor is connected
- This feature is incompatible with systems employing dynamic power reduction with multiple inverters
- Systems with AC-coupled inverters or other energy generators like wind turbines are not supported
- Please note that this feature is not available for use in 480 V grids
- For Symo GEN24 and Verto inverters, individual phase power can not surpass 33% of the nominal power:

Product	Nominal power [kW]	Max. power per phase in asymmetric generation mode [kW]	Max. power difference between phases [kW]
Symo GEN24 3.0 [Plus]	3.00	1.00	1.00
Symo GEN24 4.0 [Plus]	4.00	1.33	1.33
Symo GEN24 5.0 [Plus]	5.00	1.67	1.67
Symo GEN24 6.0 [Plus]	6.00	2.00	2.00
Symo GEN24 8.0 [Plus]	8.00	2.67	2.67
Symo GEN24 10.0 [Plus]	10.00	3.33	3.33
Symo GEN24 12.0 [Plus] SC	12.00	4.00	4.00
Verto 25.0	25.00	8.33	5.75
Verto 27.0	27.00	9.00	5.75
Verto 30.0	29.99	10.00	5.75
Verto 33.3	33.30	11.10	5.75

Note: values for 400/230 V