Planning Guidelines

SMA SMART HOME

The System Solution for Greater Independence

Table of Contents

1 Information on this Document

1.1 Content and Structure of this Document

Section structure

The contents of the sections in this document build on each other.

This document assists you in planning an SMA SMART HOME, the intelligent management system for solar generation, self-consumption, and grid feed-in.

Section	This section answers the following questions:
Generating solar power for intelligent consumption (see Section 3, page 9)	Which components are required for a basic configuration?
Managing and distributing solar energy (see Section 4, page 17)	Which components can be used for management and distribution? What is the difference between feed-in systems and self-consumption systems? How can the self-consumption quota be increased through intelligent load control? Which loads are suitable for intelligent energy management? How does the intelligent load control work? How does active power feed-in limitation to 0% or 0 W work? How does the dynamic limitation of active power feed-in for prevention of derating losses work?
Storing solar power and using it optimally (see Section 7, page 47)	Which components do I require for an SMA SMART HOME with storage solution? How can my self-sufficiency quota improve through storing solar power? How does forecast-based charging for prevention of derating losses work?
SMA Energy System Home (see Section 7.7, page 53)	What must be considered during the design of an SMA Energy System Home?
Explanation of used terms (see Section 9, page 60)	

Illustrations in this document are reduced to the essential information and may deviate from the real product.

1.2 Symbols in the Document

Icon	Explanation
i	Information that is important for a specific topic or goal, but is not safety-relevant
☐	Indicates a requirement for meeting a specific goal
☑	Desired result

Icon	Explanation
✖	A problem that might occur.
	Example

1.3 Designations in the Document

Complete designation	Designation in this document
SMA Energy Meter (EMETER-20)	SMA Energy Meter
SMA EV Charger	EV Charger, charging station
Sunny Boy Storage, Sunny Island	Battery inverter
Sunny Boy, Sunny Tripower	PV inverter
Sunny Tripower Smart Energy	Hybrid inverter
Sunny Home Manager 2.0	Sunny Home Manager
Sunny Island 4.4M, Sunny Island 6.0H, Sunny Island 8.0H	Sunny Island

2 PV Energy for Internal Power Supply and Self-Consumption

2.1 Why are Self-Consumption and Internal Power Supply Interesting?

In light of the continuing trend towards lower feed-in tariffs and rising energy prices, the focus of system design has increasingly shifted away from maximizing PV generation towards intelligent energy management. There are two key objectives here:

- As much self-consumption of the generated PV energy as possible
- Full coverage of the energy requirement with PV energy (= self-sufficiency) if possible

Both of these are economically viable as soon as the PV generation costs fall below the costs of purchasing electricity.

2.2 What Are the Effects of Internal Power Supply and Self-Consumption?

An almost total self-consumption of the PV energy makes the operator more independent of the feed-in tariff which now barely covers costs, and it increases the effective value of each generated kilowatt hour. An almost complete internal power supply makes the operator more independent of rising electricity prices and reduces the average cost of each kilowatt hour used.

Internal power supply and self-consumption also relieve the burden on the utility grid since the energy produced on site is also consumed directly on site. For this reason, the importance of technical solutions for optimization of internal power supply and self-consumption is growing constantly.

Normally, self-consumption of PV energy takes place naturally. Whenever a load is switched on while the sun is shining, the PV energy generated at that time is consumed directly.

This means that the energy generated by the PV system naturally flows first to the active loads within the household grid – only the surplus flows into the utility grid. For this reason, a primary function of energy management is to intelligently coordinate the operation of loads with the availability of PV energy, with regard to both quantity and time.

2.3 What Are the Requirements for High Energy Self-Sufficiency and Self-Consumption Quotas?

The first important requirement for effectively increasing the internal power supply and self-consumption is the right balance between annual PV generation and annual energy demand:

- If the annual PV generation is considerably lower than the annual energy demand, a significant proportion of the PV energy can almost always be used on site. This also applies when the timing of the main energy demand and the main PV generation do not coincide exactly. The high self-consumption quota is then purchased with a low self-sufficiency quota.
- If, however, the annual PV generation is much higher than the annual energy demand, only a small proportion of the PV energy can be used on site. Much of the generated PV energy must be fed into the utility grid. This results in a low self-consumption quota. The self-sufficiency quota, on the other hand, is higher.

A changed ratio of PV generation to electrical consumption, therefore, always increases either the self-sufficiency quota or the self-consumption quota. For this reason, the right balance between energy generation and energy consumption is indispensable.

A second important requirement for a high self-sufficiency quota and a high self-consumption quota is an appropriate load profile: The distribution schedule of the PV power is defined in quite narrow limits by the alignment of the PV array and the weather. For this reason, the load profile determines almost solely how well PV generation and energy demand match each other during the course of the day. Besides using electrical storage systems, effective matching of the load profile is the only way to simultaneously optimize both the self-sufficiency quota and the self-consumption quota.

Parameters for internal power supply and self-consumption

The internal power supply is specified by the self-sufficiency quota.

The self-consumption is specified by the self-consumption quota.

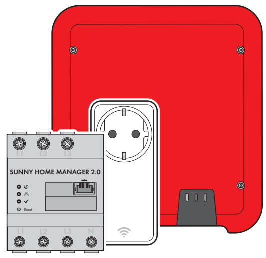
2.4 Increased Self-Consumption Through Intelligent Energy Management

If the ratio of PV generation and energy demand remains constant, internal power supply and self-consumption can only be optimized by intelligent energy management. For this purpose, SMA Solar Technology AG offers the following energy management functions:

- Basic solution for intelligent energy management: Sunny Home Manager and radio-controlled sockets
- Storage solutions for new and existing PV systems: SMA Energy System Home

Basic solution for intelligent energy management with Sunny Home Manager and radio-controlled sockets

The first step in intelligent energy management is the recording and evaluation of the energy flows in the household. This energy monitoring looks at both the total energy consumption and that of individual home appliances using the measurement function of the radio-controlled sockets.



Based on the information compiled in this way, the Sunny Home Manager creates an overview with various views and diagrams in Sunny Portal. The user can then use this overview to understand the energy flows in his/her household and can decide in which areas it is worth deploying intelligent energy management.

The Sunny Home Manager also provides recommendations on the times at which the user can switch on specific devices in order to significantly increase self-consumption.

The next step is active energy management in the form of automatic load control in the household. Via the on/off switch function of the radio-controlled sockets or via control commands through data connection, loads can be switched on by the Sunny Home Manager precisely when the PV system is generating sufficient energy or when the energy costs are particularly low.

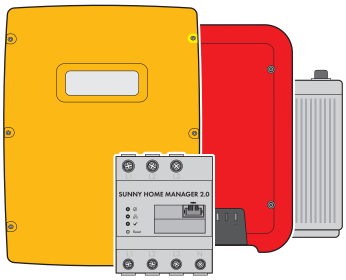
Optimization of energy utilization

We assume a typical, single-family home with an annual PV generation of 5000 kWh, an annual energy demand of 5000 kWh, and a natural self-consumption of 30%. In this example, the Sunny Home Manager can improve the energy balance through intelligent load control as follows:

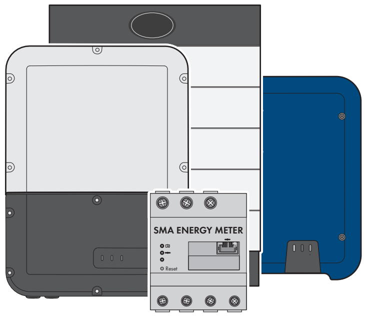
- Due to the high direct consumption by the controlled loads, the self-consumption quota increases from 30% to typically 45%.
- Accordingly, the purchased electricity amount decreases from 3500 kWh to 2750 kWh per year. This equals 55% of the entire annual energy demand. The electricity bill is decreased by 22%.

Storage solution with battery inverter for new and existing PV systems

The most important elements of an SMA storage system with Sunny Island are one or more SMA PV inverters, one or more Sunny Island inverters, a battery, an SMA Energy Meter or a Sunny Home Manager. The Sunny Island is a battery inverter for parallel grid and stand-alone mode. 3 battery inverters Sunny Island can be connected to form a three-phase cluster.



The most important elements of an SMA storage system with Sunny Boy Storage are a Sunny Boy Storage, one or several SMA PV inverters, an SMA Energy Meter, and a battery. The SMA Energy Meter can also be optionally replaced by the Sunny Home Manager. This enables intelligent energy management. The Sunny Boy Storage is a single-phase, AC coupled battery inverter for parallel grid operation.



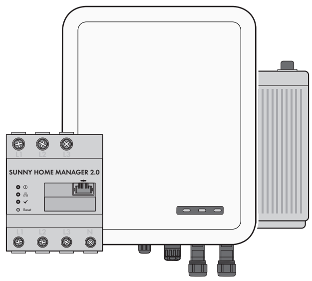
Optimization of energy utilization

We assume a typical, single-family home with an annual PV generation of 5000 kWh, an annual energy demand of 5000 kWh, and a natural self-consumption of 30%. In this example, the SMA storage system uses the available battery capacity of 5 kWh to optimize the energy balance as follows:

- Due to the significantly larger battery-storage system, the higher usable energy leads to an increase in the self-consumption quota from 30% to typically 65%.
- Accordingly, the purchased electricity amount decreases from 3500 kWh to 2150 kWh. The purchased electricity of 2150 kWh corresponds to 43% of the annual energy demand; this includes storage losses of 8%. The electricity bill is decreased by 38%.

Storage solution with hybrid inverter for new and existing PV systems

The SMA Energy System Home with the Sunny Tripower Smart Energy can be used with and without battery. The hybrid inverter combines the properties of a PV and a battery inverter. The battery capacity can be set individually. In addition to the DC-side battery charging, the Sunny Tripower Smart Energy also offers the option of AC-side charging. Consequently, the system can be flexibly extended by additional SMA PV inverters and thus meets the individual needs of the household.



The most important elements of the SMA Energy System Home with the Sunny Tripower Smart Energy are a Sunny Tripower 5.0 / 6.0 / 8.0 / 10.0 Smart Energy and an SMA Energy Meter. The Sunny Tripower Smart Energy is a hybrid inverter which can convert the PV energy into grid-compliant current as well as charge into the battery. The system can be optionally extended by further SMA PV inverters and/or the energy meter replaced by a Sunny Home Manager. By replacing the Energy Meter with a Sunny Home Manager, an intelligent energy management is possible. The AC-side charging functionality of the Sunny Tripower Smart Energy enables excess energy from the additionally connected inverters to be temporarily stored in the battery.

3 Internal Power Supply and Self-Consumption with SMA Smart Home

3.1 Basic Solution for Intelligent Energy Management

Using the intelligent load control, the Sunny Home Manager uses its control options to shift the operation of flexible loads to times with high PV generation.

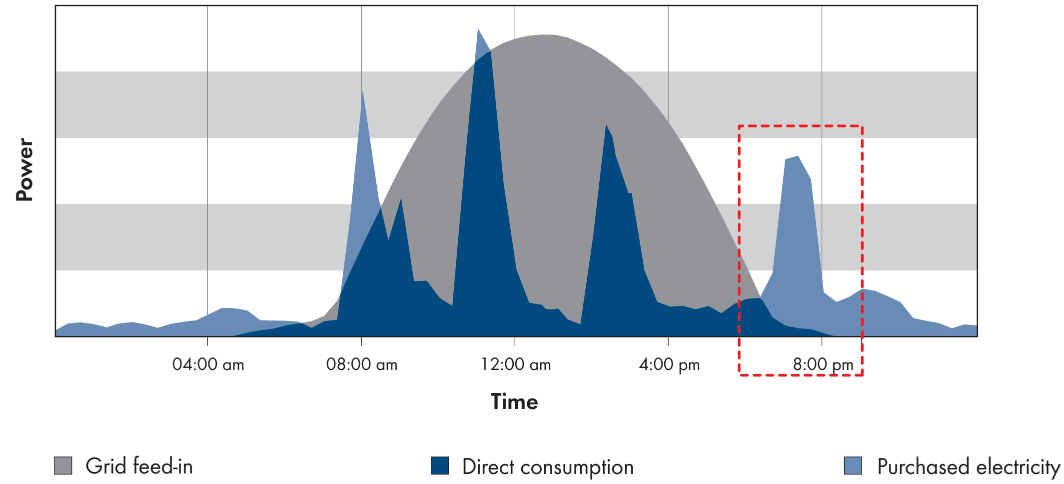


Figure 1: Daily profile of a PV system, consumption and self-consumption – without load control (example)

The red frame in this example shows a load peak in the evening. This load peak, for example, is caused by a washing machine that is switched on manually in the evening.

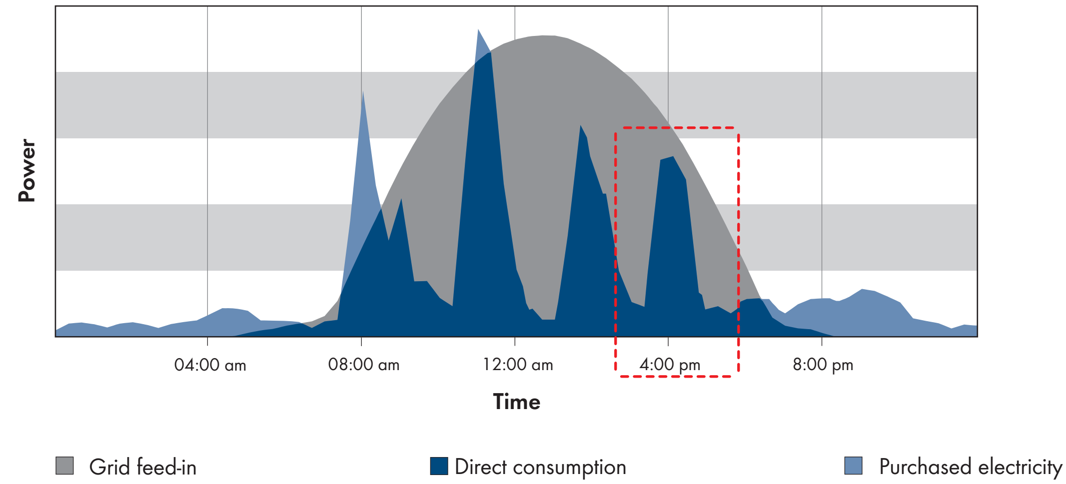


Figure 2: Daily profile of a PV system, consumption and self-consumption – with load control (example)

The red frame in this example shows the shifting of the load peak to the afternoon. Due to the automatic control by the energy management system, operation of the washing machine is shifted to a time period in which cheaper PV energy is available. PV self-consumption increases, lowering the energy costs for the user.

The Sunny Home Manager forms the core of the SMA basic solution for intelligent energy management.

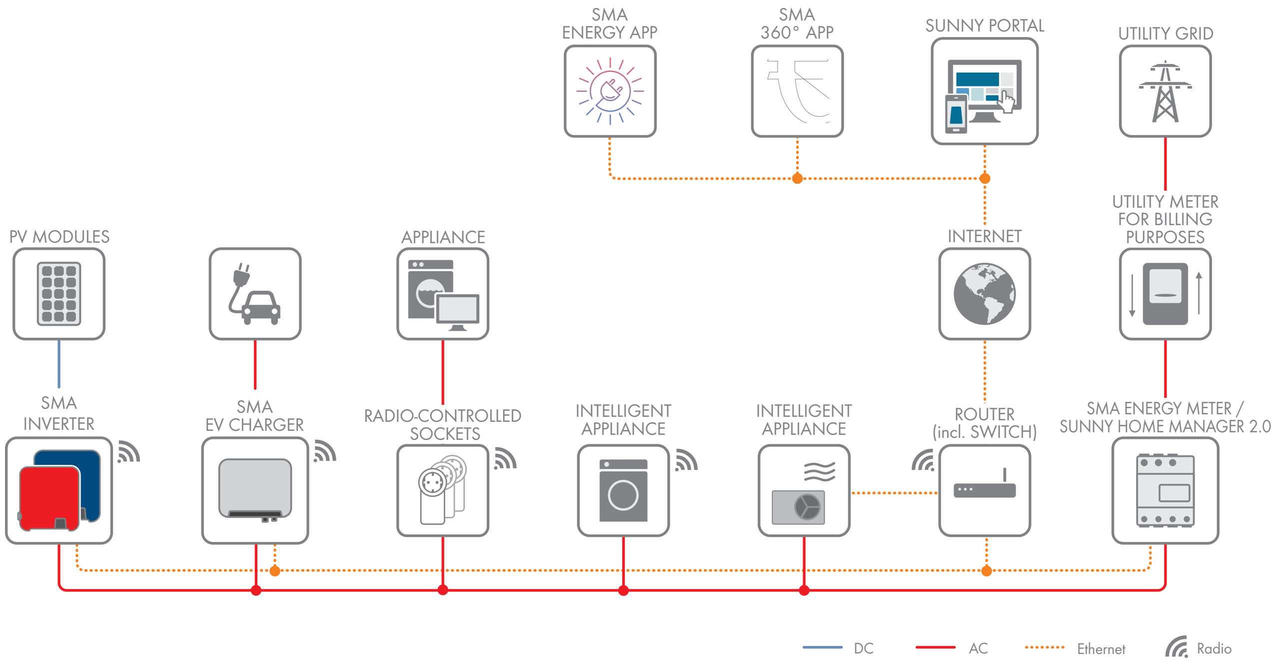


Figure 3: PV system with Sunny Home Manager (example)

The Sunny Home Manager offers the following energy management functions:

- Visualization of PV system data in Sunny Portal (see Section 4.1.2, page 17)
- Intelligent load control (see Section 4.1, page 17)
- Dynamic active power limitation (see Section 4.2, page 21)
- Zero Export (see Section 4.3.2, page 27)
- Access to grid management services via Modbus interface, e.g. for active power limitation by the grid operator

3.2 Storage Solutions for New and Existing PV Systems

With an SMA Energy System Home, automatic load control and intermediate storage can be combined.

The following examples show the measures that can be taken to achieve these values:

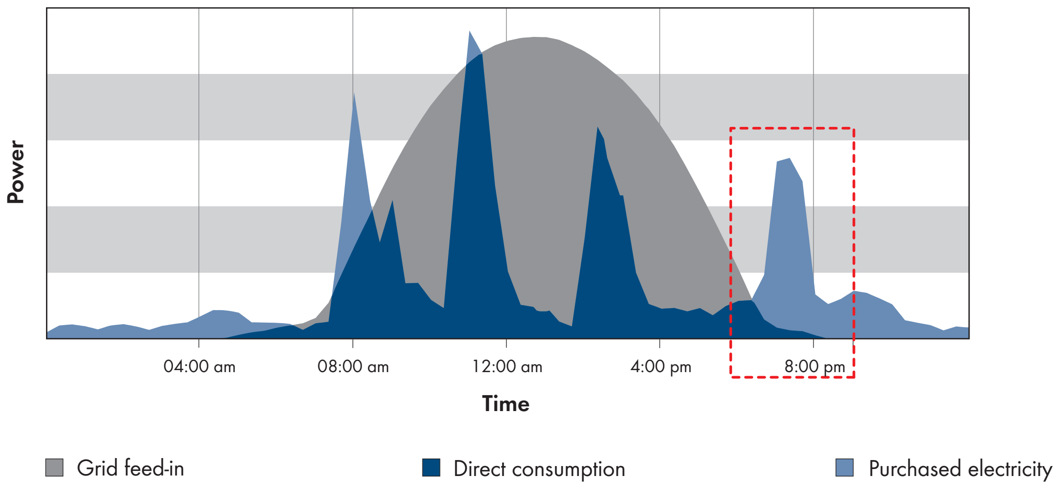


Figure 4: Daily profile of a PV system, consumption and self-consumption – without load control (example)

The red frame in this example shows a load peak in the evening. This load peak, for example, is caused by a washing machine that is switched on manually in the evening.

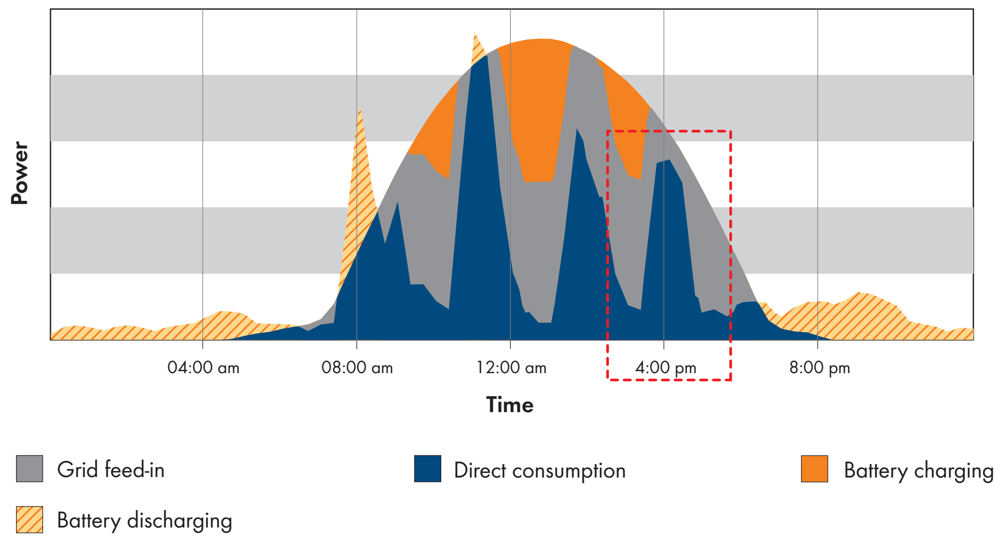


Figure 5: Daily profile of a PV system, consumption and self-consumption – with load control and intermediate storage (example for a SMA storage system)

By integrating a battery into the system, a portion of the consumption can be covered by intermediate storage. In this example, the coverage is 100%. This means that there is no longer a requirement for purchased electricity.

By way of the Energy balance page in Sunny Portal, an overview of the energy consumption in the house, energy generation by the PV system and the feeding in of excess PV energy into the utility grid is available at all times. The charging and discharging of any available battery is also visualized. This shows when the PV energy stored intermediately in the battery is consumed in the household, during the evening for example. Purchase of electricity can be avoided and the energy costs are decreased.

SMA Energy System Home with Sunny Island

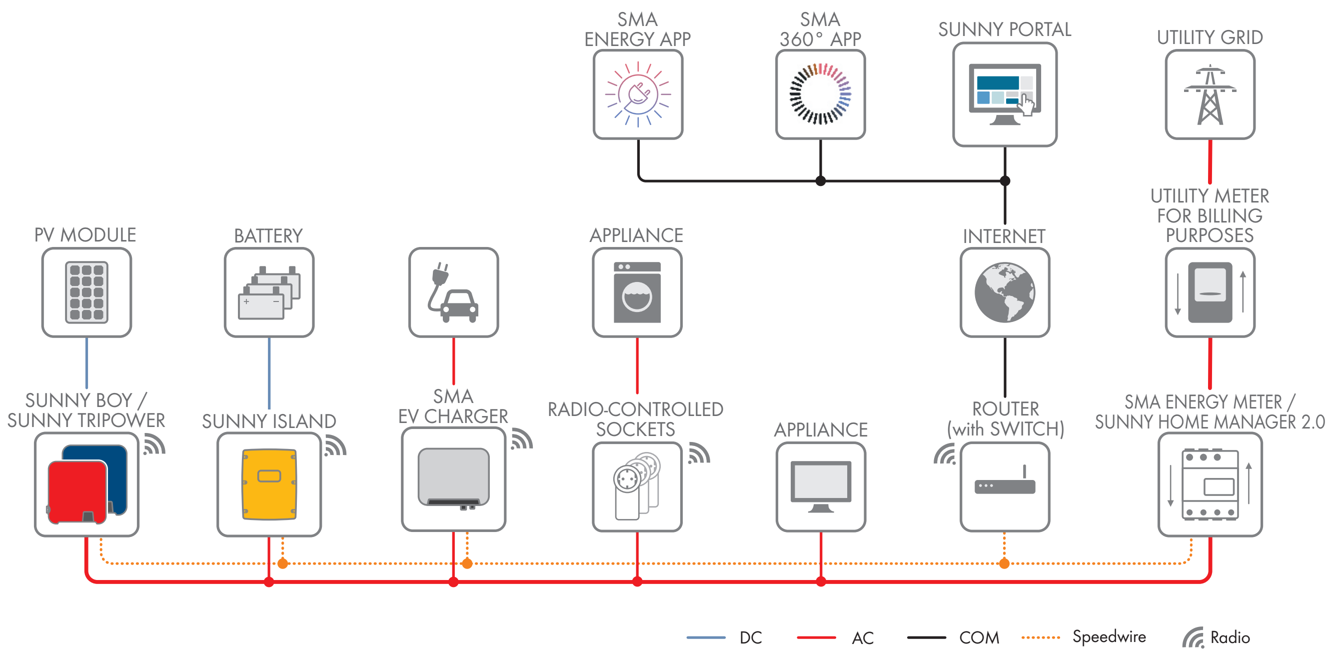


Figure 6: PV system with SMA storage system with Sunny Island (example)

At the core of the SMA Energy System Home with Sunny Island is the Sunny Island. It can use different low-voltage batteries with different battery capacities and thus, with regard to system design, offers great flexibility. Also, in the SMA storage system, different SMA PV inverters can be used.

With a high-voltage battery and the SMA Energy Meter, the Sunny Island becomes an SMA Energy System Home. The SMA Energy Meter can also be optionally replaced by the Sunny Home Manager. By using the Sunny Home Manager, the integration of EV chargers (with forecast-based charging), heat pumps and other controllable loads becomes possible.

When using the Sunny Island inverter, the SMA Energy System Home can be set up as single-phase and three-phase and can be extended with a battery-backup function. The SMA Energy System Home with battery-backup function supplies the loads with electric current in the event of a grid failure and also forms a battery-backup grid (see the Planning Guidelines "SMA Energy System Home with Battery Backup Function" at www.SMA-Solar.com).

The SMA Energy System Home with Sunny Island offers the functions listed in the following table depending on the expansion stage.

Functions	Sunny Island[1]	Sunny Island with Sunny Home Manager	Sunny Island with Sunny Home Manager and additional energy meter
Visualization of PV system data in Sunny Portal (see Section 4.1.2, page 17)	✓	✓	✓
Intelligent load control (see Section 4.1, page 17)	-	✓	✓
Dynamic active power limitation (see Section 4.2.1, page 21)	✓	✓	-
Forecast-based charging (see Section 4.2.2, page 21)	-	✓	✓
Zero export (see Section 4.3.2, page 27)	✓	✓	-
Automatic unbalanced load limitation (see Section 4.3.3, page 28)	✓	✓	✓
Cumulative power control at the point of interconnection (see Section 4.3.4, page 30)	✓	✓	✓
Access to grid management services via Modbus interface, e.g. for active power limitation by the grid operator	✓	✓	✓[2]
Support for PV inverters by third-party providers (see Section 6.2.2, page 44)	-	-	✓[2]

[1] To be able to only use the Sunny Island for increased self-consumption, only the device types SI4.4-M12, SI4.4-M13, SI6.0H-12, SI6.0H-13, SI8.0H-12 and SI8.0H-13 may be used. In this case, an SMA Energy Meter must be used for recording measured values.

[2] When using PV inverters from third-party providers, it must be ensured that the grid operator can access the required grid management services via the interfaces or user interfaces of the third-party provider.

✓ Can be utilized – Can not be utilized

SMA Energy System Home with Sunny Boy Storage

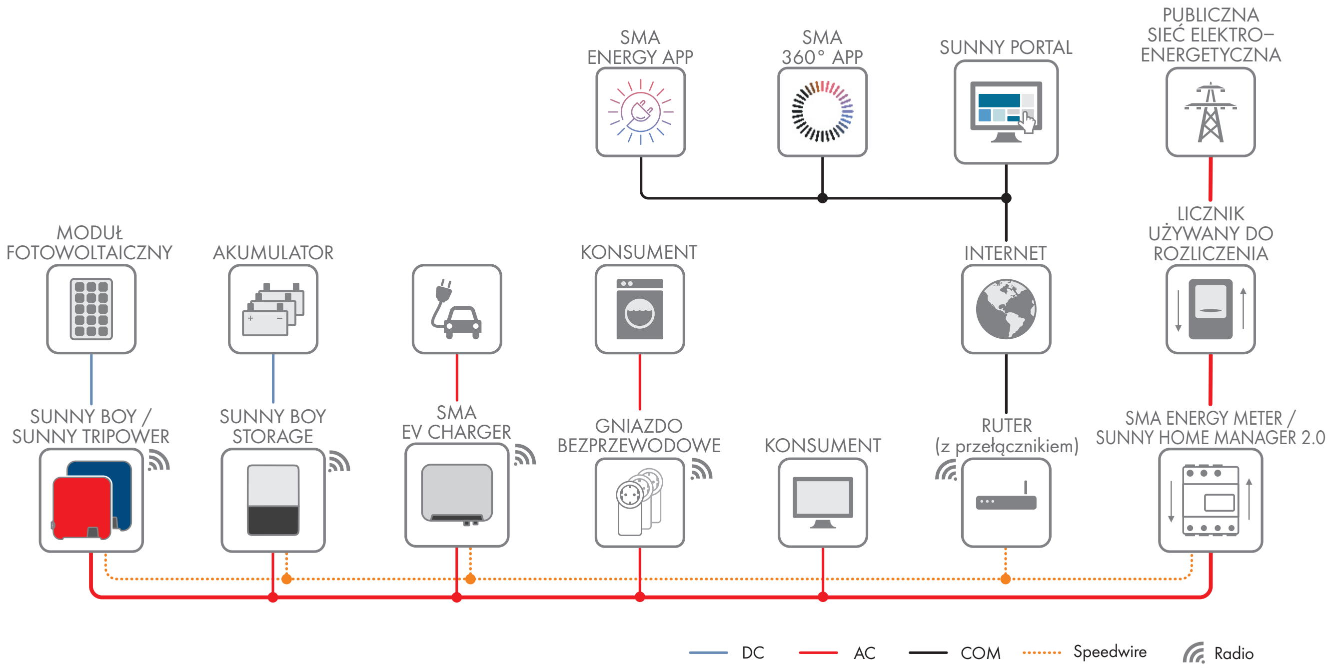


Figure 7: PV system with SMA Energy System Home with Sunny Boy Storage (example)

At the core of the SMA Energy System Home with Sunny Boy Storage is the Sunny Boy Storage 2.5 / 3.7 / 5.0 / 6.0. The Sunny Boy Storage is a single-phase, AC coupled battery inverter for parallel grid operation. By default, the Sunny Boy Storage 3.7-6.0 has an integrated emergency power function and, together with a backup-box, can optionally form a battery-backup system.

The Sunny Boy Storage converts the direct current supplied by a battery into grid-compliant alternating current. With a high-voltage battery and the SMA Energy Meter, the Sunny Boy Storage becomes an SMA Energy System Home.

The SMA Energy Meter can also be optionally replaced by the Sunny Home Manager. By using the Sunny Home Manager, the integration of EV chargers (with forecast-based charging), heat pumps and other controllable loads becomes possible.

The SMA Energy System Home with Sunny Boy Storage offers the functions listed in the following table depending on the expansion stage.

Functions	Sunny Boy Storage[3]	Sunny Boy Storage with Sunny Home Manager	Sunny Boy Storage with Sunny Home Manager and additional energy meter for PV production
Visualization of PV system data in Sunny Portal (see Section 4.1.2, page 17)	✓	✓	✓
Intelligent load control (see Section 4.1, page 17)	-	✓	✓

[3] The use of an SMA Energy Meter is recommended for recording measured values.

Functions	Sunny Boy Storage[3]	Sunny Boy Storage with Sunny Home Manager	Sunny Boy Storage with Sunny Home Manager and additional energy meter for PV production
Dynamic active power limitation (see Section 4.2.1, page 21)	✓	✓	-
Forecast-based charging (see Section 4.2.2, page 21)	-	✓	✓
Zero export (see Section 4.3.2, page 27)	✓	✓	-
Automatic unbalanced load limitation (see Section 4.3.3, page 28)	✓	✓	✓
Cumulative power control at the point of interconnection (see Section 4.3.4, page 30)	✓	✓	✓
Access to grid management services via Modbus interface, e.g. for active power limitation by the grid operator	✓	✓	✓[2]
Support for PV inverters by third-party providers (see Section 6.2.2, page 44)	-	-	✓[2]

✓ Can be utilized – Can not be utilized

SMA Energy System Home with Sunny Tripower Smart Energy

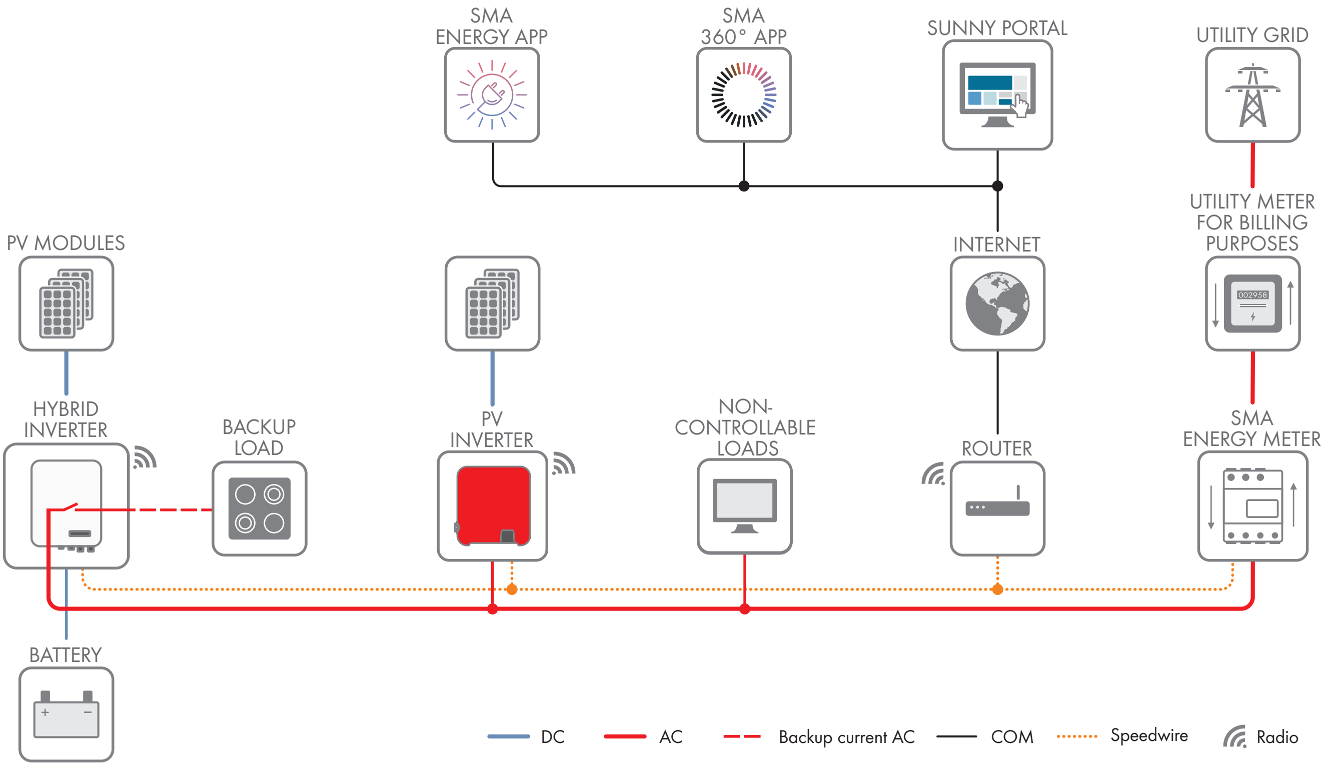


Figure 8: PV system with SMA Energy System Home with Sunny Tripower Smart Energy (example basic system)

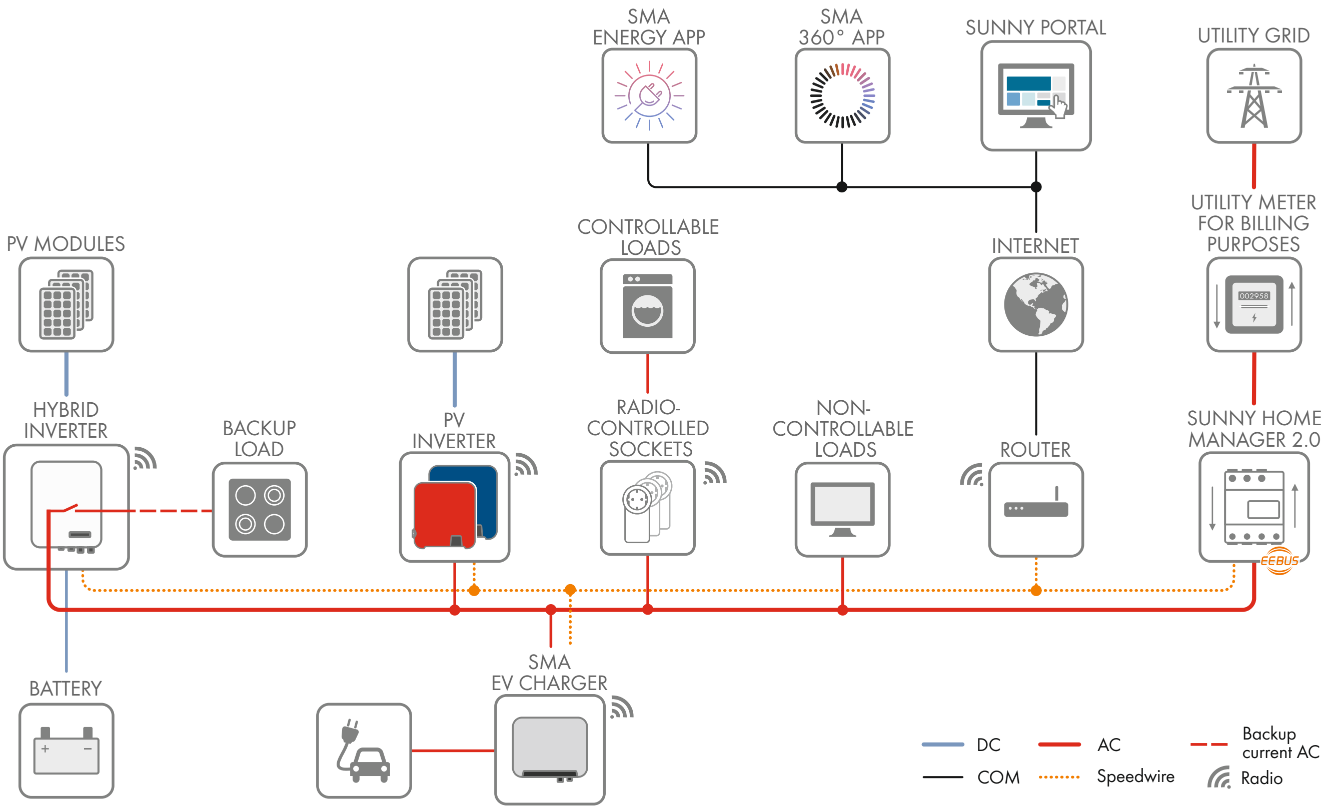


Figure 9: PV system with SMA Energy System Home with Sunny Tripower Smart Energy (example advanced system)

The most important part of the SMA Energy System Home with the Sunny Tripower Smart Energy is the Sunny Tripower 5.0 / 6.0 / 8.0 / 10.0 Smart Energy. The Sunny Tripower Smart Energy is a three-phase hybrid inverter which can convert both direct current into alternating current and alternating current into direct current. Thus, the current generated by the PV system can be fed into the household grid and the battery charged both on the DC side and AC side. The basic system consists of a Sunny Tripower Smart Energy, a high-voltage battery and an energy meter. In an extended system, the energy meter is replaced by a Sunny Home Manager.

The system can be extended by additional SMA PV inverters whose excess energy can be intermediately stored in the battery (see presentation in the extended system) through the AC-side charging of the Sunny Tripower Smart Energy. By using the Sunny Home Manager, the integration of EV chargers (with forecast-based charging), heat pumps and other controllable loads becomes possible. The Sunny Tripower Smart Energy has an integrated battery-backup function to which selected single- and three-phase loads can be connected. In the event of a grid failure, the integrated contactor automatically disconnects these at all poles from the utility grid and supplies them with electric current (see "SMA Energy System Home with Battery-Backup Function" at www.SMA-Solar.com).

Functions	**Sunny Tripower Smart Energy with SMA Energy Meter**	**Advanced system with Sunny Home Manager**
Visualization of PV system data in Sunny Portal (see Section 4.1.2, page 17)	✓	✓
Intelligent load control (see Section 4.1, page 17)	-	✓
Dynamic active power limitation (see Section 4.2.1, page 21)	✓[4]	✓
Forecast-based charging (see Section 4.2.2, page 21)	-	✓
Zero export (see Section 4.3.2, page 27)	✓	✓
Access to grid management services via Modbus interface, e.g. for active power limitation by the grid operator	✓	✓
Support for PV inverters by third-party providers (see Section 6.2.2, page 44)	-	-

✓ Can be utilized – Can not be utilized

[4] Only applies to one Sunny Tripower Smart Energy. A Sunny Home Manager is necessary for several PV inverters.

4 Functions for Energy Management Systems

4.1 Load Control

4.1.1 Energy Monitoring - Measuring and Understanding Energy Flows

The household makes use of electrical energy in different ways. To enable effective energy management, therefore, it is necessary to understand in detail the energy flows in the household.

In an SMA Smart Home, energy consumption can be measured at various points:

- The integrated measuring device of the Sunny Home Manager or the SMA Energy Meter at the point of interconnection provides the electrical measured values for PV generation, for grid feed-in, and for grid-supplied power as a cumulative value across the line conductors for the entire household.
- Using the available radio-controlled sockets, the Sunny Home Manager can individually measure and monitor the energy consumption of specific loads. The more loads that are monitored in this way, the more complete is the energy consumption data basis of the household.

The Sunny Home Manager collects all the information on the energy flows and makes it available for evaluation via Sunny Portal in various diagram displays.

The information can be used to answer the following questions, for example:

- What is the energy consumption of the household?
- How much energy is supplied by the PV system?
- How much energy is required by selected loads?
- How often and for how long are these loads in operation?

Answering these questions will enable you to analyze and understand the energy flows in the household, e.g.:

- Which loads require the most energy?
- Which loads possibly require too much energy and should be replaced by more energy-efficient models?
- Which usage habits for loads should possibly be changed in order to use PV energy more effectively?
- What effect would switching to a different electricity tariff have on the energy costs?

Using this knowledge, energy management measures can be defined. These measures can lead to savings in energy costs and also help to protect the environment. For automatic load control, these findings provide guidelines on when it is most efficient to switch on certain loads.

4.1.2 Visualization of PV System Data in Sunny Portal

Sunny Portal offers various functions for visualizing and controlling the energy flows in the household:

- By way of the **Energy balance** page in Sunny Portal, an overview of the energy consumption in the house, energy generation by the PV system and the feeding in of excess PV energy into the utility grid is available at all times. The charging and discharging of any available battery is also visualized. Depending on the time period selected, values from the past can also be displayed.

  As a result of the forecasts determined for PV generation and consumption, information on manual load control is provided which can increase self-consumption.
- The page **Load balance and control** shows the energy consumption, energy mix and the time of operation for selected loads. You can select various time periods and views in the overview.
- Selected loads can be time-controlled in such a way that primarily PV energy is consumed or energy is allocated at optimum cost. As a result of the PV generation forecast available and the consumption behavior experienced, an optimum increase in self-consumption can be achieved (see Section 4.1.3, page 18).
- System status information can be used to monitor the proper operation of the PV system.

4.1.3 Components and Mode of Operation of Load Control

Components of Load Control

In the SMA Energy System Home, radio-controlled sockets can be used to control home appliances and they enable optimization of energy consumption and the self-consumption quota through load shifting. The radio-controlled sockets also measure the power consumption of the connected loads and thus enable energy monitoring.

As an adapter for a load, a radio-controlled socket can switch on the power supply or interrupt it. It also measures the power that the load requires for operation.

Compatible radio-controlled sockets for the SMA Smart Home can be found in the Technical Information "SMA SMART HOME - Compatibility List for Loads" at www.SMA-Solar.com.

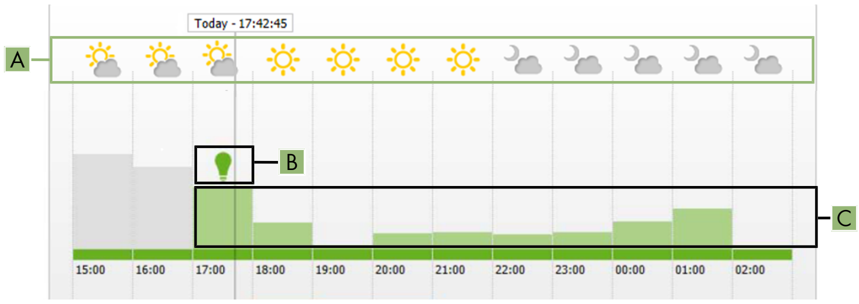
Mode of operation of load control

Using various displays and settings in the system pages of Sunny Portal, you can display current information, e.g. status information, energy balances, and forecasts for PV generation and for specific electrical consumption in the household. From these, the Sunny Home Manager derives action recommendations and uses these recommendations to control the loads.

<table>
<tr><th>Function</th><th>Explanation</th></tr>
<tr><td>Creation of a PV yield forecast</td><td>
The Sunny Home Manager continuously logs the energy generated by the PV system. The Sunny Home Manager also receives location-based weather forecasts via the Internet. Based on this information, the Sunny Home Manager creates a PV yield forecast for the PV system.

To query forecast information, you must fill in the following input fields on the System properties page in Sunny Portal:
• Longitude
• Latitude
• Nominal system power

If one of the three entries is missing, either the weather symbols are not displayed, the power forecast is not present, or it is incorrect.



If the forecast information is set correctly in Sunny Portal, the hourly weather symbols (A) are displayed on the page Current Status and Forecast.

The power forecast for each hour of the forecast time period is shown as a green bar (C). If the mouse pointer is moved over these bars, numerical values are displayed.

The green light bulbs (B) above the bars refer to time periods in which, according to the power forecast, there will be a high proportion of surplus PV energy which could be consumed effectively by manual switching on of a load. In this way, by manual switching of loads (e.g. vacuum cleaning if there is a lot of sunshine in the afternoon), it is possible to actively increase the self-consumption of PV energy.
</td></tr>
</table>

Function	Explanation
Creation of a load profile	The Sunny Home Manager logs data on PV generation, grid feed-in and purchased electricity. Based on PV generation, grid feed-in and purchased electricity, the Sunny Home Manager determines how much energy is typically consumed at certain times and uses this to create a load profile for the household. This load profile can be different for each day of the week. The Sunny Home Manger receives the measured data for PV generation, grid feed-in and grid-supplied power via the installed or integrated energy meters (SMA Energy Meter). The measured data can also be transmitted directly from the inverters via the data connection.
Configuration and system monitoring via Sunny Portal	Sunny Portal serves as the user interface of the Sunny Home Manager. The Sunny Home Manager establishes the Internet connection to Sunny Portal via a router and sends the read-out data to Sunny Portal. The user can make all the required settings for the Sunny Home Manager system via Sunny Portal. You can call up data on energy consumption and generation and also forecasts and information on energy use via diagrams and tables. In addition, basic PV system monitoring is also possible via Sunny Portal.
Load control via radio-controlled sockets	Specific loads connected to radio-controlled sockets can be switched on and off by the Sunny Home Manager. The Sunny Home Manager uses the generation forecast and the load profile to determine favorable time periods for optimization of internal power supply and self-consumption. In accordance with the PV system operator's specifications and taking the determined time periods into account, the Sunny Home Manager controls the switching on and off of the loads automatically. Furthermore, radio-controlled sockets provide the option of individually monitoring and recording the energy consumption of loads.
Preventing Derating Losses	The Sunny Home Manager can also use intelligent energy management to ensure that loads in the household are switched on at precisely those times when so much PV energy is available that the feed-in limits prescribed in certain countries and grid areas would be exceeded. If switching on a load means that more power is consumed directly in the household, then the PV generation must not be reduced by as much or must not be reduced at all. When used with SMA battery inverters, the intermediate storage can be used additionally to prevent derating losses. Taking the PV generation forecast and the consumption forecast into account, the timing and duration of battery charging are controlled automatically and the battery charge is optimized according to the available energy supply, if excess PV energy cannot otherwise be used and would be lost.

4.1.4 Application Examples

The following application examples of load control in SMA Smart Home are available in the download area of the Sunny Home Manager at www.SMA-Solar.com:

- "SMA SMART HOME - Load Control via MUST Time Period - Example: Washing Machine"
- "SMA SMART HOME - Load Control via CAN Time Period - Example: Pool Pump"
- "SMA SMART HOME Load Control Using Relays or Contactors - Example: Heating Rod"
- "SMA SMART HOME - Energy Management with Loads via EEBUS"
- "SMA SMART HOME - Battery Charging Management with Time-of-Use Energy Tariffs"

4.1.5 Distinguishing Between Self-Consumption Systems and Feed-In Systems in SMA Smart Home

In the system properties in Sunny Portal, you can set the system type for the relevant system. There are two system types:

- Self-consumption system
- Feed-in system

Self-consumption system

The objective in a self-consumption system is to consume as much of the generated PV energy oneself as possible. This works best if the loads in the household are switched on whenever the sun is shining and the PV system is generating a lot of electricity.

The Sunny Home Manager uses its intelligent energy management to ensure that the controllable loads are switched on automatically when there is sufficient PV energy available.

Self-consumption systems are attractive whenever the feed-in tariff for PV energy is significantly below the purchase cost of grid current. Therefore, high self-consumption contributes to lowering the energy costs.

The energy meters must be installed in such a way that the household loads can consume the PV energy before the feed-in or grid-connection point. Then only the surplus PV energy is fed into the utility grid.

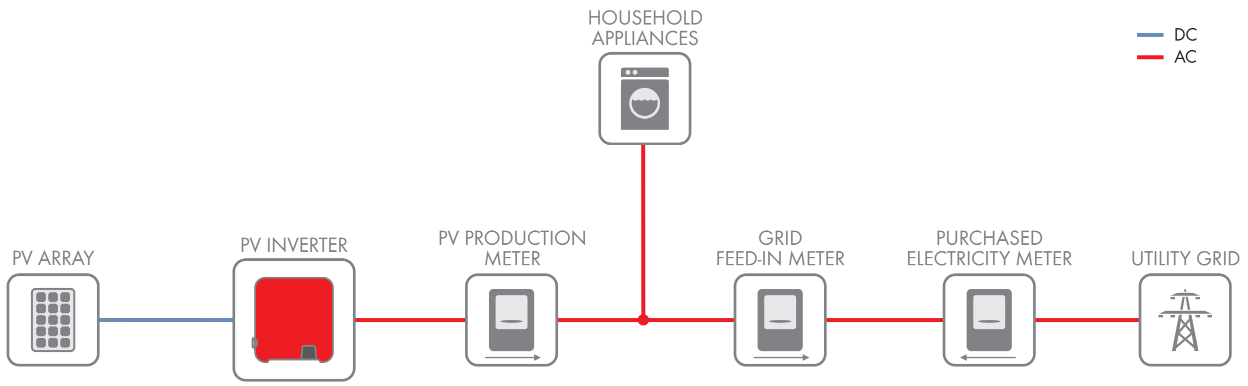


Figure 10: Energy meter installation in a self-consumption system (example)

Feed-in system

The objective of a feed-in system is to feed all the generated PV energy into the utility grid in order to receive the relevant feed-in tariff.

Feeding in of generated PV energy is attractive whenever the feed-in tariff is significantly above the purchase cost of grid current. In this case, the grid feed-in of PV energy is an attractive source of income for the PV system operator. Energy management for such systems is of limited value.

The energy meter must be installed in such a way that the household loads do not consume the PV energy directly:

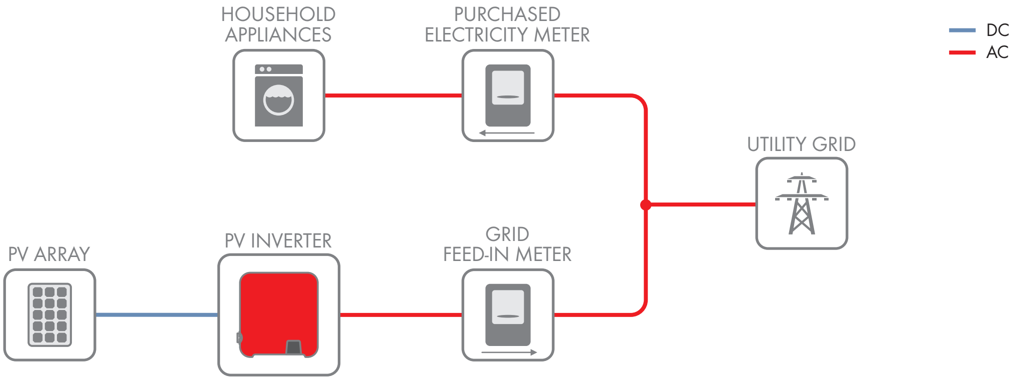


Figure 11: Energy meter installation in a feed-in system (example)

Restriction with feed-in systems with Sunny Home Manager

In feed-in systems with Sunny Home Manager, you cannot configure a CAN time period in Sunny Portal for load control.

4.2 Dynamic Limitation of Active Power Feed-In to Avoid Derating Losses

4.2.1 General information regarding the limitation of active power feed-in

In addition to the dynamic limitation of PV generation, the Sunny Home Manager can also use intelligent energy management to ensure that loads in the household are switched on at precisely those times when so much PV energy is available that the feed-in limit would be exceeded. If switching on a load means that more power is consumed directly in the household, then the PV generation must not be reduced by as much or must not be reduced at all.

Limitation of the active power feed-in to 70% of the nominal PV system power

Due to high levels of solar irradiation, the system (system size: 10 kWp / feed-in limit: 7 kW) can currently produce 90% of the nominal PV system power.

- 20% of the nominal PV system power is currently being consumed by loads in the household. The remaining amount of 70% of the nominal PV system power is being fed into the utility grid.
  No limitation of PV generation is required.
- A load is switched off and only 10% of the nominal PV system power is consumed in the household. As a result, 80% of the nominal system power is available for feed-in to the utility grid – more than allowed.
  The Sunny Home Manager reduces PV generation from the theoretically possible 90% of nominal PV system power to 80%. 70% of the nominal PV system power continues to be fed into the utility grid.

The Sunny Home Manager can be used alone or as part of a storage solution for limitation of active power feed-in.

From firmware version 1.13.xx.R, the Sunny Home Manager enables the limitation of active power feed-in to 0% or 0 W. This "Zero Export" mode can also be used for storage solutions (see Section 4.3.2, page 27).

4.2.2 Avoiding Derating Losses Through Forecast-Based Battery Charging in SMA Storage Solutions

On days with strong sunshine around noon, a large portion of the available PV power may have to be derated to limit the active power feed-in due to local requirements. The Sunny Home Manager energy management already ensures that, especially on such days the controllable loads in the household are switched on exactly at those times in order to consume the energy that would otherwise be derated.

In addition, the energy from the noon peak can also be stored in the battery of the battery inverter. This is particularly effective since the stored energy can then be used when required at a later time.

Surplus of generated PV energy

Battery inverters draw power to charge the battery from a surplus of generated PV energy. This means that, before PV energy is fed into the utility grid, the system first attempts to use the energy to charge the battery. On days with strong sunshine, there may be a surplus of PV energy in the morning and the battery may even be fully charged before the noon peak. In this case, limitation of the PV feed-in is necessary at noon as the battery can no longer use the surplus PV energy.

This curtailment is avoided during forecast-based battery charging. Based on a PV power generation forecast and load planning, it is being forecast whether derating losses are expected at noon of the following day due to the limitation of PV feed-in. Already in the afternoon of the current day or in the morning of the next day, only the amount of energy is fed into the battery to absorb the forecast derating losses with the remaining battery capacity. This way, sufficient battery capacity will remain for the noon period so that the energy, which would otherwise be derated, can be charged to the battery. As a result, more PV energy is used and the electricity consumption is reduced due to the load shift.

SMA Energy System Home with Sunny Island, Sunny Boy Storage or Sunny Tripower Smart Energy

In Sunny Portal, in the device properties of the Sunny Home Manager, you can activate the optimized storage management for the Sunny Island, Sunny Boy Storage or the Sunny Tripower Smart Energy. This setting is deactivated by default. When the forecast-based battery charging is activated, the Sunny Home Manager can ensure a forecast-based battery charge through triggering of the battery inverter or hybrid inverter (see Section 4.2.3, page 26).

Together with the Sunny Home Manager, an inverter-internal generated forecast regarding a probable curtailment during the noon peak brings about delayed charging of the battery during the morning. If the active power feed-in limitation is set to 100%, this optimization is practically deactivated.

Examples of power control with the SMA Energy System Home with storage solution

Below, the power control of the SMA Energy System Home with the Sunny Tripower Smart Energy is illustrated by way of examples from Sunny Portal.

Example 1: Avoiding derating losses through forecast-dependent charging

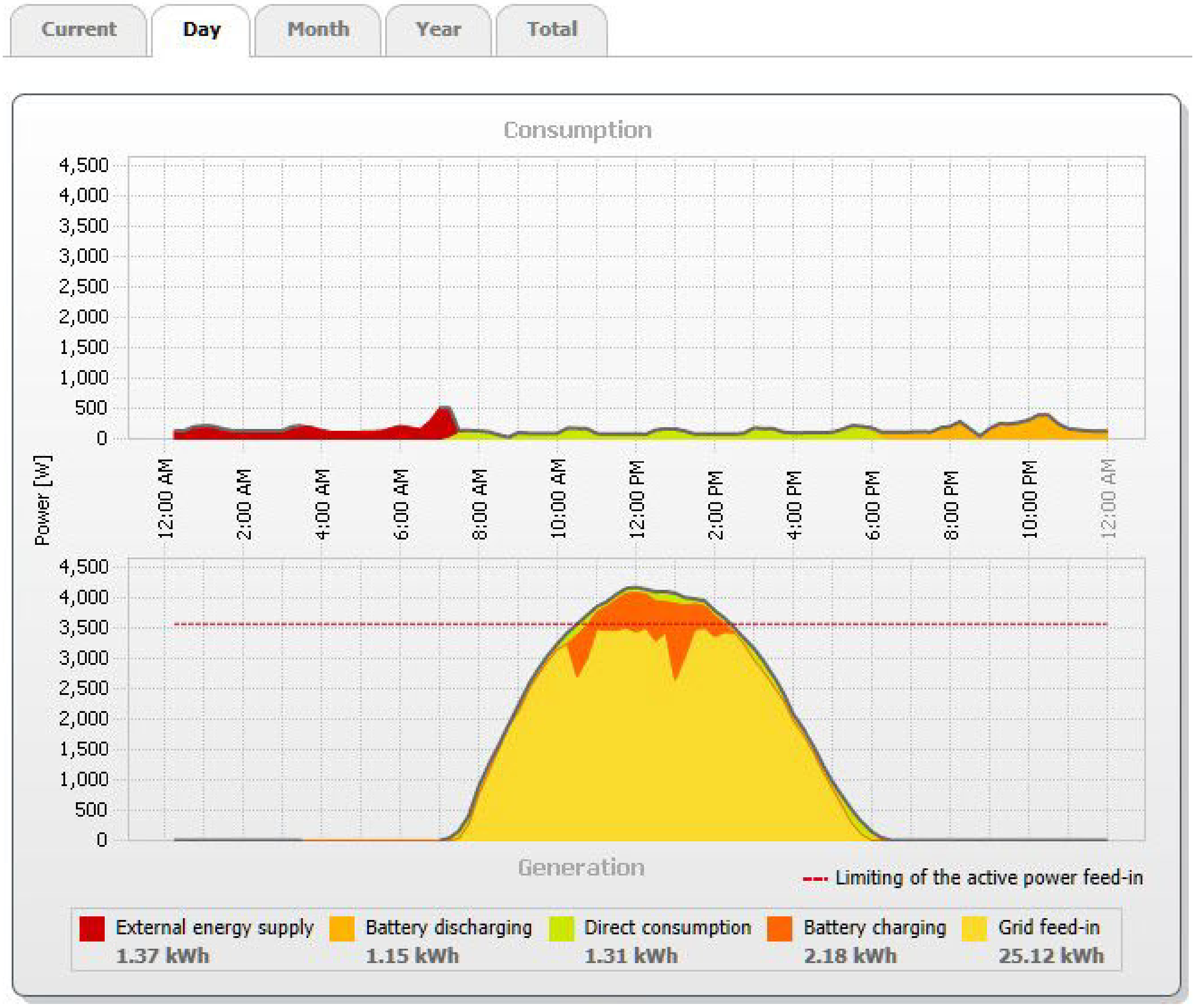


Figure 12: Consideration of PV generation and consumption in Sunny Portal (example 1)

The current daily forecast of the system predicts a limitation of active power feed-in around noon when the energy requirement of the loads is very low and PV production is high. For this reason, derating losses can be expected.

According to this forecast, the system only begins to charge the battery in the late morning. The derating losses are almost completely avoided through battery charging.

Example 2: Avoiding derating losses through direct consumption and battery charging

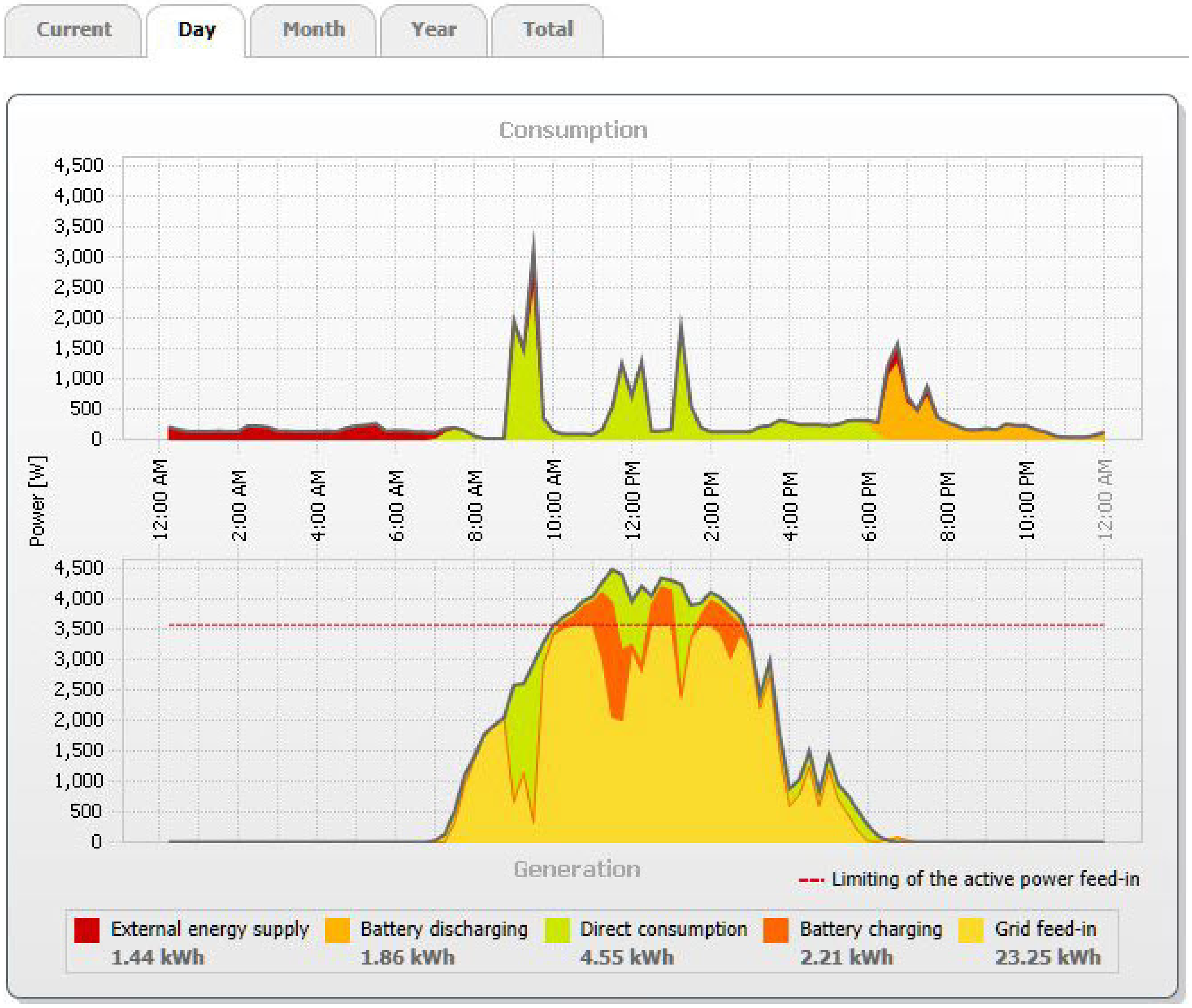


Figure 13: Consideration of PV generation and consumption in Sunny Portal (example 2)

As in example 1, the current daily forecast anticipates limitation of the active power feed-in around noon. In this case, however, the loads have a slightly higher energy demand. To avoid derating losses, therefore, the SMA storage system schedules direct consumption and intermediate storage for the midday period.

According to its forecast, the system only begins to charge the battery in the late morning. The derating losses are avoided through direct consumption and battery charging.

Example 3: Avoiding derating losses through direct consumption

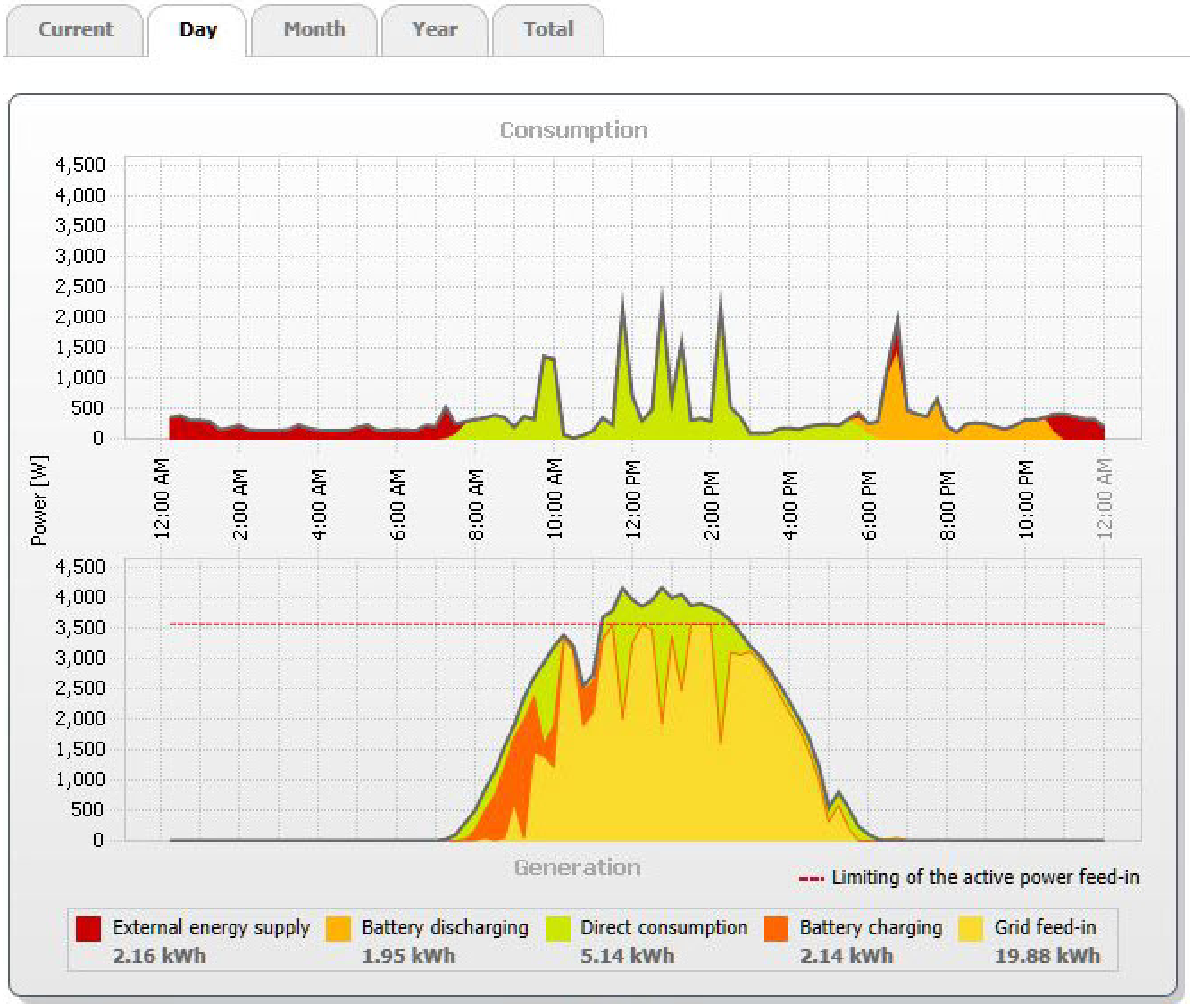


Figure 14: Consideration of PV generation and consumption in Sunny Portal (example 3)

As in examples 1 and 2, the current daily forecast anticipates limitation of the active power feed-in around noon. In this case, however, the loads have a much higher energy demand. The expected derating losses are therefore avoided completely through direct consumption.

The system, therefore, fully charges the battery during the morning and, in this example, avoids derating losses exclusively through direct consumption, for example, through intelligent load control.

Example 4: No forecast for derating losses

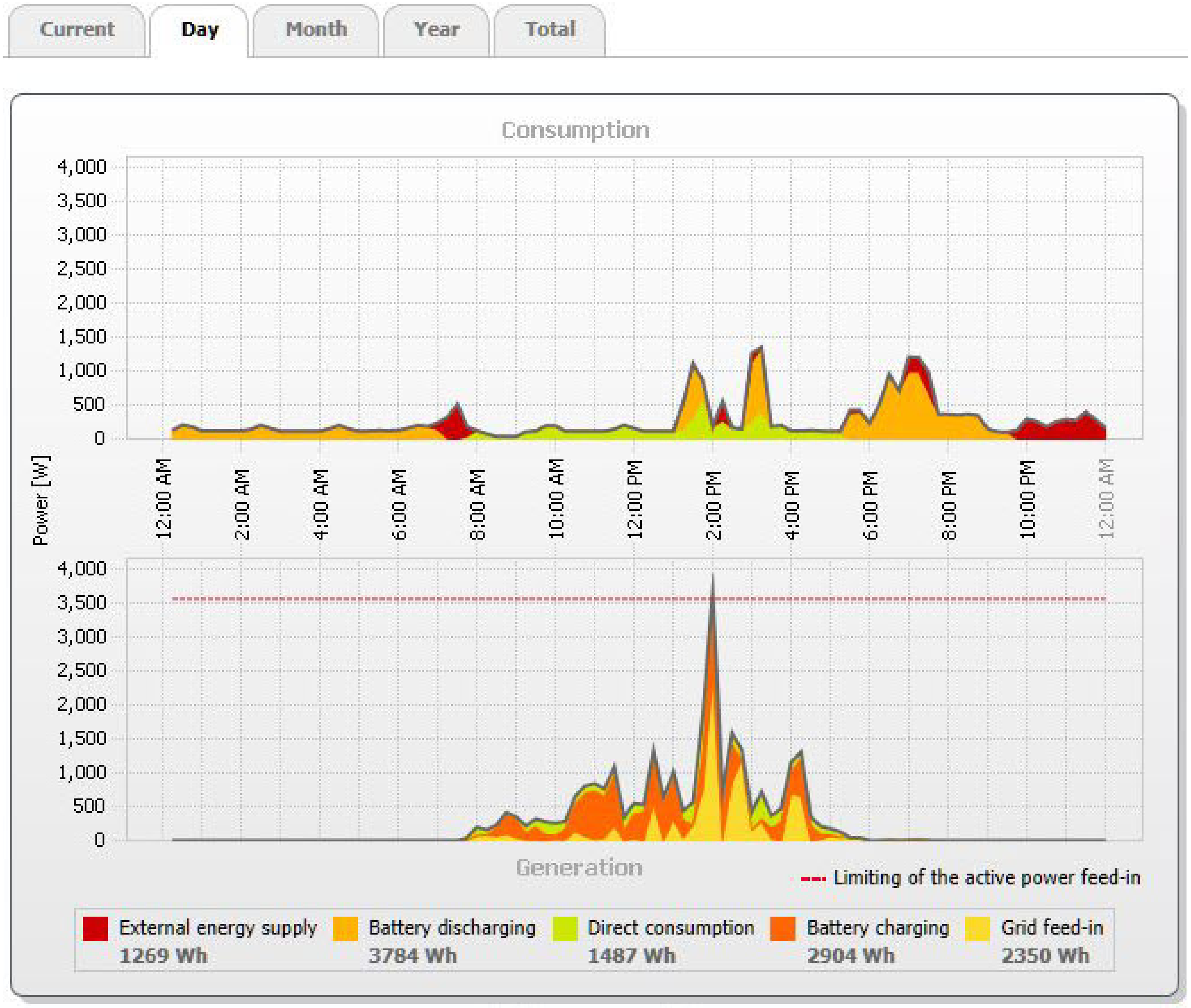


Figure 15: Consideration of PV generation and consumption in Sunny Portal (example 4)

If no limitation of active power feed-in is forecast for the current day, the SMA Integrated Storage System works in accordance with the general power control (see Section 4.3.1, page 27).

4.2.3 Example of Avoiding Derating Losses with Forecast-Based Battery Charging

With the SMA Energy System Home, you can choose between an economically optimized mode of operation (activation of the forecast-based battery charging) and an optimized mode of operation with regard to the self-sufficiency (no activation of the forecast-based battery charging).

The advantages and disadvantages of forecast-based battery charging using an example are considered in this Section. We assume a limitation of the feed-in power of 60%.

Input data:

- Peak power of the PV system: 5000 Wp
- Annual energy demand: 5000 kWh
- Total battery capacity: 10000 Wh, of which the Sunny Island uses 50% for intermediate storage of the PV energy.

The usable battery capacity therefore amounts to 5000 Wh.

The following figure illustrates the percentage derating losses with and without forecast-based battery charging:

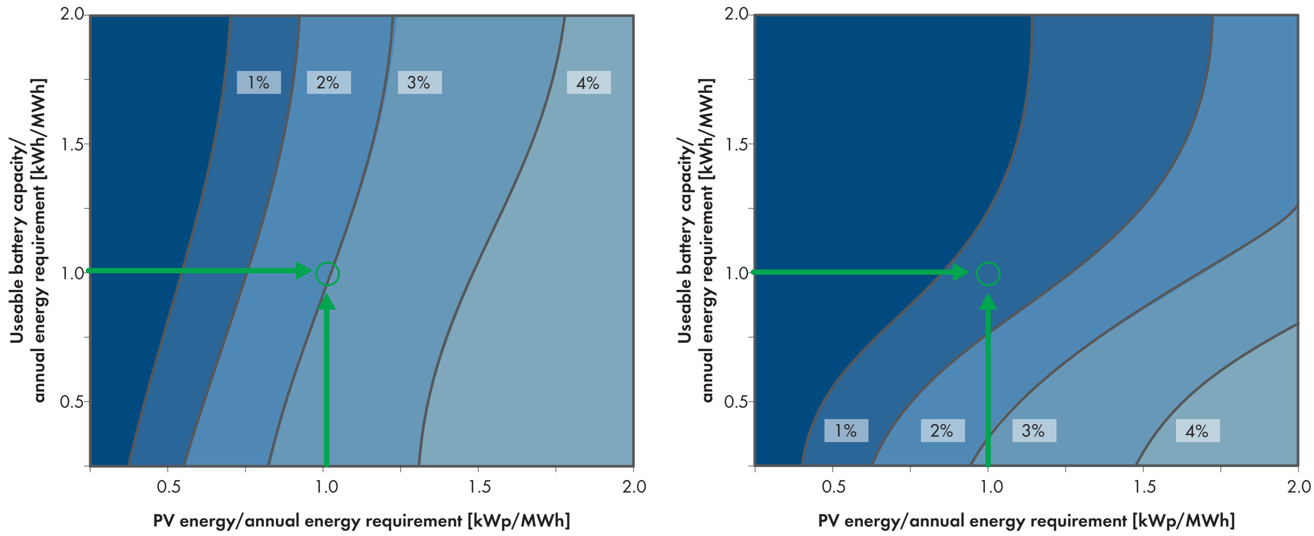


Figure 16: Annual percentage losses based on the PV generation with limitation of grid feed-in to 60% – without (A) and with (B) forecast-based battery charging

If we assume a PV generation of 4500 kWh per year for a PV system with a power of 5 kWp, we see the following results:

- With fixed active power feed-in limitation, 315 kWh of the generated PV energy is derated – this equals 7% of 4500 kWh (the value of 7% applies for all configurations)
- Without forecast-based battery charging, 135 kWh of the generated PV energy is derated - this equals 3% of 4500 kWh (see part A in the figure above)
- With forecast-based battery charging, only 67 kWh of the generated PV energy is derated - this equals 1.5% of 4500 kWh (see part B in the figure above)

Through forecast-based battery charging, we could thus intermediately store 68 kWh of PV energy (135 kWh – 67 kWh) in the battery and use it to supply the household instead of having it derated. By shifting the charging operation from morning to noon, the PV system could also feed in more during the morning.

Conclusion:

If we compare the options with and without forecast-based battery charging, the forecast-based battery charging results in a positive financial effect in most cases. However, it is possible that the forecasts are not correct. As a result, the battery may be used less which can lead to lower self-sufficiency quotas.

4.3 Power Control at the Grid-Connection Point

4.3.1 General Power Control

In the interests of the highest possible internal power supply and the highest possible self-consumption, the power control at the grid-connection point has the following objectives:

- Before the PV system feeds into the utility grid, this electrical energy should be consumed directly or stored intermediately in a battery.
- Before the loads draw energy from the utility grid, this energy should be provided by the PV system or by discharging the battery.

The energy management system achieves these objectives taking the forecast for PV generation and electricity consumption for the current day into account.

4.3.2 Limitation of Active Power Feed-In to 0% or 0 W

Some grid operators permit connection of PV systems only on condition that no active power is fed into the utility grid. The PV energy is therefore consumed exclusively at the place where it is generated.

During the limitation of active power feed-in to 0% or 0 W, it must be ensured that the active power currently generated by the PV inverters is controlled in such a way that it equals the power currently being consumed in the household. If, in this situation, an active load in the household is switched off, the inevitable active power feed-in will be reduced to a value less of than 2% of nominal PV system power within a reaction time of 1.5 to 2.5 seconds. This means that PV systems can be created with 100% self-consumption.

The following products enable the limitation of the active power feed-in to 0% or 0 :

- Sunny Home Manager from firmware version 1.11.4.R

  From firmware version 1.13.X.R of the Sunny Home Manager, battery inverters are fully supported.
- Sunny Boy Storage 2.5 from firmware version 02.02.01.R
- Sunny Boy Storage 3.7 / 5.0 / 6.0
- Sunny Island of the device type SI4.4M-12 / SI6.0H-12 / SI8.0H-12 / SI4.4M-13 / SI6.0H-13 / SI8.0H-13
- Sunny Tripower 5.0 / 6.0 / 8.0 / 10.0 Smart Energy

For that, the following requirements must be met when installing the PV system:

- In the event of an interruption of the communication for system control, the PV inverters must be capable of limiting their active power feed-in to a predefined value (see PV inverter documentation).
- A Sunny Home Manager 2.0 or an SMA Energy Meter must be used to measure grid purchase and grid feed-in power levels at the grid-connection point.
- Configuration of the active power limitation settings to 0% must be done by a qualified person.
- For proper and fast control, a time interval of 200 ms must be set in the SMA Energy Meter or Sunny Home Manager 2.0.

4.3.3 Avoiding Unbalanced Load

Requirements of the "VDE Forum Network Technology / Network Operations (FNN)"

When using an SMA Energy System Home in Germany, the requirements regarding symmetry and monitoring of feed-in power must be implemented in accordance with the Technical Information "Connecting and Operating Storage Units in Low Voltage Networks" published by the FNN. Current information and manufacturer declarations can be found at www.SMA-Solar.com in the download area. Requirements:

- In these systems, the single-phase battery inverter must be connected to the same line conductor supplied by a single-phase PV inverter. If there are only three-phase PV inverters connected, the battery inverter can be connected to any line conductor.
- Single-phase generating means, storage and charging devices must always be connected to a common line conductor. When connecting several charging stations, ensure that line conductor L1 is evenly distributed over the three line conductors.
- The requirements of the technical information "Connection and Operation of Storage Units in Low-Voltage Networks" published by the FNN influence the discharge behavior of the battery inverter. When using systems with one battery inverter and single-phase PV inverter, the feed-in power of all inverters (minus the power of the load) must not exceed 4.6 kVA per phase. That is why the SMA storage system reduces the maximum discharge power of the battery inverter as required.

Examples for the implementation

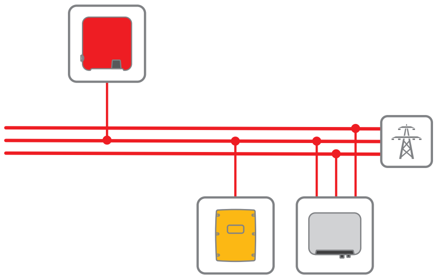
In the following illustrations, the Sunny Island is shown as an example for battery inverters. The Sunny Boy Storage must be connected according to the same principles.

Example 1:

All PV inverters are single-phase and are feeding in asymmetrically (Sunny Boy). The PV inverters are connected to one line conductor.

In these systems, the single-phase battery inverter must be connected to the same line conductor in which the PV inverters feed into.

The charging station (SMA EV Charger) must be connected with L1 to the same line conductor in which the PV inverters feed into.



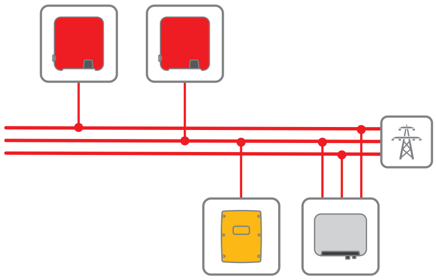
Example 2:

All PV inverters are single-phase and are feeding in asymmetrically (Sunny Boy).

PV inverters are connected to two line conductors.

The single-phase battery inverter must be connected to a line conductor via a single-phase PV inverter. TIP: Connect the battery inverter to the line conductor being supplied with the least PV energy. This will increase the control range for increased self-consumption.

The charging station must be connected with L1 to the same line conductor to which the battery inverter is connected.

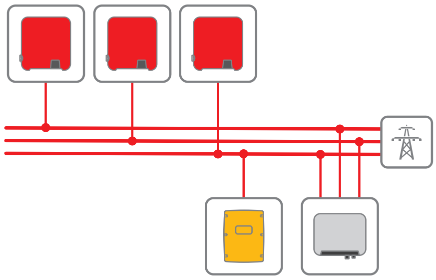


Example 3:

All PV inverters are single-phase and are feeding in asymmetrically (Sunny Boy). One PV inverter is connected to each line conductor.

The single-phase battery inverter can be connected to any line conductor. TIP: Connect the battery inverter to the line conductor being supplied with the least PV energy. This will increase the control range for increased self-consumption.

The charging station must be connected with L1 to the same line conductor to which the battery inverter is connected.

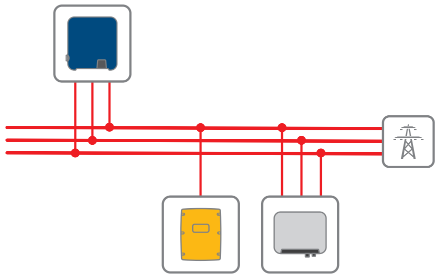


Example 4:

All PV inverters are three-phase and are feeding in symmetrically (Sunny Tripower).

The single-phase battery inverter can be connected to any line conductor.

The charging station must be connected with L1 to the same line conductor to which the battery inverter is connected.



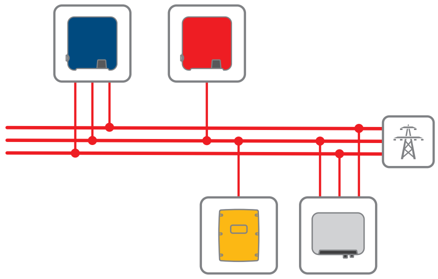
Example 5:

The PV system consists of three-phase PV inverters (Sunny Tripower) and single-phase PV inverters (Sunny Boy). The PV system is feeding in asymmetrically.

The single-phase battery inverter must be connected to a line conductor via a single-phase PV inverter.

IMPORTANT: The battery inverter can only discharge the battery if less than 4.6 kVA are being fed in on the line conductor of the battery inverter at the point of common coupling.

The charging station must be connected with L1 to the same line conductor in which the single-phase PV inverters feed into.



Using the Sunny Home Manager or SMA Energy Meter

For the single-phase SMA storage system to be able to monitor the limitation of the feed-in power, the Sunny Home Manager 2.0 or the SMA Energy Meter must be used. Only these two devices provide the phase-specific measured values of the feed-in power that are required for the limitation to 4.6 kVA.

The Sunny Home Manager 2.0 or the SMA Energy Meter must also be used for three-phase PV inverters in the single-phase or in the three-phase storage system since only these devices supply the measured values at the required level of breakdown.

4.3.4 Power Control in Accordance with the Summation Current Principle

If, with a three-phase grid connection, an SMA Energy System Home or a single-phase hybrid or battery inverter is installed, power control in accordance with the summation current principle also applies. The summation current principle must also be applied when the three-phase Sunny Tripower Smart Energy feeds in symmetrically since single-phase electrical appliances result in an asymmetrical power distribution on the line conductors.

Requirement: cumulative meter values

With a three-phase grid connection and a PV system with a single-phase inverter, only those loads that are connected to the same line conductor are physically supplied with self-generated solar power. The excess current, which these loads do not require, is fed into the utility grid. At the same time, it can happen that electric current is required on one of the other two line conductors, which then has to be purchased from the utility grid. To minimize the complexity of billing, instead of using a phase-specific approach, a balance sheet approach is used for the energy flows. So-called cumulative meters offset the current fed into one line conductor against the other two line conductors. Phase powers taken from the utility grid are provided with a negative sign and phase powers fed into the utility grid are provided with a positive sign and then added up to form a total power. This ensures that electronic meters behave just as conventional Ferraris meters. In this way, all loads in the house can be supplied with self-generated solar power and only the difference between current generation and current consumption is fed into the utility grid or purchased. A cumulative meter value, however, does not permit any conclusion to be drawn about the power flows and directions of each individual line conductor.

The Sunny Home Manager 2.0 and the SMA Energy Meter supply balanced measured values. Installation must be downstream of the billing-relevant meter in the same power path.

$$P_{\text{total power}} = P_{\text{phase conductor 1}} + P_{\text{phase conductor 2}} + P_{\text{phase conductor 3}}$$

In an SMA Energy System Home, the battery or hybrid inverter is in charge of the intermediate storage over all three line conductors of the grid connection. For power control in accordance with the summation current principle, the storage system uses the cumulative values of the SMA Energy Meter or of the Sunny Home Manager 2.0 for grid feed-in and grid-supplied power. Depending on the grid operator's local requirements, the measurement interval of the SMA Energy Meter or the Sunny Home Manager 2.0 must be adjusted from 1000 ms to 200 ms.

Implementation of the summation current principle is explained below with the example of the SMA Energy System Home and three different situations.

Situation 1:

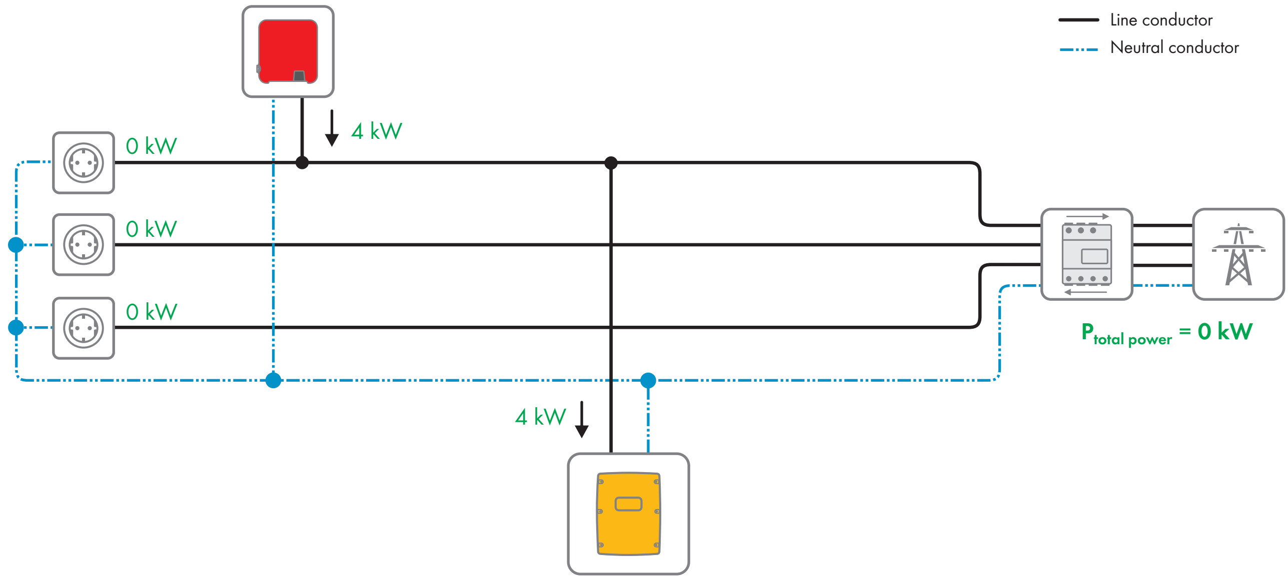


Figure 17: The battery inverter charges the battery.

It is early morning. At sunrise, the PV system begins to feed in and after a while reaches electric power of 4 kW. The loads are still switched off.

$$P_{\text{total power}} = 4\text{ kW} + 0\text{ kW} + 0\text{ kW} = 4\text{ kW}$$

First, the PV system feeds the total PV power into the utility grid via phase 1. The battery inverter recognizes the grid feed-in, switches on immediately and uses the PV power of 4 kW to charge the battery.

$$P_{\text{total power}} = 0\text{ kW} + 0\text{ kW} + 0\text{ kW} = 0\text{ kW}$$

Thus, no more cumulative power is fed into the utility grid.

Situation 2:

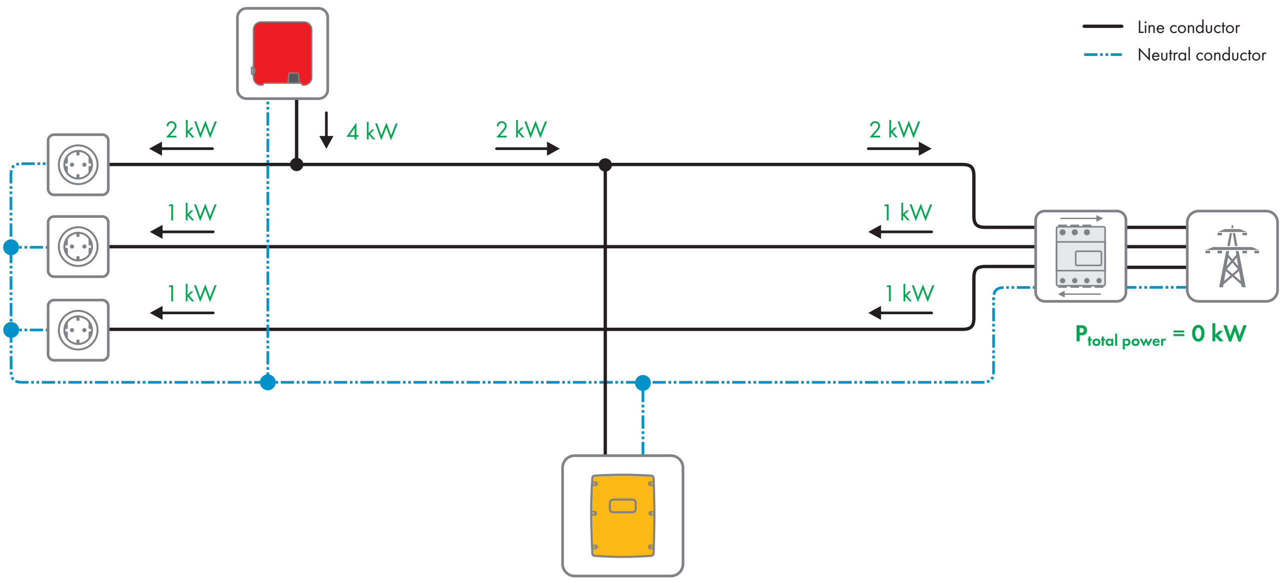


Figure 18: The loads are using the total PV power.

It is around noon. The battery is fully charged. The PV system provides 4 kW. The load on phase 1 uses the power generated by the PV system directly which, therefore, now only feeds 2 kW into the utility grid. The loads on line conductors 2 and 3 draw their power of 1 kw each from the utility grid.

The total power at the bidirectional meter for grid feed-in and purchased electricity is shown as follows:

$$P_{\text{total power}} = 2\text{ kW} - 1\text{ kW} - 1\text{ kW} = 0\text{ kW}$$

From a cumulative perspective, there is no grid feed-in and no purchase of electricity taking place. The battery inverter does not need to intervene and leaves the state of charge of the battery unchanged.

Situation 2a:

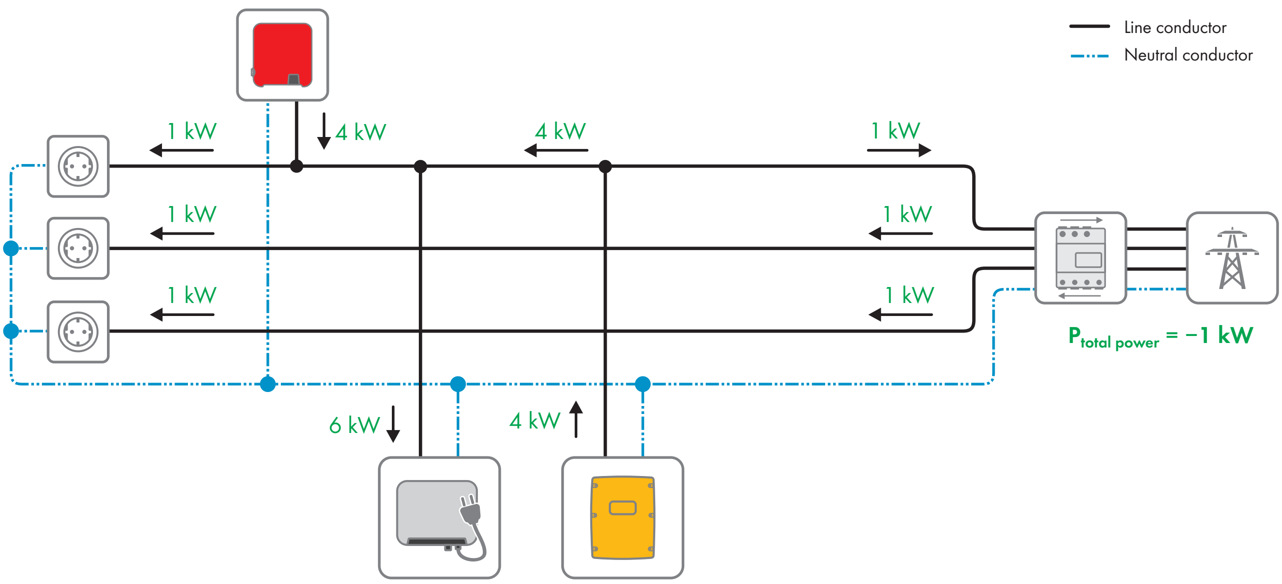


Figure 19: The SMA EV Charger uses the single-phase PV generation for faster charging of the electric vehicle (boost function).

It is afternoon. The battery is fully charged. The PV system provides 4 kW. The loads on line conductors L1, L2 and L3 draw 1 kW of electric power each. The charging station (SMA EV Charger) has an additional power requirement of 6 kW on line conductor L1. Thanks to the boost function of the SMA EV Charger, the power requirement of the charging station can be at least partially covered by the direct use of the electrical output of the PV system, while at the same time complying with the maximum unbalanced load limit required by the standard at the point of interconnection. The total power at the bidirectional meter for grid feed-in and purchased electricity is shown as follows:

$$P_{\text{total power}} = -3\text{ kW} + (-1\text{ kW}) + (-1\text{ kW}) = -5\text{ kW}$$

The utility grid is now the sole energy source for the loads and supplies them with 5 kW. The battery inverter detects the purchased electricity and consequently uses the energy from intermediate storage to supply the loads. The total power at the bidirectional meter for grid feed-in and purchased electricity is shown as follows:

$$P_{\text{total power}} = 1\text{ kW} - 1\text{ kW} - 1\text{ kW} = -1\text{ kW}$$

The energy stored intermediately by the battery inverter in the battery is insufficient to completely supply the loads. There is a low grid-supplied power of 1 kW.

Situation 3:

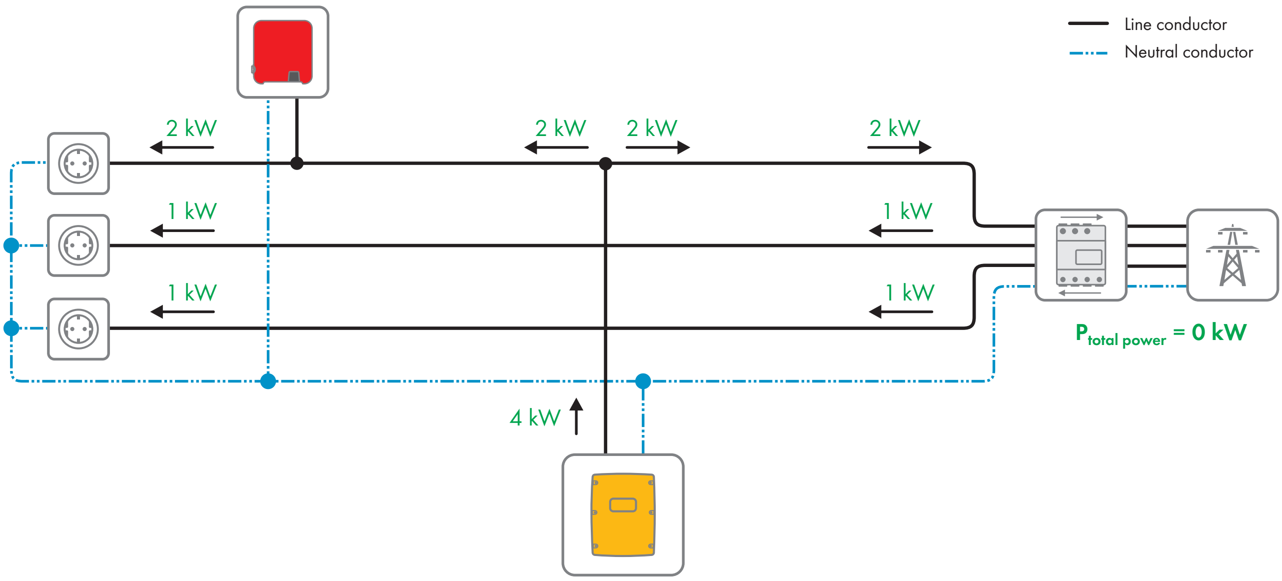


Figure 20: The battery inverter supplies the loads with energy from intermediate storage.

It is now evening. The PV system is not feeding in. The loads are switched on and are drawing 2 kW of electric power on phase 1, 1 kW on phase 2, and 1 kW on phase 3.

The total power at the bidirectional meter for grid feed-in and purchased electricity is shown as follows:

$$P_{\text{total power}} = 2\text{ kW} + 1\text{ kW} + 1\text{ kW} = 4\text{ kW}$$

The utility grid is now the sole energy source for the loads and supplies them with 4 kW. The battery inverter detects the purchased electricity and consequently uses the energy from intermediate storage to supply the loads.

The total power at the bidirectional meter for grid feed-in and purchased electricity is shown as follows:

$$P_{\text{total power}} = 2\text{ kW} - 1\text{ kW} - 1\text{ kW} = 0\text{ kW}$$

The energy stored intermediately by the battery inverter in the battery is sufficient to supply the loads. No more electricity is purchased from the grid.

5 Loads in Energy Management Systems

5.1 Suitability of Loads for an Energy Management System

An important form of intelligent energy management is automatic load control. Without any compromises in convenience or supply reliability, the operation of suitable loads is rescheduled to times with high PV generation. To be able to benefit from these advantages, it is important to know which loads are suitable for operation in an energy management system:

- Loads should be capable of consuming a significant portion of the locally generated PV energy. The higher the energy demand of load per day, the more worthwhile is the control of such a load.
- Loads should be in operation either daily or on fixed days during the week.
- Loads should be flexible with regard to time and should not be obliged to produce a specific result immediately after being switched on.

Examples of suitable loads

The following loads are particularly suitable for an energy management system - not least because they are flexible with regard to time:

- A **heat pump** for provision of warm water requires 3 kWh to 5 kWh of energy per day and runs daily.
- A **washing machine** requires 1 kWh to 1.25 kWh of energy depending on the program selected and it runs several times each week.
- A **dryer** requires 1.5 kWh to 2.5 kWh of energy depending on the program selected and it runs several times each week.
- A **dishwasher** requires 1.5 kWh of energy for each wash and typically runs daily.
- A **heating element** for a hot-water tank requires 2 kWh to 3 kWh of energy per day and is in operation daily.
- A **charging station for electric vehicles** requires 4 kWh to 22 kWh of energy per day to charge an electric vehicle depending on the individual driving profile and is in operation daily.

Examples of unsuitable loads

The following loads are unsuitable for an energy management system:

- A **desk lamp** with an energy requirement of e.g. 20 Wh can only consume a very small portion of the PV energy.
- **Toasters** and **kettles** are only switched on when they are required. Toast and hot water are required promptly.
- An **electric cooker** is switched on when the user wishes to cook. The food is to be prepared promptly and not simply whenever sufficient PV energy is available for operation of the electric cooker.

5.2 SMA EV Charger in the Energy Management System

The EV Charger is an AC charging station that is designed for unidirectional charging of a vehicle. The SMA EV Charger along with the Sunny Home Manager 2.0 makes an intelligent charging station for the SMA Energy System Home. If the EV Charger is operated without the Sunny Home Manager 2.0, the modes for intelligent charging are not available.

Properties of charging modes

The EV Charger has 3 charging modes that can be switched between. The effect of the setting on the charging mode is described below.

Icon	Explanation
	**Fast charging** The vehicle is charged with the maximum available power. There is no optimization here with regard to electricity costs and the use of PV energy. The charging power is limited by the maximum charging power of the vehicle, the house connection and the EV Charger.
	**Intelligent charging - Charging with PV surplus** The vehicle is charged with excess PV energy that would otherwise be fed into the utility grid or cut off. The Sunny Portal is used to set how high the proportion of excess PV energy must be in order for the EV Charger to charge the vehicle. The Sunny Home Manager schedules the charging by the EV Charger only as soon as it can fulfill the set optimization target. Depending on the configuration of the priority of the optional appliances, the EV Charger is taken into account by Sunny Home Manager before or after other appliances when scheduling. In this charging mode, it is not possible to ensure that the vehicle is charged in all cases. If the surplus PV energy is not sufficient for charging, no charging takes place. In this case, the optionally available home storage is not discharged for charging the electric vehicle.
	**Intelligent charging - Charging with specified target** The EV Charger is operated as a necessary appliance with as much surplus PV energy as possible. By entering a departure time and an amount of energy to be charged in the SMA Energy App, the Sunny Home Manager intelligently plans the charging process. The Sunny Home Manager enables charging at minimum cost and with maximum utilization of PV power with sufficient charging to reach the destination at the entered departure time. If there is no sufficiently excess PV energy available to achieve the charging goal, the optionally available home storage is first discharged for charging the electric vehicle before the grid-supplied power finally ensures the readiness for departure. After sufficient charging for the target range, the EV Charger automatically switches to **Charging with PV surplus**.

Multi-EVC operation mode

Multi-EVC operation is supported from firmware version 1.02.##.R and allows the connection of a maximum of 3 SMA EV Chargers. Mixed systems with single-phase charging stations (EVC7.4-1AC-10) and three-phase charging stations (EVC22-3AC-10) are possible.

In multi-EVC operation mode, all charging stations must be connected to the utility grid on a rolling basis.

The Sunny Home Manager provides the charging stations with information on the number of active charging stations every minute.

In multi-EVC operation mode, if multiple charging stations are charging a vehicle and there is a two-phase charging vehicle among the vehicles, this vehicle is limited to single-phase charging for symmetry reasons.

If communication between Sunny Home Manager and the charging stations fails, only single-phase or three-phase charging vehicles can be charged. Two-phase charging vehicles are also limited to single-phase charging in this case. You can set fallback values that take effect in the event of a communication breakdown.

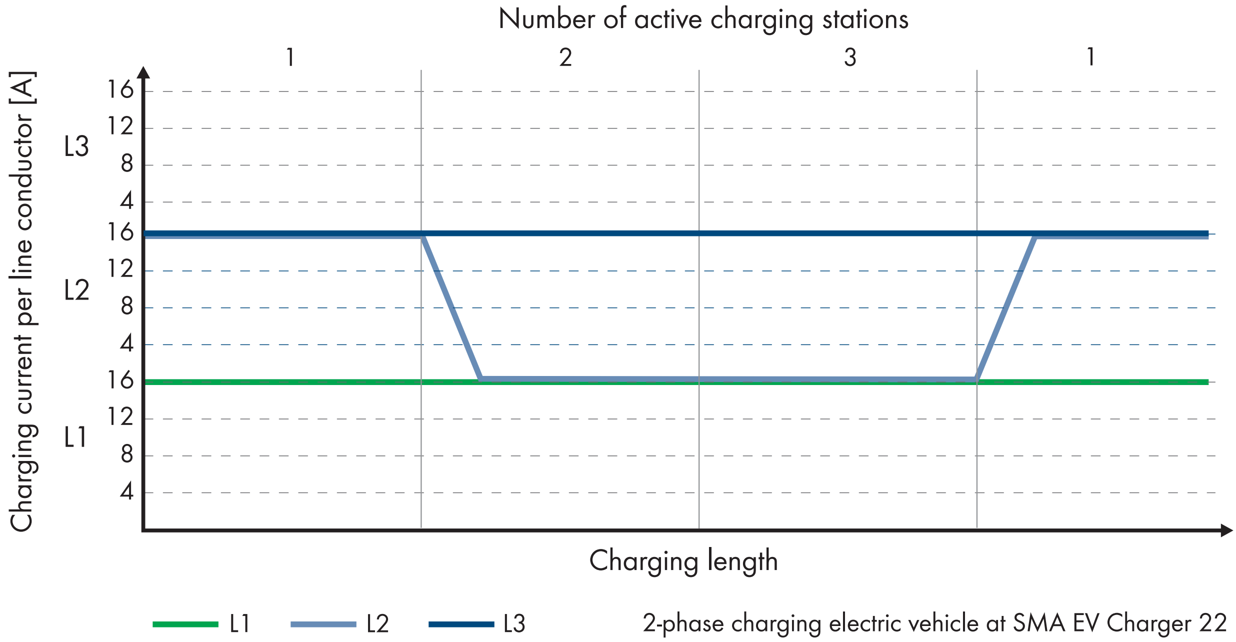


Figure 21: Limiting a two-phase charging vehicle to single-phase charging

In multi-EVC mode, the maximum charging current is limited to ensure overload protection (maximum charging current/ number of active charging stations). If, for example, 3 charging stations are connected to a point of interconnection with a nominal current of 35 A, the charging current is limited as follows:

- 1 active charging station: 32 A
- 2 active charging stations: 17.5 A per charging station
- 3 active charging stations: 11.67 A per charging station

Note that loads with high power consumption can cause the charging stations to disconnect from the utility grid to ensure overload protection.

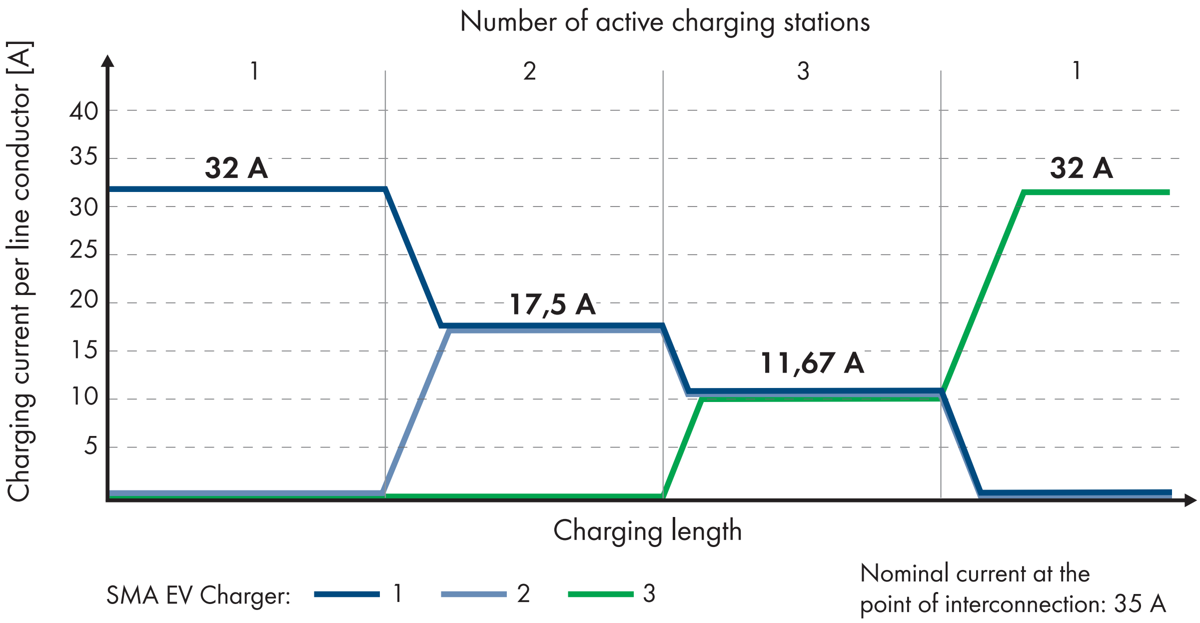


Figure 22: Charge current limitation

Circuitry Overview

System with 1 SMA EV Charger

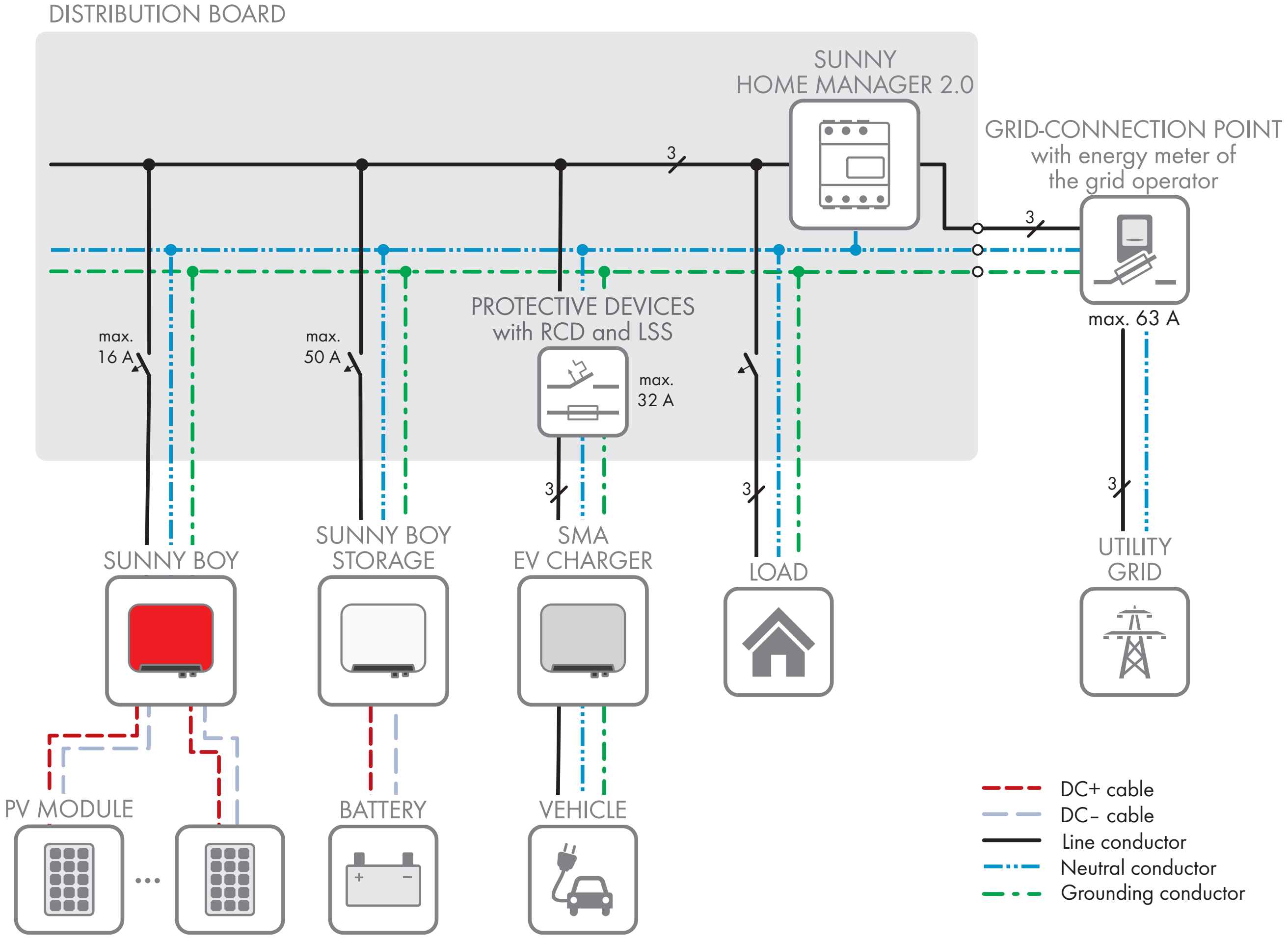


Figure 23: Circuitry overview (example with 1 EVC22-3AC-10)

Three-phase system with up to 3 SMA EV Chargers

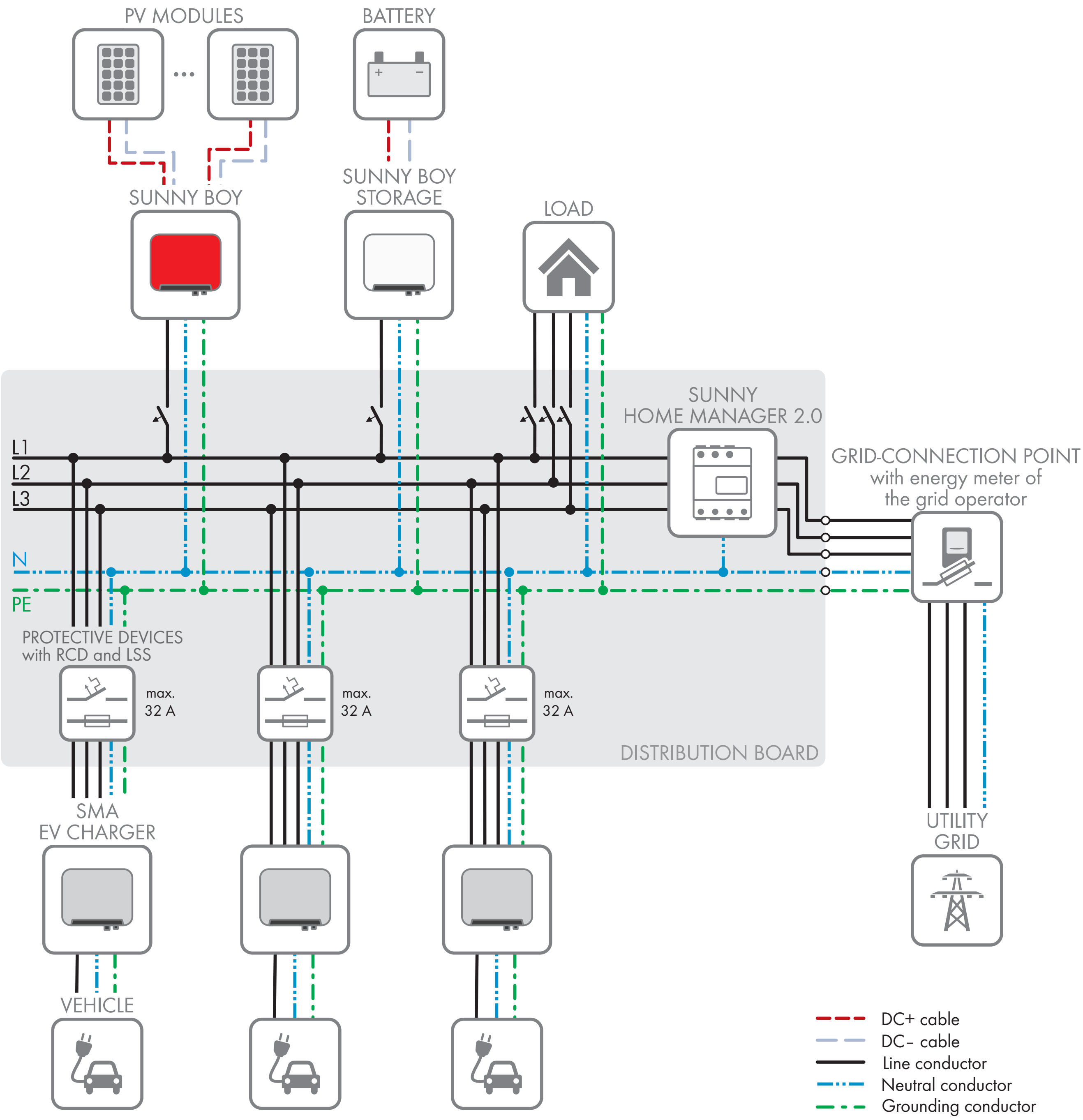


Figure 24: Circuitry overview (example with 3 EVC22-3AC-10)

5.3 Options for Load Control

The Sunny Home Manager is offered by many manufacturers of heating systems, charging stations for electric cars and household appliances as an energy manager for use with PV systems. A prerequisite is that there is a compatible controlling interface between the devices and systems in the household via which the Sunny Home Manager can send its control commands.

In principle there are two types of control interfaces for this:

- SMA radio-controlled sockets
- Direct data connection
- Moxa for SG-ready heat pumps and power control functionality

SMA radio-controlled sockets

Switching three-phase loads using only one common actuator

Three-phase loads that are dependent on the simultaneous availability of all phases (e.g. three-phase motors), must not be controlled via three separate actuators (e.g. three radio-controlled sockets). In this case, you must use a single actuator with control of a three-phase contactor.

With this type of control, the devices can be started or stopped directly via connecting or interrupting the main power supply (e.g. a pond pump).

Alternatively, a relay or a three-phase contactor, which in turn can start a load, can also be controlled via the radio-controlled socket. This method can be used to switch on large loads (e.g. a large pump or a heater with three-phase power connection).

For example, the Modbus device Moxa E1214 offers the possibility to control a heat pump via the relay output R0 (terminal 9 and 10). These switching contacts then start the heat pump in a special operating mode in which surplus PV energy can be used to operate the heat pump.

Direct data connection

Some modern home appliances (see Technical Information "SMA SMART HOME - Compatibility List for Loads" at www.SMA-Solar.com) have an Ethernet connection with which the data of the device can be called up via the local network. If there is an Internet connection via the network router, the manufacturers of household devices can use this data for maintenance purposes, for example. Visualization and control of the household devices via mobile devices (e.g. via app in the Smartphone) is also possible with this.

A further application of this direct data connection is the control of the device via the Sunny Home Manager in the energy management system. For this, a compatible data protocol must be implemented in the respective device via which information for energy management can be exchanged. Such data protocols are, for example, the EEBUS/SPINE Standard and the SMA proprietary SEMP protocol (information at www.sma.de/produkte/sma-developer.html).

The smart appliances send information on the load type, the planned energy requirement, and the preferred operating time period to the Sunny Home Manager. The Sunny Home Manager factors this information into its load control, and also taking the configured optimization targets in the context of load control into account, sends appropriate start and stop signals to the loads Home appliances with intelligent communication interface.

6 Components for Energy Management Systems

6.1 Product Overview

6.1.1 SMA and Radio-Controlled Sockets for Basic Solution

Control of household appliances	Sunny Home Manager
PV inverter [5]	✓
Compatible radio-controlled sockets (e.g. Edimax, AVM) [6]	•
Compatible intelligent loads (e.g. EV Charger) [6]	•

✓ Required • Optional

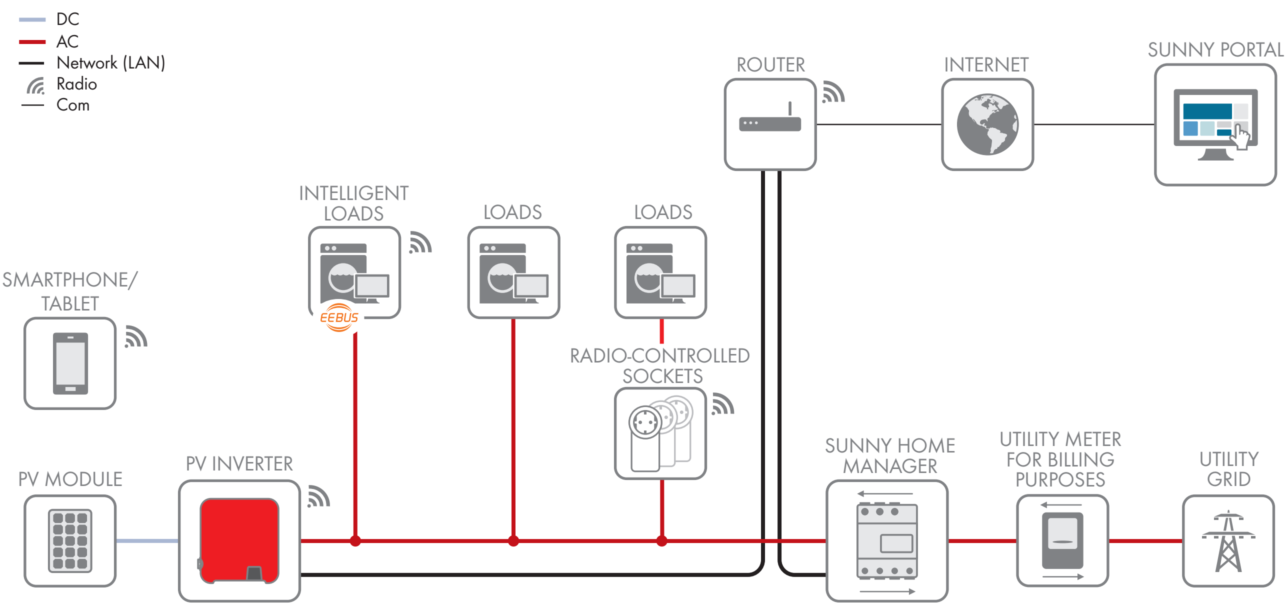


Figure 25: Control of household appliances in the SMA Smart Home

In a SMA Smart Home, radio-controlled sockets and EEBUS-standard interfaces can be used to control loads and they enable optimization of energy consumption and the self-consumption quota through load shifting. The communication of the devices with one another typically occurs via Wi-Fi/LAN and a router.

[5] To communicate in a SMA Smart Home, PV inverters typically need a Wi-Fi connection to a router or a communication interface via SMA Speedwire fieldbus (see Section 6.2.1, page 44) with the Sunny Home Manager.

[6] A detailed list of compatible radio-controlled sockets and intelligent loads (e.g. household devices with EEBUS standard interface) for the SMA Smart Home can be found in the technical information "SMA SMART HOME - Compatibility List for Loads" at www.SMA-Solar.com.

6.1.2 SMA storage system with inverter for low-voltage batteries

SMA Energy System Home with inverter for low-voltage batteries

SMA Energy System Home	Sunny Island	Sunny Island with Sunny Home Manager	Sunny Island with Sunny Home Manager and additional energy meter
PV inverter	✓	✓	✓[7)]
Sunny Home Manager	-	✓	✓
SMA Energy Meter	✓	-	1 time
SMA radio-controlled sockets	-	•	•
Compatible intelligent loads (e.g. EV Charger)	-	•	•
Sunny Island with battery fuse	✓	✓	✓
Approved low-voltage battery	✓	✓	✓
	✓ Required	– Not required	• Optional

SMA Energy System Home with inverter for high-voltage batteries

SMA Energy System Home	Sunny Boy Storage	Sunny Boy Storage with Sunny Home Manager	Sunny Boy Storage with Sunny Home Manager and additional energy meter
PV inverter	✓	✓	✓[8)]
Sunny Home Manager	-	✓	✓
SMA Energy Meter	✓	-	1 time
SMA radio-controlled sockets	-	•	•
Compatible intelligent loads (e.g. EV Charger)	-	•	•
Sunny Boy Storage 2.5 / 3.7 / 5.0 / 6.0	✓	✓	✓
Approved high-voltage battery	✓	✓	✓

[7)] PV inverters from third-party providers can be integrated into the SMA Energy System Home with Sunny Island, Sunny Home Manager and additional energy meter. The energy meter must then be installed as PV generation meter (see Section 6.2.2, page 44). It is recommended to use the SMA Energy Meter as an additional energy meter.

[8)] PV inverters from third-party providers can be integrated into the SMA Energy System Home with Sunny Boy Storage, Sunny Home Manager and additional energy meter. The energy meter must then be installed as PV generation meter (see Section 6.2.2, page 44). It is recommended to use the SMA Energy Meter as PV generation meter.

✓ Required – Not required • Optional

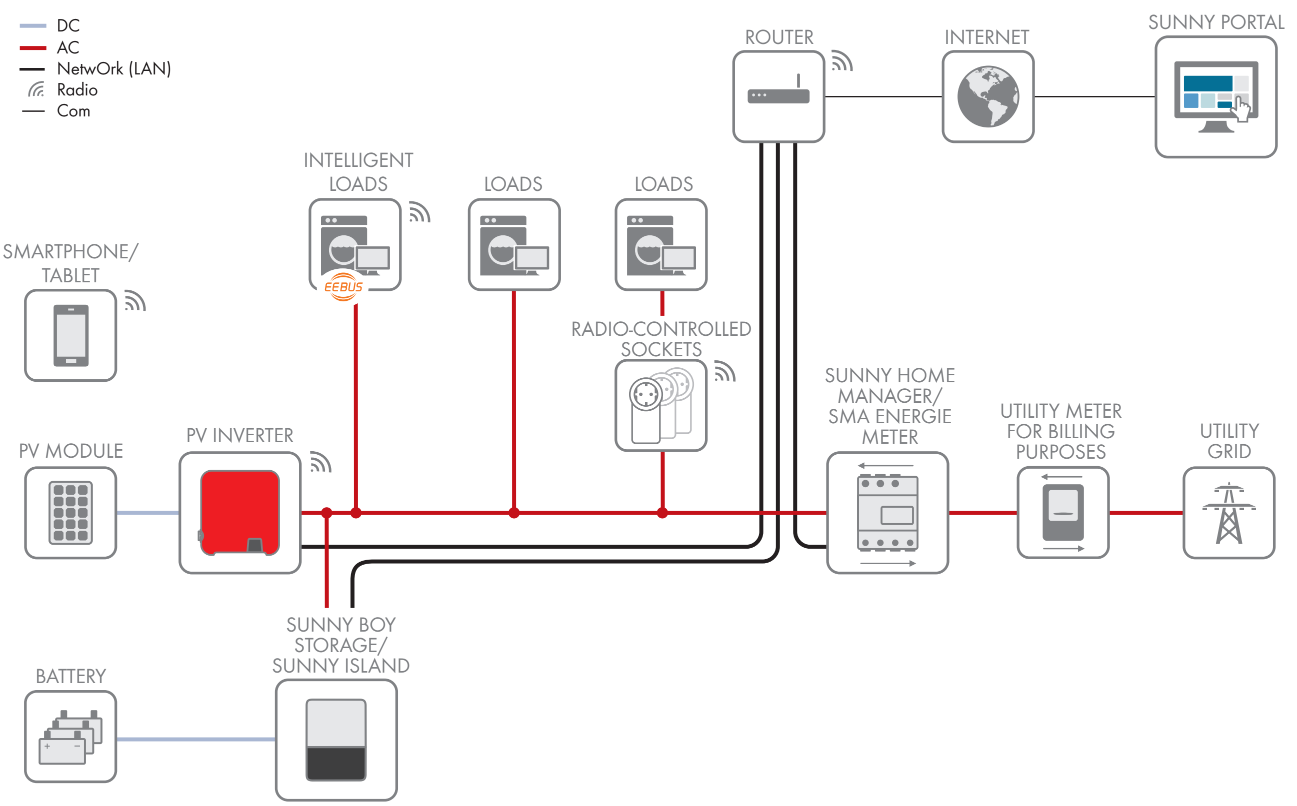


Figure 26: SMA storage system with inverter batteries

PV systems can be equipped with an individually dimensioned battery-storage system and with two different battery inverters, the Sunny Island for low-voltage batteries or the Sunny Boy Storage for high-voltage batteries. The system size and power of the PV inverters can also be selected to suit the requirements of each household. In the SMA Smart Home, the SMA storage systems are typically integrated into the local network via LAN or Wi-Fi (e.g. a router).

SMA Energy System Home with hybrid inverter for high-voltage batteries

SMA Energy System Home	Sunny Tripower Smart Energy	Sunny Tripower Smart Energy with Sunny Home Manager
PV inverter	✓	✓
Sunny Home Manager	-	✓
SMA Energy Meter	✓	-
SMA radio-controlled sockets	-	•
Compatible intelligent loads (e.g. EV Charger)	-	•
Sunny Tripower 5.0 / 6.0 / 8.0 / 10.0 Smart Energy	✓	✓
Approved high-voltage battery	✓	✓

✓ Required – Not required • Optional

6.2 PV Inverters

6.2.1 PV Inverters with Sunny Home Manager

PV inverters can communicate in two different ways in SMA Smart Home with the Sunny Home Manager:

- Wired via Ethernet

  The inverter must be connected to the local network via a network cable (e.g. via a router).

- Wireless via WLAN

  Depending on the ambient conditions, wireless networks can have a limited range. In free-field conditions without any disruptive objects, a high radio range is possible. Inside buildings, obstacles such as walls, ceilings and doors or other sources of interference can reduce the range to a few meters. Range problems can be eliminated with standard WLAN repeaters.

i Wireless via WLAN

Despite a good radio connection, there may be temporary interruptions in communication. SMA Solar Technology AG therefore generally recommends a wired connection via Ethernet.

The Sunny Home Manager supports all PV inverters with integrated or retrofitted Speedwire interface of SMA Solar Technology AG. The PV inverters must have the current firmware version in each case (see the inverter product page at www.SMA-Solar.com).

i No support for the Sunny Boy 240 and the Sunny Multigate

The Sunny Boy 240 and the Sunny Multigate are not intended for use in Sunny Home Manager systems. Although the Sunny Home Manager can detect the Sunny Multigate, use of the Sunny Home Manager for the configuration of this inverter is not recommended. SMA Solar Technology AG does not accept liability for missing or incorrect data and any yield losses that may result.

i Data on PV generation from the PV inverter

All compatible SMA PV inverters can transmit their PV generation data directly to the Sunny Home Manager. For this reason, a separate PV production meter is not necessary.

If inverters from other manufacturers are to be integrated into the systems, an SMA Energy Meter must be installed centrally as a PV production meter. The PV production meter is then configured appropriately via the Sunny Home Manager settings in Sunny Portal. The generation data from SMA PV inverters is no longer used. For this reason, dynamic active power control in such mixed systems is no longer possible. The inverters must be limited to a fixed active power limit.

i Maximum number of supported PV inverters

The Sunny Home Manager supports a maximum of 24 SMA inverters within one system. This is also the maximum number of devices.

With 24 SMA inverters within one system, radio-controlled sockets or directly controllable loads can no longer be supported.

6.2.2 PV Inverters in the SMA Energy System Home

Sunny Boy Storage or Sunny Island and other PV inverters	Operating conditions	Permitted
Sunny Island with PV inverters	• The PV inverter must be compatible with the Sunny Home Manager.	yes

Sunny Boy Storage or Sunny Island and other PV inverters	Operating conditions	Permitted
1 Sunny Boy Storage and PV inverter	• The PV inverter must be of the type Sunny Boy or Sunny Tripower. • If the PV inverter is not equipped with SMA Webconnect, the Sunny Home Manager must be installed.	yes
1 Sunny Boy Storage and additional Sunny Boy Storage devices	–	no
1 Sunny Boy Storage and PV inverters from another manufacturer 1 Sunny Boy Storage and SMA micro inverter	• An additional energy meter must be installed as a PV production meter. • The entire PV generation must be routed via the additional energy meter, otherwise no distinction can be made between PV generation and grid feed-in/purchased electricity. When the additional PV production meter is installed, this value is being taken as PV generation value instead of the values provided by the PV inverter. • The SMA Energy Meter must be used as a PV generation meter.	yes
3 EV Chargers and Sunny Home Manager	In multi-EVC operation mode, all charging stations must be connected to the utility grid on a rolling basis.	yes

6.2.3 PV Inverters in the SMA Energy System Home with Sunny Tripower Smart Energy

Sunny Tripower Smart Energy and other PV inverters	Operating conditions	Permitted
1 Sunny Tripower Smart Energy with PV inverters	The PV inverter must be compatible with the Sunny Home Manager.	yes
1 Sunny Tripower Smart Energy with Sunny Boy Storage	–	no
1 Sunny Tripower Smart Energy with Sunny Island	–	no
1 Sunny Tripower Smart Energy and third-party PV inverter / SMA micro inverter	–	no

6.3 Energy Measuring Device SMA Energy Meter

The Sunny Home Manager contains an integrated measuring device that corresponds to the measuring function of the SMA Energy Meter. If the Sunny Home Manager is installed at the point of interconnection, no further measuring device is necessary for the basic function. Where necessary, an additional SMA Energy Meter can be installed for measuring the PV generation power.

The SMA Energy Meter determines electrical measured values at the connection point and makes them available via Speedwire. The SMA Energy Meter can record energy flows in both directions (counting direction: grid feed-in and purchased electricity or PV generation). It can be connected both three-phase and single-phase.

The SMA Energy Meter is not an energy meter for measuring effective consumption in compliance with the EU directive 2004/22/EC (MID) The SMA Energy Meter must not be used for billing purposes.

The SMA Energy Meter and the Sunny Home Manager are licensed for a limiting current of 63 A per line conductor. From firmware version 1.02.04.R of the SMA Energy Meter, installations with more than 63 A per line conductor are possible if one external current transformer is used for each line conductor.

Additional material in the event of more than 63 A per line conductor from firmware version 1.02.04.R:

From firmware version 1.02.04.R of the SMA Energy Meter and for the Sunny Home Manager, installations with more than 63 A per line conductor are possible. With an SMA Energy Meter installation of more than 63 A per line conductor, one external current transformer is required for each line conductor. SMA Solar Technology AG recommends current transformers designed for a secondary current of 5 A. The current transformers should have at least accuracy class 1.

6.4 Communication

Router

A router/network switch connects the Sunny Home Manager via the Internet to Sunny Portal.

When using the Sunny Home Manager, SMA Solar Technology AG recommends a permanent Internet connection and the use of a router which supports the dynamic assignment of IP addresses (DHCP – Dynamic Host Configuration Protocol).

The values measured by the integrated measuring device are also made available to other devices in the local network via the Ethernet connection of the Sunny Home Manager to the router.

SMA Energy Meter

An additional SMA Energy Meter must be located in the same local network as the Sunny Home Manager. The SMA Energy Meter must also be connected via a network cable either to the network switch or to the router with integrated network switch.

Cable types recommended for the network cable are SF/UTP, S-FTP, S/UTP, SF/FTP, S/FTP and S-STP (for further information on the cable types see Technical Information "SMA SPEEDWIRE FIELDBUS" at www.SMA-Solar.com).

6.5 Maximum Number of Devices in the Energy Management System

The Sunny Home Manager supports a **maximum of 24 devices**.

The term device includes all components that exchange data with the Sunny Home Manager, i.e. SMA inverters, radio-controlled sockets, and smart loads. The SMA Energy Meter is not included in these devices.

Of the 24 devices, a maximum of 12 devices may be actively controlled by the Sunny Home Manager. Actively controlled means that the Sunny Home Manager not only displays the consumption of the device, but actively switches the device. Even if the limit of a maximum of 12 devices is reached, further devices can be monitored via radio-controlled sockets and visualized, so long as the maximum number of devices of 24 is not exceeded.

Fully equipped energy management system

A fully equipped energy management system (with a maximum of 24 devices) can consist of the following components:

- 3 x SMA Inverters
- 1 x heat pump that is controlled by the Sunny Home Manager via a direct data connection.
- 20 x radio-controlled sockets

  Due to the actively controlled heat pump, only eleven radio-controlled sockets can be actively controlled by the Sunny Home Manager.

7 SMA Energy System Home

7.1 Circuitry Overview for a System with One Sunny Island Inverter

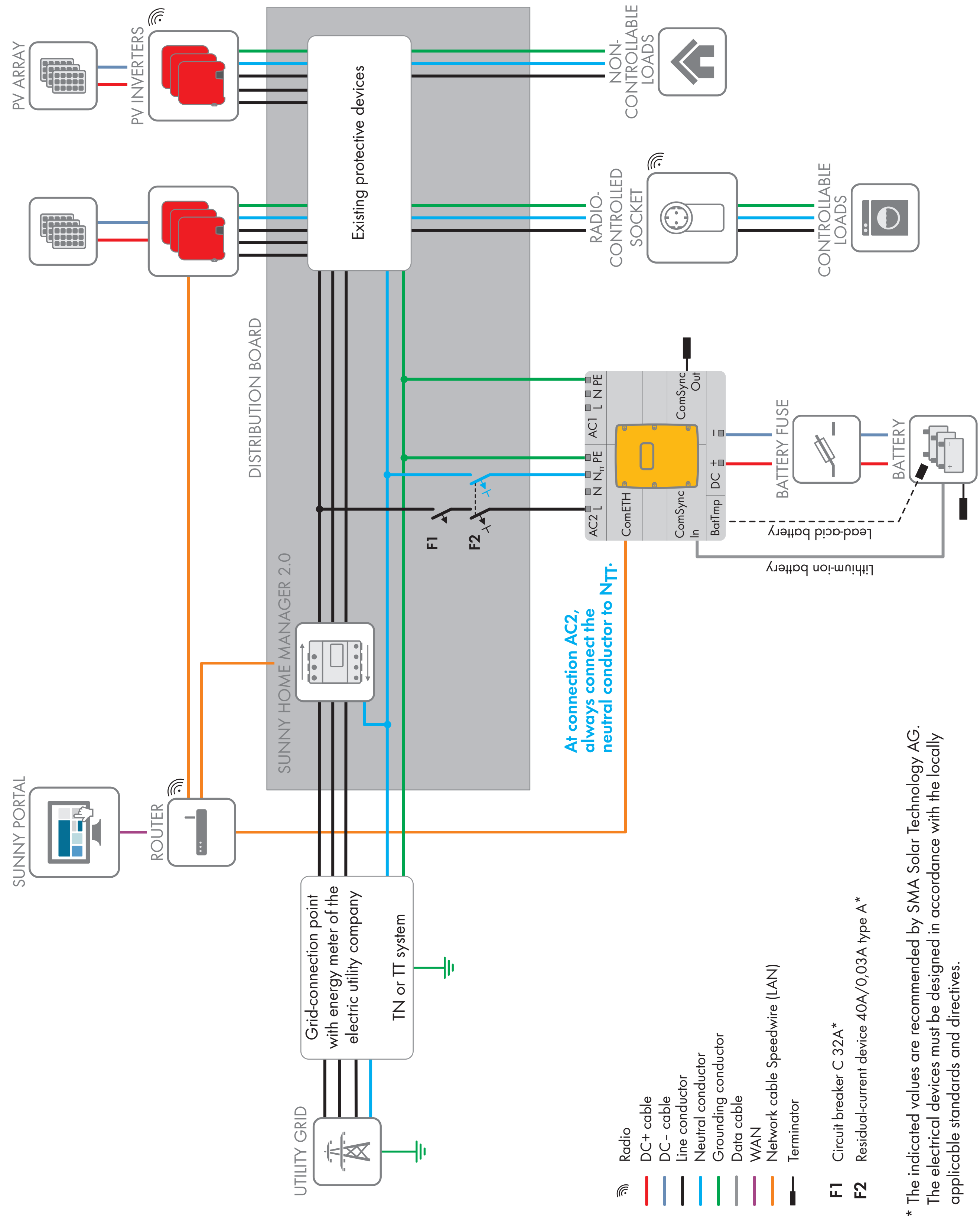


Figure 27: Circuitry of the SMA Energy System Home for TN and TT Systems

7.2 Material for Circuitry of the System with One Sunny Island

Material	Number of units	Description
Circuit breaker for protection of the Sunny Island	1	32 A, C rating, 1-pole
Residual-current device	1	40 A/0.03 A, 1-pole + N, type A

Wiring diagram will be supplied whenever a Sunny Island 4.4M / 6.0H / 8.0H is ordered.

7.3 Circuitry Overview for a System with One Sunny Boy Storage

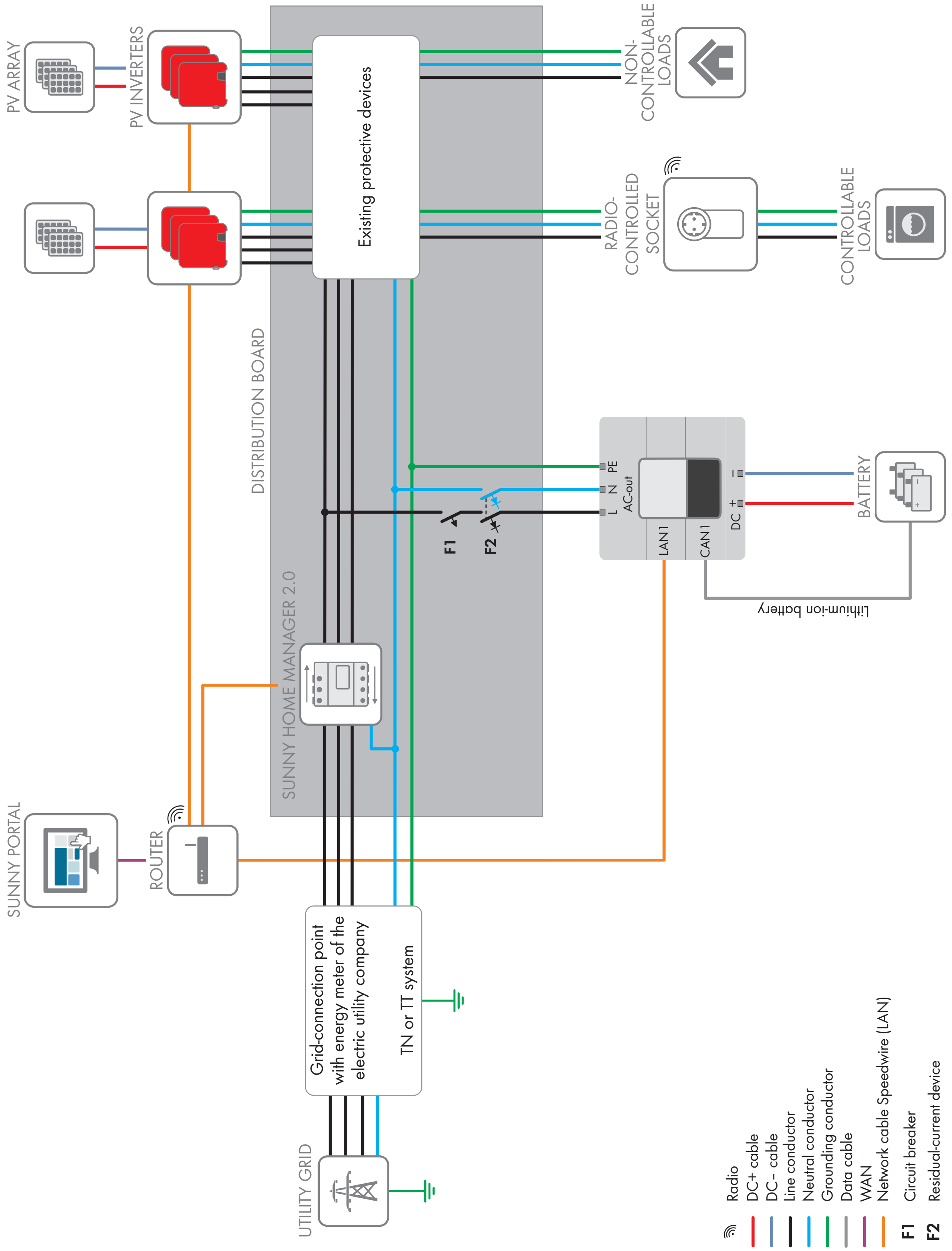


Figure 28: Circuitry of the SMA Energy System Home

7.4 Material for Circuitry of the System with One Sunny Boy Storage

Material	Number of units	Description
Circuit breaker for protection of the Sunny Boy Storage	1	For information and design examples, see the Technical Information "Circuit Breaker" at www.SMA-Solar.com
Residual-current device	1	If an external residual-current device is required, install a residual-current device which trips at a residual current of 100 mA or higher (for details on selecting a residual-current device, see the Technical Information "Criteria for Selecting a Residual-Current Device" at www.SMA-Solar.com).

7.5 Circuitry Overview for a System with Three Sunny Island Inverters

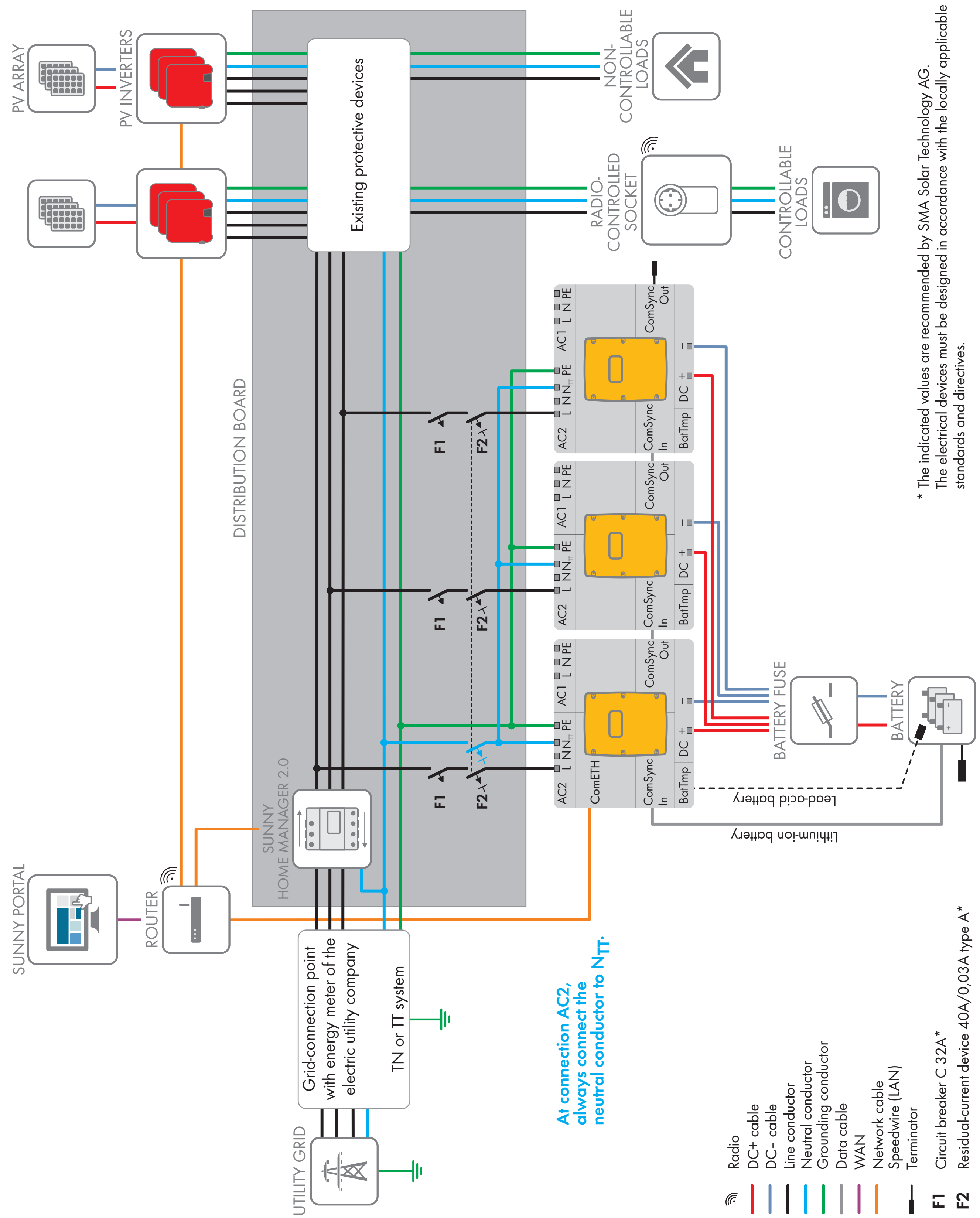


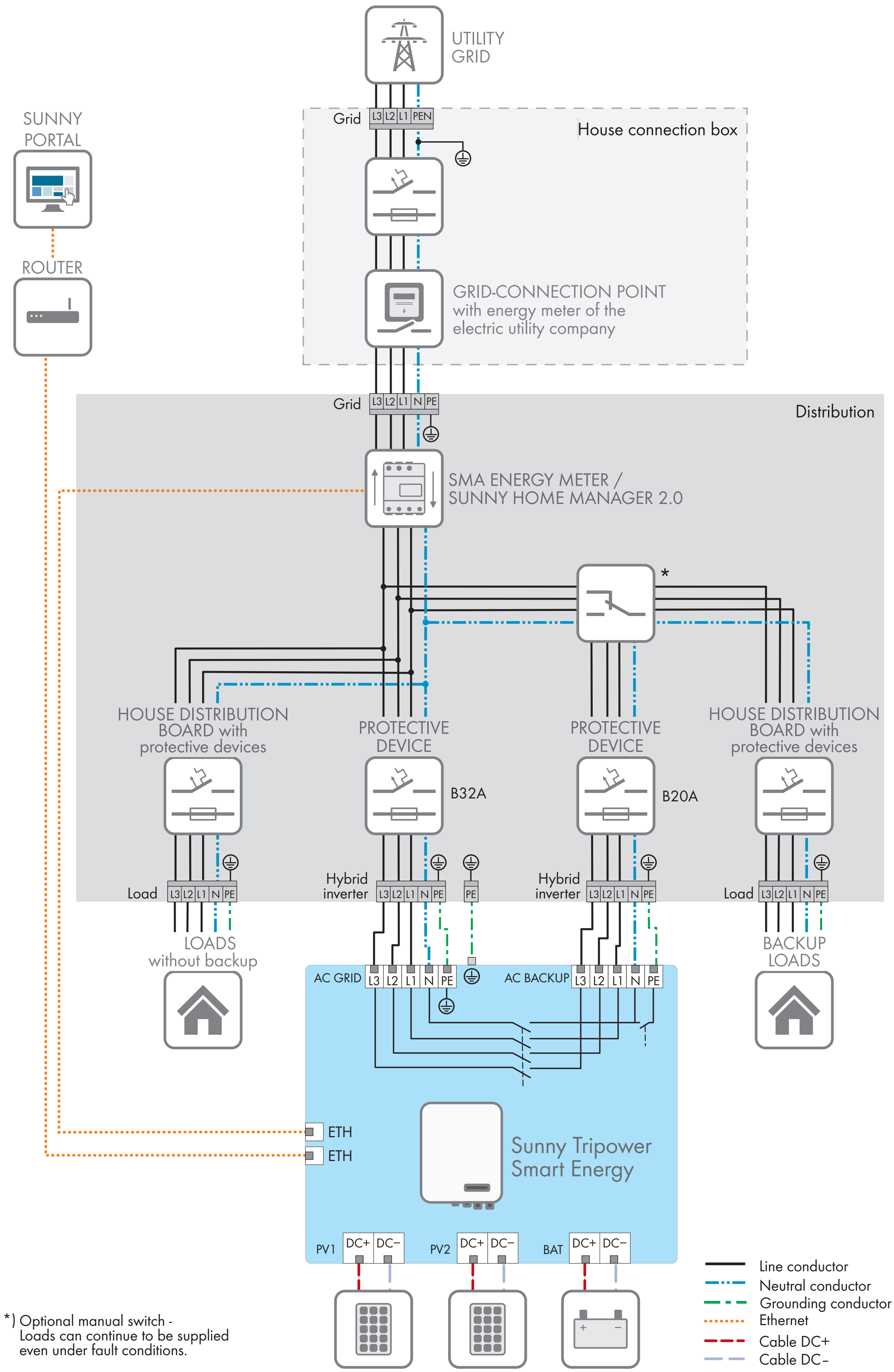
Figure 29: SMA Energy System Home for TN and TT Systems

7.6 Material for Circuitry of the System with Three Sunny Island Inverters

Material	Number of units	Description
Circuit breaker for protection of the Sunny Island	3	32 A, C rating, 1-pole
Residual-current device	1	40 A/0.03 A, 1-pole + N, type A

Wiring diagram will be supplied whenever a Sunny Island 4.4M / 6.0H / 8.0H is ordered.

7.7 Circuitry overview for a system with 1 Sunny Tripower Smart Energy



*) Optional manual switch - Loads can continue to be supplied even under fault conditions.

Figure 30: SMA Energy System Home with Sunny Tripower Smart Energy

7.8 Supported Batteries

Sunny Island

The Sunny Island supports lead-acid batteries of types FLA and VRLA as well as various lithium-ion batteries. It is important to observe the capacity:

- Lead-acid batteries with a capacity of 100 Ah to 10000 Ah can be connected.
- Lithium-ion batteries with a capacity of 50 Ah to 10000 Ah can be connected.

This corresponds to a maximum storage capacity of 480 kWh for a battery with 48 V and 10000 Ah.

A lithium-ion battery is especially suited for intermediate storage of PV energy due to its high cycle stability. The lithium-ion batteries must be compatible with the Sunny Island:

- The battery must comply with the locally applicable standards and directives and must be intrinsically safe.
- The Sunny Island must only be operated in connection with an intrinsically safe lithium-ion battery approved by SMA Solar Technology AG (see Technical Information “List of Approved Batteries” at www.SMA-Solar.com).
- If no lithium-ion battery approved for the Sunny Island can be used, use a lead-acid battery.

Sunny Boy Storage

The Sunny Boy Storage must only be operated in connection with an intrinsically safe lithium-ion battery approved by SMA Solar Technology AG (see Technical Information "Approved batteries and battery communication connection" at www.SMA-Solar.com).

Sunny Tripower Smart Energy

The Sunny Tripower Smart Energy must only be operated in connection with an intrinsically safe lithium-ion battery approved by SMA Solar Technology AG (siehe Technical Information "Approved batteries and battery communication connection" at www.SMA-Solar.com).

Lithium-ion battery for Sunny Island, Sunny Boy Storage and Sunny Tripower Smart Energy

The battery management of lithium-ion batteries controls the operation of the battery. To enable battery management, the lithium-ion battery must be connected to the battery inverter or hybrid inverter via a data cable.

In the case of compatible lithium-ion batteries, SMA Solar Technology AG has only tested the interaction between the battery inverter and the battery management of the lithium-ion battery. For information on other technical properties of the batteries, please contact the respective manufacturer of the lithium-ion battery.

7.9 PV System Design of an SMA Energy System Home with Sunny Design

Sunny Design is a software for planning and designing PV systems with and without self-consumption, off-grid systems, PV hybrid systems as well as energy systems. Sunny Design provides you with design recommendations for your planned systems. Sunny Design proposes a combination of PV array(s) and inverter(s) which meet, as closely as possible, your requirements regarding power class, energy yield and efficiency.

In addition, you have the option of determining and optimizing your potential self-consumption, sizing cables, evaluating efficiency and, in case of PV hybrid and off-grid systems, configuring gensets.

i Sunny Design Pro:
Additional access authorization required

You require an additional access authorization for Sunny Design Pro to be able to design an energy system and to use the advanced settings. You get information by clicking on the button [**Energy systems**] on the Sunny Design home page or on your personal home page after login.

Function	Anonymous user Sunny Design	Registered user Sunny Design	Registered user Sunny Design Pro
Creating PV systems without self-consumption option	✓	✓	✓
Creating PV systems with self-consumption option	✓	✓	✓
Creating off-grid systems	–	✓	✓
Creating PV hybrid systems	–	✓	✓
Saving and managing projects	–	✓	✓
Calculating harmonics	–	✓	✓
Creating own PV modules, locations and load profiles	–	✓	✓
Creating energy systems	–	–	✓
Storage simulation for peak load shaving	–	–	✓
Managing tariffs	–	–	✓
Consumption and load profile analysis	–	–	✓
Support of SMA 360° documents	–	✓	✓
Advanced project documentation	–	–	✓
Export of time series	–	–	✓
Self-consumption optimized planning of heat pumps with SHM	✓	✓	✓
Take e-mobility into account (charging station, driving profile)	✓	✓	✓

You can find additional information on Sunny Design at www.SMA-Solar.com.

8 Frequently Asked Questions

Detailed answers to your questions on the products can be found in the SMA Online Service Center at www.my.sma-service.com.

Is it possible to measure currents of more than 63 A per line conductor with the SMA Energy Meter and/or Sunny Home Manager 2.0?

From firmware version 1.02.04.R of the SMA Energy Meter, installations with more than 63 A per line conductor are possible if one external current transformer is used for each line conductor. SMA Solar Technology AG recommends current transformers designed for a secondary current of 5 A. The current transformers should have at least accuracy class 1.

Can devices with BLUETOOTH interface also communicate with the Sunny Boy Storage?

No: The Sunny Boy Storage, however, is equipped with a Speedwire and WLAN interface.

Can existing PV systems be retrofitted with the Sunny Home Manager or the SMA Energy System Home?

Yes: New and existing PV systems can be retrofitted with the Sunny Home Manager or the SMA Energy System Home.

Do any limitations apply to the PV System when using the SMA Energy System Home?

No: The SMA Energy System Home is technically independent of the peak power of the PV system. Whether the intermediate storage of PV energy on site makes economic sense will need to be evaluated in each individual case:

- Use Sunny Design Web to design and evaluate an SMA Energy System Home (for Sunny Design, see www.SMA-Solar.com).
- Use the method described in this document to design and evaluate an SMA Energy System Home (see Section 7.9, page 55).

Can PV inverters from other manufacturers be installed together with a Sunny Island or a Sunny Boy Storage?

If you want to retrofit an existing PV system with the Sunny Island or a Sunny Boy Storage for intermediate storage of PV energy, but do not require active power limitation, you can use PV inverters from any manufacturer. Active power limitation may be stipulated by the grid operator or may bring financial rewards due to local legislation (e.g. the PV storage incentive program in Germany). If the active power limitation is required, the selected inverters must ensure the limitation.

Which batteries can be used with the SMA Energy System Home?

The Sunny Island supports all lead-acid batteries of types FLA and VRLA as well as various lithium-ion batteries. The Sunny Boy Storage supports selected lithium-ion batteries (see Technical Information "Approved batteries and battery communication connection" at www.SMA-Solar.com).

Which battery capacities can be implemented with the SMA Energy System Home ?

The battery capacity for an SMA Energy System Home with Sunny Island can be freely selected within a wide range.

The Sunny Island supports lead-acid batteries of types FLA and VRLA as well as various lithium-ion batteries. It is important to observe the capacity:

- Lead-acid batteries with a capacity of 100 Ah to 10000 Ah can be connected.
- Lithium-ion batteries with a capacity of 50 Ah to 10000 Ah can be connected.

This corresponds to a maximum storage capacity of 480 kWh for a battery with 48 V and 10000 Ah.

The battery capacity for an SMA Energy System Home with Sunny Boy Storage is prescribed by the lithium-ion battery used.

Is it possible, in addition to the PV system, to connect other AC sources to the SMA Energy System Home?

You can also connect other AC sources to a Sunny Island or Sunny Boy Storage, for example, a combined heat and power plant (CHP plant). Keep in mind that within the SMA Energy System Home, the Sunny Home Manager does not support wind power inverters or CHP plants.

If your system combines various AC power sources (e.g. PV system and wind energy inverters or CHP plants), then the Sunny Island can only detect the PV inverters and limit their power. No wind power inverters or CHP plants are displayed in Sunny Portal for the SMA Flexible Storage System.

Since the data from wind power inverters or CHP plants is not taken into account by the Sunny Island, the data calculated in Sunny Portal and the displayed diagrams may be inaccurate.

Can I connect a single-phase system for intermediate storage of energy to a three-phase PV inverter?

Yes: Single-phase battery-backup grids can be connected to three-phase utility grids.

Note: With single-phase Sunny Island systems for intermediate storage with three-phase inverters, the optional battery-backup function only works to a limited extent since, in the event of a grid failure, the three-phase PV inverter can not be used for battery recharge (see Planning Guidelines "SMA Energy System Home with Battery-Backup Function" at www.SMA-Solar.com).

How much maintenance work does the SMA Energy System Home involve?

The Sunny Island, the Sunny Boy Storage and the Sunny Tripower Smart Energy are largely maintenance-free (see operating manual of the inverter). Information on battery maintenance can be obtained from the battery manufacturer.

Will I receive information on the Sunny Boy Storage in Sunny Portal?

Yes: The Sunny Boy Storage is equipped with a Webconnect function as standard. The Webconnect function enables direct data transmission between the inverters of a small-scale system and the Internet portal Sunny Portal without any additional communication device and for a maximum of four inverters per Sunny Portal system. It is also possible to integrate the Sunny Boy Storage into Sunny Portal via Sunny Home Manager.

What rated power does the Sunny Island have?

For intermediate storage of PV energy in Germany, the output power of the Sunny Island inverter is limited to 4.6 kW per line conductor due to the standard requirements.

Product	Sunny Island rated output power
Sunny Island 4.4M	3300 W
Sunny Island 6.0H	4600 W
Sunny Island 8.0H	6000 W

What rated power does the Sunny Boy Storage have?

For intermediate storage of PV energy in Germany, the output power of the Sunny Island inverter is limited to 4.6 kW per line conductor due to the standard requirements.

Product	Sunny Boy Storage rated output power
Sunny Boy Storage 2.5	2500 W
Sunny Boy Storage 3.7	3680 W

Product	Sunny Boy Storage rated output power
Sunny Boy Storage 5.0	5000 W
Sunny Boy Storage 6.0	6000 W

Is it possible for two Sunny Island or Sunny Boy Storage devices to feed in via a single phase?

No: Only one Sunny Island or Sunny Boy Storage per phase is allowed to feed in.

Can I use a Sunny Island or Sunny Boy Storage only within the SMA Energy System Home?

If no automatic load control and no limitation of the active power feed-in are required, you can equip a PV system solely with a Sunny Island or Sunny Boy Storage and do without the complete SMA Energy System Home installation. With this option however, you implement only the intermediate storage of PV energy.

For a purely Sunny Island storage system, the following SMA products are required:

- Sunny Island 4.4M / 6.0H / 8.0H (SI4.4M-13 / SI6.0H-13 / SI8.0H-13)
- SMA Energy Meter

In a Sunny Island storage system, the SMA Energy Meter must be connected directly to the Sunny Island via a network cable. The Sunny Island receives no data regarding PV generation. This means that the Sunny Island cannot display some of its parameters, e.g. the increased self-consumption values.

For a purely Sunny Boy Storage system, the following SMA products are required:

- Sunny Boy Storage
- SMA Energy Meter

Can the Sunny Boy Storage be operated with three phases?

No: The Sunny Boy Storage can only be operated with one phase.

Can the Sunny Island or the Sunny Boy Storage without a Sunny Home Manager limit active power feed-in of a PV system ?

Yes: The Sunny Island or the Sunny Boy Storage without a Sunny Home Manager is able to limit active power feed-in of a PV system under the following conditions:

- Only the following device types may be used with the Sunny Island for the active power limitation: SI4.4M-13 / SI6.0H-13 / SI8.0H-13.
- A maximum of three PV inverters can be installed in the PV system.
- All PV inverters in the PV system must be equipped with Webconnect function.
- An SMA Energy Meter must be installed.

Can the Sunny Boy Storage be used as WLAN access for PV inverters?

No: As all network participants, PV inverters also need a direct WLAN access.

9 Explanation of Used Terms

Term	Explanation
Self-sufficiency quota	Current ratio of internal power supply to total consumption The loads can cover their energy demand from the PV system, from the utility grid, and from any available batteries.
Battery discharging	Power that is currently being drawn from the battery. Battery discharging takes place when the energy demand of the loads exceeds the current power of the PV system.
Battery charging	Power that is being currently charged from your system into the battery
Battery cycle	In a battery cycle, the battery is discharged once from 100% of the nominal capacity to a depth of discharge specified by the manufacturer and than recharged up to 100% of the nominal capacity.
Direct consumption	Power that the loads draw directly from the PV system Flexible loads are switched on at the time when their energy demand is completely covered by the PV system.
Self-consumption	Generated PV power is consumed at the site where it is generated. Self-consumption is made up of direct consumption and battery charging.
Self-consumption quota	Current ratio of self-consumption to PV power
Internal power supply	Supply of loads with PV energy generated on site Internal power supply is made up of direct consumption and battery discharging.
Intermediate storage	Battery charging and discharging as a measure of energy management The intermediate storage enables the consumption of PV energy independent of the time of generation, e.g. in the evening or during bad weather. This means that time-controlled electrical appliances can also be operated with PV energy.
Energy management	The total of all measures for optimizing the consumption of the energy made available by a PV system. The objective of energy management is either the highest possible self-sufficiency quota or the highest possible self-consumption quota.
Energy Management System	System for optimizing energy flows automatically and intelligently, for increasing self-consumption or improving internal power supply
Battery-backup function	Capacity of an energy management system to also function as a battery-backup system (in the context of these planning guidelines)
Grid supply	Electric power that is currently being drawn from the utility grid
Purchased electricity meter	Energy meter for recording purchased electricity
Grid feed-in	Electric power that is currently being fed into the utility grid
Feed-in meter	Energy meter for recording the grid feed-in
PV Generation	Electric power that is currently being provided by the PV system

Term	Explanation
PV production meter	Energy meter for recording the PV generation
Cycle stability	Characteristic for the service life of a battery The cycle stability indicates how many times a battery can be discharged and charged before the available battery capacity falls below a specific value (see the battery manufacturer's specifications).

10 Appendix

10.1 Planning Mounting Locations

The following products within the SMA Energy System Home with battery-backup function impose requirements on the installation site which must be taken into account at the planning stage:

Sunny Island 4.4M / 6.0H / 8.0H with:

- Battery
- Battery fuse
- Automatic transfer switching device with Sunny Home Manager 2.0

Sunny Boy Storage 3.7 / 5.0 / 6.0 with:

- Battery
- Automatic transfer switching device with Sunny Home Manager 2.0

Sunny Tripower 5.0 / 6.0 / 8.0 / 10.0 Smart Energy with:

- Battery

The following points should be considered as early as the planning stage:

- The minimum clearances to walls, objects, SMA products or other technical devices must be complied with.
- The ambient conditions at the planned deployment sites must meet the requirements the individual products place on the mounting locations.
- The maximum cable routes and radio ranges between the listed SMA products and to other devices must be feasible.
- The cable cross-sections and conductor materials of the planned cables must meet the requirements of the listed products.
- The battery room must meet the requirements of the battery manufacturer.
- Only when using the Sunny Island with a lead-acid battery: A battery fuse must be installed between the DC connection of the Sunny Island and the battery (for the requirements for the battery fuse see the inverter operating manual).

Links to additional information can be found at www.SMA-Solar.com:

Title and information content	Type of information
Sunny Home Manager 2.0	Operating manual
SMA Energy Meter	Installation manual
SMA EV Charger	Operating manual
SUNNY ISLAND 4.0M / 6.0H / 8.0H	Operating manual
Sunny Boy Storage 2.5	Operating manual
Sunny Boy Storage 3.7 / 5.0 / 6.0	Operating manual
SUNNY TRIPOWER 5.0 / 6.0 / 8.0 / 10.0 SMART ENERGY	Operating manual

The requirements made on the installation site of the automatic transfer switching device are listed in the manufacturer documentation of the switch cabinet and its components.

The requirements for the mounting location of the PV inverters used are listed in the manuals for the PV inverters.

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