/ Perfect Welding / Solar Energy / Perfect Charging

CORRECTLY SETTING THE TIME-OF-USE STORAGE SYSTEM CONTROLLER PARAMETERS

Configuration instructions

Version 1.0.1, 04/2019

Business Unit Solar Energy

CONTENTS

1 INTRODUCTION

The ‘default’ settings of a battery storage system with the Fronius Symo Hybrid inverter are configured to achieve the highest possible self-consumption. The aim is to ensure that as much of the energy generated by the PV generator is used by consumers in the household itself.

If additional framework conditions such as time-dependent electricity tariffs (time-of-use), variable reserves of emergency power, or power limits are to be taken into account, it may make sense to apply additional battery storage system settings.

Users have to decide the relative importance of this behaviour, costs, and convenience for them depending on the application. If storage system parameters are defined, there may be less energy available for direct consumption.

This document explains which settings can be applied and how to do so.

The “TIME-OF-USE SETTINGS WITH FRONIUS SYMO HYBRID” document, which can be downloaded from www.fronius.com, explains the purpose and benefits of time-of-use settings.

2 WEB INTERFACE FOR SETTINGS

2.1 Connecting to the inverter

The relevant software settings are made in the inverter's web interface (also called the Datamanager interface) using a web browser on a PC, smartphone or tablet.
Do this by completing the following steps:

1. Select the menu item "SETUP" on the inverter display

2. Select the menu item "Wi-Fi Access Point"

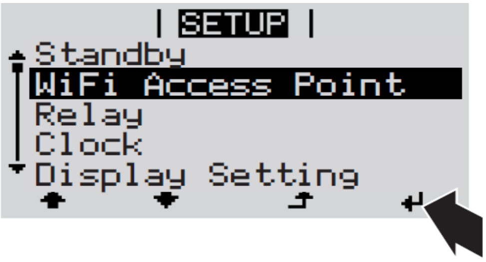


Figure 1: - Activating the access point on the inverter display

3. Connect the end device to the Wi-Fi access point
    a. On the end device, search for a network with the name "FRONIUS_xxx.xxxxx"
    b. Establish a connection to this network
    c. Enter the password: 12345678
    d. Enter http://datamanager or 192.168.250.181 (IP address of the WLAN connection) into the end device's browser. For a LAN connection (wired), enter 169.254.0.180.

For further information relating to establishing a connection, see the Operating Instructions for the Fronius inverter or Datamanager 2.0.

2.2 Settings on the Datamanager/Hybridmanager web interface

When starting the device for the first time, the installation wizard will guide you through the process.

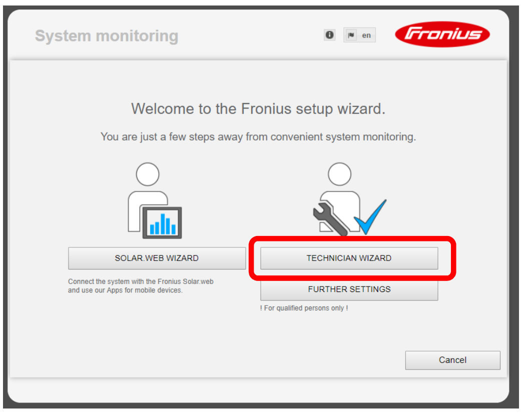


Figure 2: Starting the technician wizard

If the device has already been commissioned, you will be taken directly to the Datamanager/Hybridmanager web interface.

The appropriate settings can be made on the Datamanager/Hybridmanager web interface under ‘Settings’ -> ‘Energy management’ in the ‘Battery management’ section.

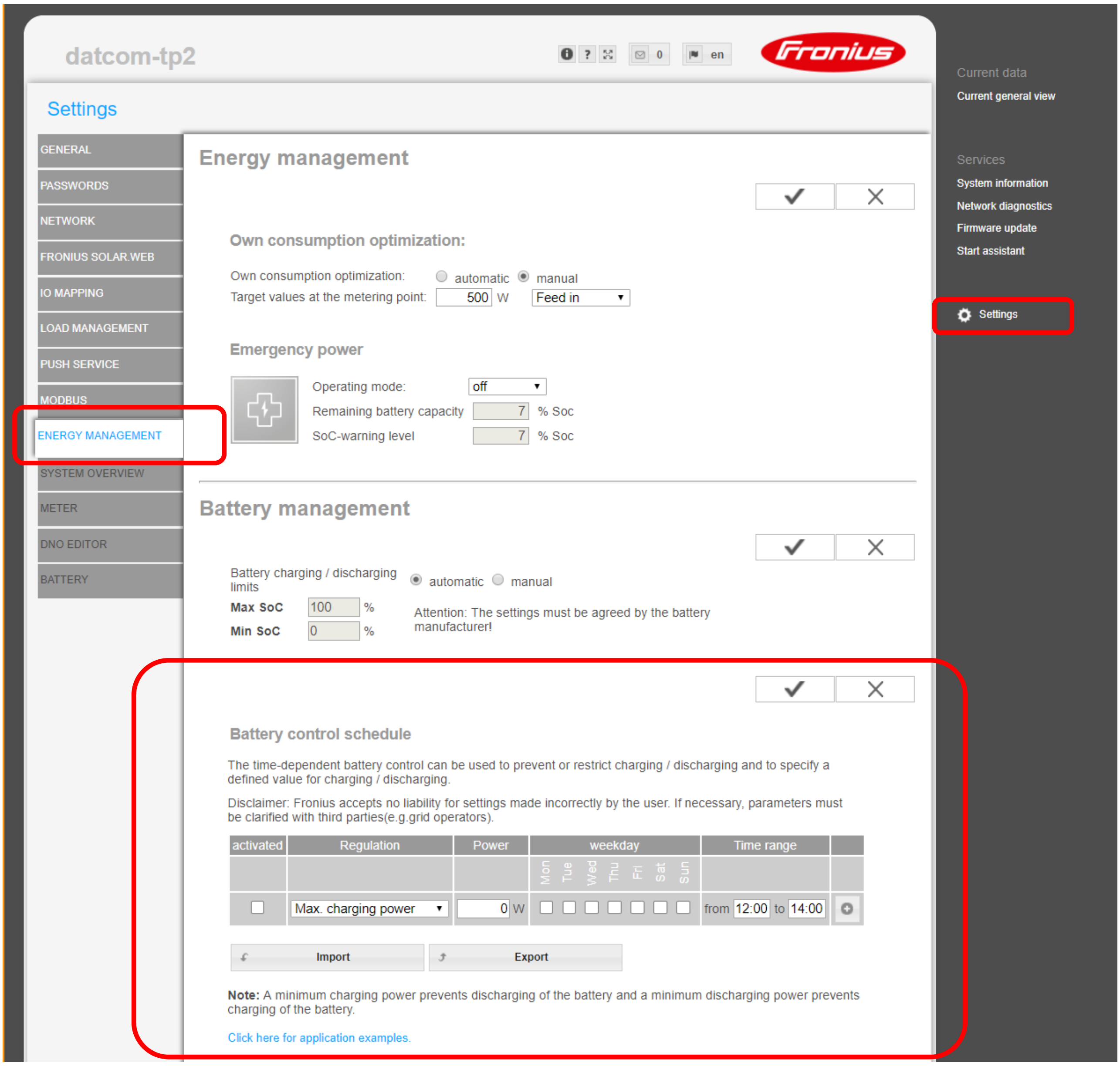


Figure 3: Time-of-use settings on the Datamanager/Hybridmanager interface

3 PARAMETERS FOR THE BATTERY STORAGE SYSTEM

The Fronius Symo Hybrid inverter allows users to set different time-dependent parameters for the energy storage system in relation to charging and discharging power for each weekday. This means that the storage system's operating range can be specified and time-of-use applications covered.

However, there are a number of external factors which influence these parameters or even render them ineffective. These include calibration charging, a ban on charging from the AC grid, power limitations for the inverter or control parameters sent via Modbus. The time-dependent parameters have the lowest priority here and it may not be possible to meet these due to other specifications.

3.1 Default settings – storage system power limitations without parameters

If no value is entered for a time period, the power is only restricted by the inverter and storage system during this period.

3.2 PV power reduction

The option of creating parameters for the storage system was developed to ensure the energy produced can be consumed by the user as efficiently as possible. However, situations may arise in which PV energy cannot be fully used due to storage system parameters.

For example: A Fronius Symo Hybrid 3.0-S is configured with a Fronius Solar Battery 7.5 with a defined discharge of 3000 W. 1000 W PV power is produced at the same time. In this case, the inverter would need to reduce the PV power to 0 W, as the output power of the Fronius Symo Hybrid 3.0-S is 3000 W and the device is already fully utilised through the discharging.

Since wasting PV power is not in the interest of the user, the power limitation for the battery control parameters is automatically adjusted so that no PV energy is wasted. In the above example, this means that the battery is only discharged with 2,000 W, so that the 1,000 W of PV power can be used (see Figure 4).

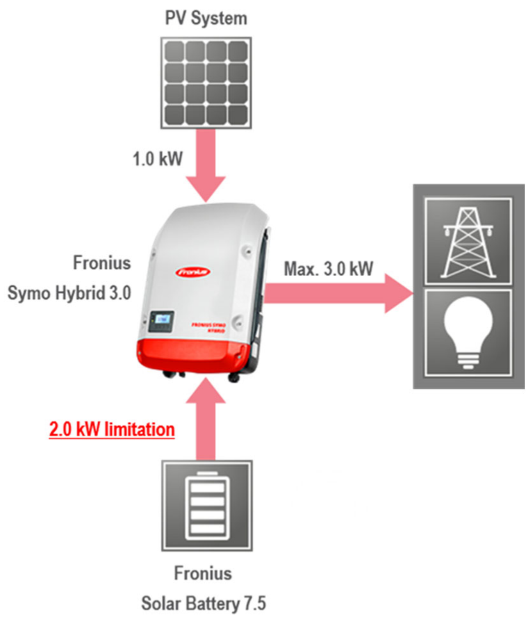


Figure 4: Restricting the storage system discharging power

Please note: When using external control commands (e.g. via Modbus or control via IOs), these parameters are also strictly adhered to even if this means PV energy will be lost.

Some special cases are also described in the following section as part of the explanations for the possible parameters.

3.3 Possible manual parameters for the battery storage system

Users can apply four restrictions to the storage system's charging/discharging behaviour via the inverter's website (Settings -> Energy management -> Battery management):

- Maximum charging power
- Minimum charging power
- Maximum discharging power
- Minimum discharging power

A parameter always consists of one of the four limitations above and the times during which the limitation applies. At any one time, none, one or a maximum of two limitations that are compatible with one another can be active.

Please note: Time ranges that span midnight are not permitted. If, for example, a parameter is required from 22:00 to 6:00, one parameter must be specified for 22:00 to 24:00 and a second for 0:00 to 6:00.

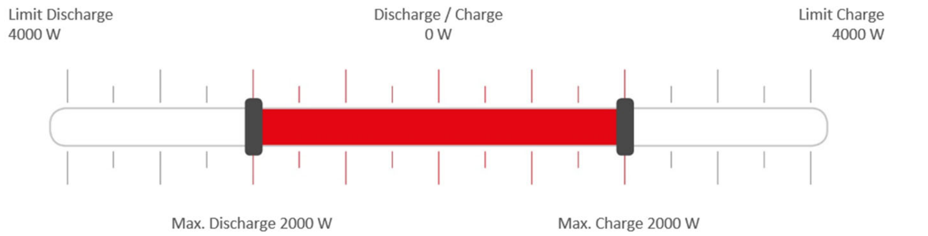
The permitted operating range can be pictured as a slide control with two sliders, with the discharging range on the left, neither discharging nor charging in the middle, and the charging range on the right.

The operating point of the storage system can be found between the two indicators. The actual behaviour is ultimately determined by the inverter and depends on the loads in the household and the availability of PV energy.

There are five permissible combinations of two storage system restrictions, which are described here. Section 4 covers specific examples and applications for these settings.

3.3.1 Maximum charging and discharging limits

The maximum charging and maximum discharging power can be configured at the same time (see Figure 5).



activated	Regulation	Power	weekday							Time range	
			Mon	Tue	Wed	Thu	Fri	Sat	Sun		
☑	Max. discharging power ▼	2000 W	☑	☑	☑	☑	☑	☑	☑	from 0:00 to 24:00	⊖
☑	Max. charging power ▼	2000 W	☑	☑	☑	☑	☑	☑	☑	from 0:00 to 24:00	⊖

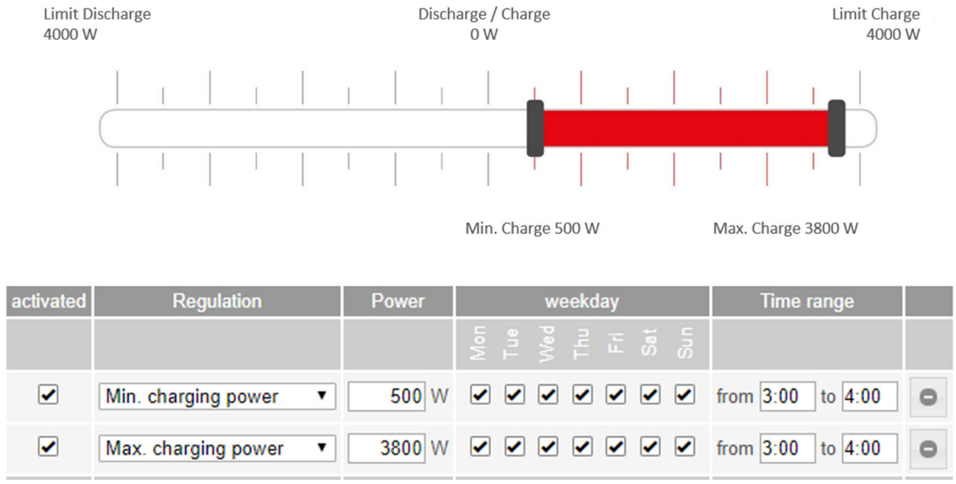
Figure 5: Maximum charging and discharging limits

3.3.2 Specifying the charging range

A charging range can be defined by setting minimum and maximum charging limits (see Figure 6). In this case, it is not possible for the storage system to discharge.

If the current PV power is actually lower than the minimum charging power, all the available PV energy is fed into the grid. If, however, the “Permit battery charging from DNO grid” setting is active, then the additional power required to reach the minimum charging limit is drawn from the grid. In this way, the storage system can be charged with the minimum charging power.

If the available PV power is greater than the maximum charging power, the storage system is charged with the specified maximum power and the excess is fed into the grid. If “dynamic power reduction” (DPR) is active, the storage system is charged with the specified maximum charging power and the excess is fed into the grid based on the DPR specification.

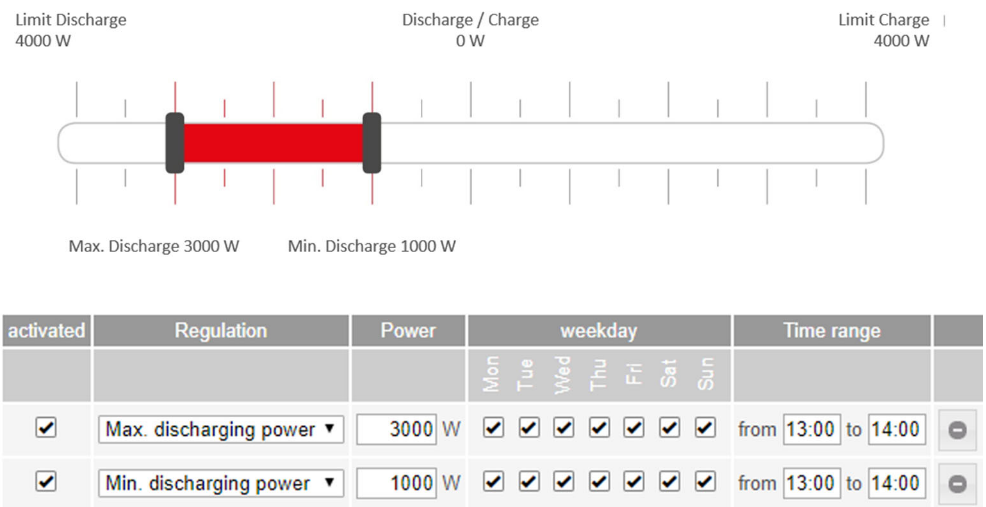


activated	Regulation	Power	weekday							Time range	
			Mon	Tue	Wed	Thu	Fri	Sat	Sun		
✔	Min. charging power ▼	500 W	✔	✔	✔	✔	✔	✔	✔	from 3:00 to 4:00	⊖
✔	Max. charging power ▼	3800 W	✔	✔	✔	✔	✔	✔	✔	from 3:00 to 4:00	⊖

Figure 6: Charging range parameters

3.3.3 Specifying the discharging range

A discharging range can be defined by setting minimum and maximum discharging limits (see Figure 7). In this case, it is not possible for the storage system to charge. However, there is one exception: If “dynamic power reduction” (DPR) is active, the storage system can be charged to avoid wasting any PV energy.
The storage system is always discharged with the set minimum discharging power, but not more than the set maximum discharging power. If consumption is covered, the PV excess and specified minimum discharging power is fed into the grid. If DPR is active and consumption is covered, then the storage system’s discharging power is reduced based on the DPR specification. As mentioned above, the storage system could even be charged.

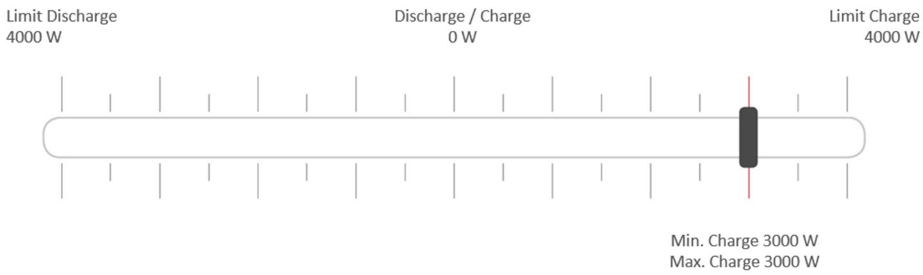


activated	Regulation	Power	weekday							Time range	
			Mon	Tue	Wed	Thu	Fri	Sat	Sun		
✔	Max. discharging power ▼	3000 W	✔	✔	✔	✔	✔	✔	✔	from 13:00 to 14:00	⊖
✔	Min. discharging power ▼	1000 W	✔	✔	✔	✔	✔	✔	✔	from 13:00 to 14:00	⊖

Figure 7: Discharging range parameters

3.3.4 Specifying a defined charging power

A defined charging power can be specified by setting the minimum and maximum charging power to the same value (see Figure 8).
If the available PV power is less than specified, all PV energy is fed into the grid, i.e. the storage system is not charged. If the “Permit battery charging from DNO grid” setting is active, the additional power required to reach the minimum charging limit is drawn from the grid.
If the available PV power is greater than that defined, the storage system is charged with the specified power and the excess is fed into the grid. If “Dynamic power reduction” (DPR) is active, the storage system is charged with the specified power and the excess is fed into the grid based on the DPR specification.

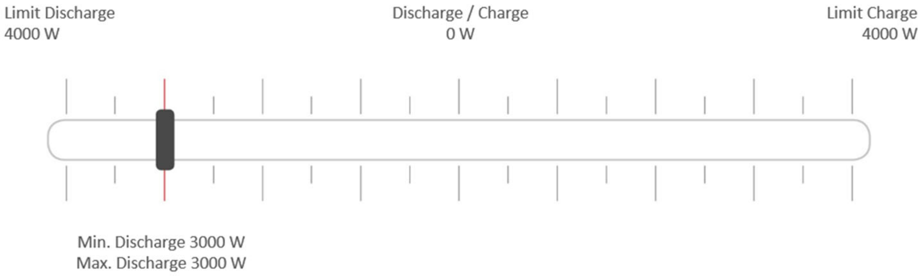


activated	Regulation	Power	weekday							Time range	
			Mon	Tue	Wed	Thu	Fri	Sat	Sun		
☑	Min. charging power	3000 W	☑	☑	☑	☑	☑	☑	☑	from 3:00 to 4:00	⊖
☑	Max. charging power	3000 W	☑	☑	☑	☑	☑	☑	☑	from 3:00 to 4:00	⊖

Figure 8: Defined charge

3.3.5 Specifying a defined discharging power

A defined discharging power can be specified by setting the minimum and maximum discharging power to the same value (see Figure 9).
The storage system is always discharged with the specified power. If consumption is covered, the PV excess and specified discharging power is fed into the grid. If DPR is active and consumption is covered, then the storage system’s discharging power is reduced based on the DPR specification. This can even result in the storage system being charged to avoid wasting PV energy.



activated	Regulation	Power	weekday							Time range	
			Mon	Tue	Wed	Thu	Fri	Sat	Sun		
✔	Min. discharging power ▾	3000 W	✔	✔	✔	✔	✔	✔	✔	from 13:00 to 14:00	⊖
✔	Max. discharging power ▾	3000 W	✔	✔	✔	✔	✔	✔	✔	from 13:00 to 14:00	⊖

Figure 9: Defined discharge

4 APPLICATION EXAMPLES

The applications described below are based on a 6 kWh storage system with a fully usable capacity of 5.7 kWh. The parameters specified are simply example values; optimal settings depend on the consumption behaviour, the size of the PV system and storage system, the tariff difference and other factors (such as the emergency power function).

It should also be noted that despite a ban on charging from the AC grid, energy may be drawn from the grid to cover consumption, as part or all of the PV energy is being used to charge the storage system.

4.1 Time-dependent electricity tariffs

There are time-dependent electricity tariffs (time-of-use) for which peak and off-peak only differ by around 10%. It is not worth manually configuring the storage system for such a small difference. However, there are also markets with considerable tariff differences (such as Australia or Hawaii; see Figure 10) where manually setting parameters for the charging/discharging behaviour of a PV system's storage system can be highly advantageous. Details and calculation examples for these time-of-use tariffs can be found in the "Time-of-use settings with Fronius Symo Hybrid" whitepaper.

Figure 10: Time-of-use tariffs in Australia and Hawaii

4.2 Fully charging the storage system before the peak phase

Probably the simplest application is having the energy storage system fully charged specifically at the start of the phase with the highest electricity price. In this case – depending on consumption and the size of the storage system – consumption could be fully covered from the storage system. In this case, no expensive electricity will need to be drawn from the grid. Further details on this application can be found in sections 4.1 and 4.2 of the "TIME-OF-USE SETTINGS WITH FRONIUS SYMO HYBRID, examples A2-B2" whitepaper.

The storage system should be fully charged by the start of the peak phase. A minimum charging power could be specified (5.7 kWh divided by the number of hours until the peak phase). However, to be sure that the storage system will be fully charged on time, despite fluctuations in insolation, a higher minimum charging power should be specified. If charging from the AC grid is permitted, the storage system can also be charged from the grid if necessary, when not enough PV energy is available.
Specifying the minimum charging power also prevents the storage system from being discharged during the day.
Of course, users could also simply specify the maximum possible charging power so that the storage system is fully charged as quickly as possible. However this may not be the optimum setting, as then consumption during the day might not be covered by PV energy, which would result in additional current being drawn from the grid.

<u>Example – Australia (A1/A2):</u>
Suppose you want the storage system to fully charge from approx. 8:00 in the morning to the start of the peak phase at 15:00. The minimum charging power would be approx. 820 W (5.7 kWh in 7 h). To be sure that the storage system will be fully charged on time, despite fluctuations in insolation, a higher minimum charging power should be selected, such as 1500 W (see Figure 11).

activated	Regulation	Power	weekday							Time range	
			Mon	Tue	Wed	Thu	Fri	Sat	Sun		
☑	Min. charging power ▾	1500 W	☑	☑	☑	☑	☑	☑	☑	from 8:00 to 15:00	⊖

Figure 11: Example 1, Australia

<u>Example – Hawaii (B1/B2):</u>
For the example of Hawaii (9:00 to 16:00), this would mean a minimum charging power of approx. 950 W (5.7 kWh in 6 h). To be sure that the storage system will be fully charged on time, despite fluctuations in insolation, a higher minimum charging power should be selected, such as 1500 W (see Figure 12).

activated	Regulation	Power	weekday							Time range	
			Mon	Tue	Wed	Thu	Fri	Sat	Sun		
☑	Min. charging power ▾	1500 W	☑	☑	☑	☑	☑	☑	☑	from 9:00 to 16:00	⊖

Figure 12: Example 1, Hawaii

4.3 ToU and grid power feed restrictions

Some markets have grid power feed restrictions, i.e. users can only feed some of the connected PV power (e.g. 70% in Germany) or potentially none (e.g. zero feed-in in Hawaii) into the grid. However, as household consumption can be taken into account, ideally 100% of the PV energy can be used, thereby avoiding a reduction in the output power.

On such systems, it may be the case that PV energy cannot be optimally used at midday, as the energy storage system, which could otherwise take the excess energy, is already fully charged. If there is sufficient capacity available at that time to store the energy that cannot be fed into the grid, then the output power does not need to be reduced and valuable PV energy is not “wasted”. In this case, the storage system must not be charged without limit in the morning, i.e. the maximum charging power of the storage system should be restricted.
Further details on this application can be found in section 4.3 of the “Time-of-Use settings with Fronius Symo Hybrid, example A3 and B3” whitepaper.
The parameters for the minimum charging power prevent the storage system from discharging.

<u>Example – Australia & Hawaii (A3/B3):</u>

In order to charge the storage system slowly in the morning, the charging power could be restricted for example, to 500 W from 8:00 to 10:00 and to 1000 W from 10:00 to 11:00 (see Figure 13).

activated	Regulation	Power	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Time range	
✔	Min. charging power	0 W	✔	✔	✔	✔	✔	✔	✔	from 8:00 to 10:00	⊖
✔	Max. charging power	500 W	✔	✔	✔	✔	✔	✔	✔	from 8:00 to 10:00	⊖
✔	Min. charging power	0 W	✔	✔	✔	✔	✔	✔	✔	from 10:00 to 11:00	⊖
✔	Max. charging power	1000 W	✔	✔	✔	✔	✔	✔	✔	from 10:00 to 11:00	⊖

Figure 13: Example 2, Australia & Hawaii

4.4 Charging the storage system from the grid overnight

The energy storage system that was previously fully discharged during the peak phase can be fully re-charged overnight when the electricity is at its cheapest. This means users can cover their consumption in the morning – during phases with higher electricity prices – from the storage system and only pay the cheapest price. The storage system can be charged continuously throughout the entire night or as quickly as possible if it is also used for emergency power mode.
This application would not make sense for the time-of-use phases for Hawaii as the electricity price is not cheap enough during the night.
Further details on this application can be found in section 4.4 of the “Time-of-Use settings with Fronius Symo Hybrid” whitepaper.

<u>Example – Australia:</u>

The storage system is charged until midnight with a minimum power of 3000 W (see Figure 14). After this time, the storage system should be prevented from discharging if the user wants to use all the energy in the morning or during the day. This means that the stored energy is intentionally reserved for the morning, from 8:00 onwards. Before 8:00, electricity is intentionally consumed from the grid.

activated	Regulation	Power	weekday							Time range	
			Mon	Tue	Wed	Thu	Fri	Sat	Sun		
✔	Min. charging power ▾	3000 W	✔	✔	✔	✔	✔	✔	✔	from 22:00 to 24:00	⊖
✔	Max. discharging power ▾	0 W	✔	✔	✔	✔	✔	✔	✔	from 0:00 to 8:00	⊖

Figure 14: Example 3, Australia

4.5 Disabling the storage system at night

If consumption peaks in the evening and in the morning fall within the peak phases (e.g. from 7:00 to 8:30 and from 15:00 to 21:00), then users may specifically want to cover these peaks with the stored energy.
In this case, it may make sense to “disable” the storage system after the peak phase in the evening for the rest of the night. This only really makes sense if the stored energy has not already been fully consumed.
If the storage system is set so that it cannot discharge during the night, then the stored energy can be used specifically when the electricity price rises again.
With the prices presented, this application only makes sense if there is also a peak phase in the morning, otherwise the feed-in could yield more during the day.
This application would not make sense for the time-of-use phases for Hawaii as there is no peak phase here in the morning.
Further details on this application can be found in section 4.5 of the “Time-of-Use settings with Fronius Symo Hybrid, example A4” whitepaper.

<u>Example, Australia (A4):</u>

In this case, the max. discharging power is simply set to 0 W during the night (see Figure 15).

activated	Regulation	Power	weekday							Time range	
			Mon	Tue	Wed	Thu	Fri	Sat	Sun		
✔	Max. discharging power ▾	0 W	✔	✔	✔	✔	✔	✔	✔	from 22:00 to 24:00	⊖
✔	Max. discharging power ▾	0 W	✔	✔	✔	✔	✔	✔	✔	from 0:00 to 7:00	⊖

Figure 15: Example 4, Australia

4.6 Limiting discharge in the evening/at night

If there is also a peak phase in the morning (from approx. 7:00) but not an excessive amount of consumption during the evening peak phase (see Figure 16), then it may make sense to restrict the maximum discharging power in the evening (and afterwards possibly completely prohibit discharging). This enables users to ensure that there is still enough energy in the storage system in the morning to cover the consumption during the peak phase.

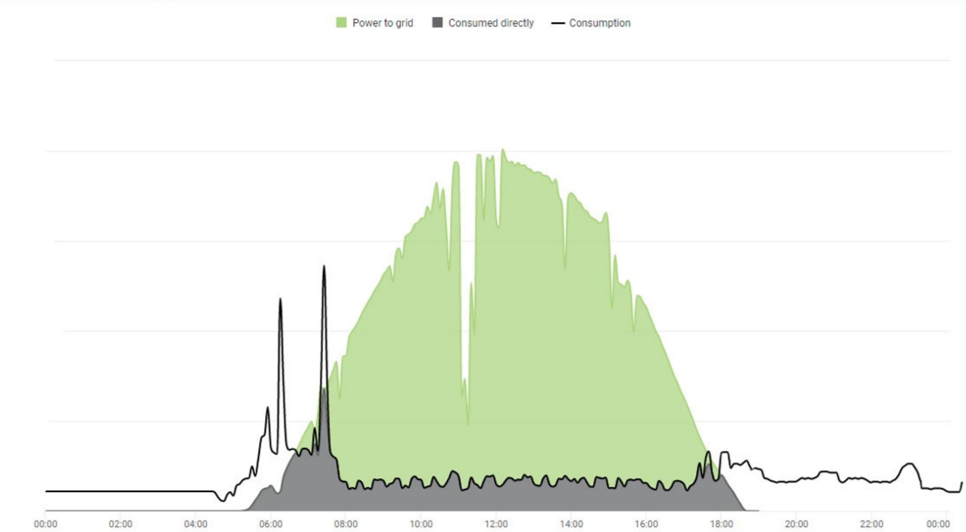


Figure 16: Consumption with peak in the morning

Only a defined maximum discharging power is permitted during the night. This means that all consumption in the evening and only a certain amount during the night (e.g. 2.5 kWh) is covered by the stored energy. The rest is used during the peak phase in the morning.
Further details on this application can be found in section 4.6 of the “Time-of-Use settings with Fronius Symo Hybrid, example A6 and B6” whitepaper.

<u>Example – Australia & Hawaii (A6/B6):</u>
The maximum discharging power is set to approx. 280 W (2.5 kWh/9 h) (see Figure 17). This means a maximum of 2.5 kWh should be drawn from the storage system during the night.

activated	Regulation	Power	weekday							Time range	
			Mon	Tue	Wed	Thu	Fri	Sat	Sun		
☑	Max. discharging power ▾	280 W	☑	☑	☑	☑	☑	☑	☑	from 22:00 to 24:00	⊖
☑	Max. discharging power ▾	280 W	☑	☑	☑	☑	☑	☑	☑	from 0:00 to 7:00	⊖

Figure 17: Example 5, Australia & Hawaii

4.7 Time-dependent feed-in tariffs

Some markets have time-of-use feed-in tariffs. One such market is Victoria, Australia, where this type of tariff has been in effect since July 2018. This looks like the tariff for electricity drawn from the grid (see Figure 18):

- Peak, 15:00 to 21:00: 29 ct/kWh
- Shoulder, 7:00 to 15:00 and 21:00 to 22:00: 10.3 ct/kWh
- Off-peak, 22:00 to 7:00: 7.1 ct/kWh

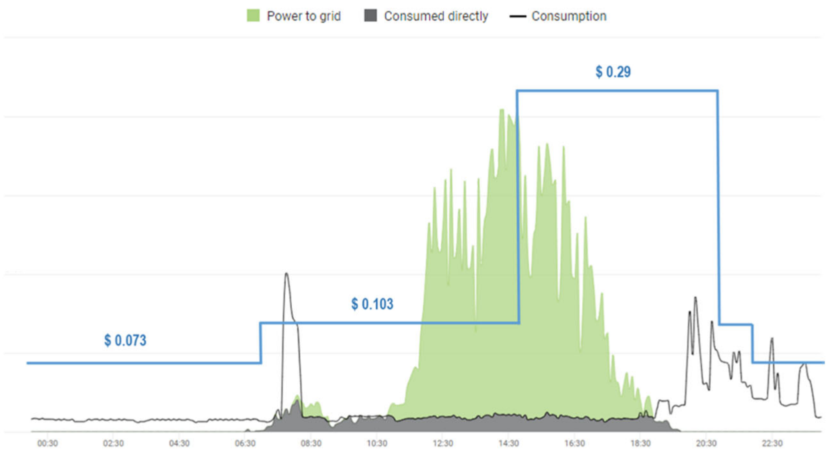


Figure 18: Energy balance with time-dependent feed-in tariffs

In this case, it makes sense to fully charge the storage system before 15:00 and then fully discharge it up to 21:00 (see Figure 19). This will make it possible to 1) cover the self-consumption at that time (this is also when it is most expensive to draw electricity) and 2) feed in unused energy from the storage system. In addition to the savings, the maximum feed-in tariff can also be achieved. If there is still energy in the storage system after the end of the peak phase, then in this case, it can also be used to cover some of the consumption during the one-hour shoulder phase beginning at 21:00.

Further details on this application can be found in section 4.7 of the “Time-of-Use settings with Fronius Symo Hybrid, example A7” whitepaper.

activated	Regulation	Power	weekday							Time range	
			Mon	Tue	Wed	Thu	Fri	Sat	Sun		
✔	Min. charging power	1500 W	✔	✔	✔	✔	✔	✔	✔	from 8:00 to 15:00	⊖
✔	Min. discharging power	800 W	✔	✔	✔	✔	✔	✔	✔	from 15:00 to 21:00	⊖

Figure 19: Example 6, Australia

4.8 Time-dependent capacity reservation for emergency power

A capacity reserve can be configured for emergency power mode. However, this surplus capacity is then also held in reserve when there is nobody at home.
Individual adjustments can be made using the storage system parameters, so for a household where nobody is home during weekdays, the following parameters can be defined: the storage system should always be full in the evening, and during the day self-consumption should be optimised. To do so, the system must be set to charge before the owners come home in the evening. In this case, it would also be possible to leave the storage system to only discharge slowly until midnight, so that capacity is available if emergency power is required. Furthermore, at weekends, discharging could be restricted during the day.

5 SUMMARY

This document illustrates that manually setting the charging and discharging behaviour of a PV system's storage system can be highly advantageous.
With the right parameters, users can set their Fronius storage solution to suit their personal needs and adjust it in line with time-dependent electricity prices. This means that unnecessarily high costs for additional, and mainly expensive, electricity from the grid can be avoided. The resulting advantages depend primarily on the difference between the time-dependent tariffs. This means that the greater the tariff difference, the greater the benefit from setting one's energy storage system to work with these conditions. However, if there is only a slight difference between the tariffs, setting parameters for the storage system may not be worthwhile.

6 LIST OF FIGURES