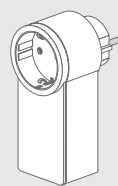
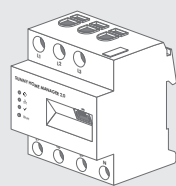
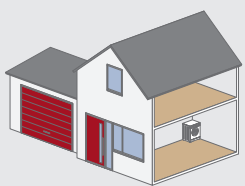


Technical Information

# SMA SMART HOME Load Control Using Relays or Contactors Example: Heating Rod



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# 1 Application

You want to switch or trigger a load (e.g., a heat pump or heating rod) using a relay or contactor in SMA Smart Home.

- You must use relays or contactors for switching loads in the following cases:
  - Three-phase (the radio-controlled socket used by the SMA Smart Home can only switch single-phase loads)
  - Single-phase with more than 3.6 kW power (the radio-controlled socket used by the SMA Smart Home cannot switch more than 3.6 kW)
- Triggering loads with triggers and control signals:
  - The load is hard-wired to the main power supply, but can be started and stopped using a control signal (e.g., for heat pumps with SG Ready control inputs).

Other assumptions:

- The load can be switched on at any time. In other words, Sunny Home Manager can select one or more periods within the user-defined time frame in which it can switch the load on or off.
- The load may have a switch-on delay or may switch off automatically when the end point is reached ("end point switch-off").
- The load's power consumption stays relatively constant while running.
- Sunny Home Manager should automatically switch the load on and off so that the load mostly consumes PV energy and incurs the lowest-possible energy costs during operation.

## Background Information

The SMA Smart Home distinguishes between two types of loads:

- Non-program-controlled loads
- Program-controlled loads

### Non-program-controlled loads

These loads must be able to switch on and off as needed. When loads are controlled by Sunny Home Manager, they can optionally be switched on whenever there is enough PV energy or whenever the actual energy costs fall below the configured maximum threshold. The load can also be switched off quickly if the switch-on condition is no longer met, as when the weather suddenly changes. To prevent loads from being switched on and off too frequently, you can configure a minimum switch-on time and a minimum switch-off time when configuring the load characteristics on Sunny Portal.

Typical non-program-controlled loads include pool pumps or heating rods in hot water storage tanks.

### Program-controlled loads

A program-controlled load runs through a preset program during operation. The program is typically selected by the user prior to operation and started by pressing the start button on the load. Once the program has started, the load should no longer be switched off.

Typical program-controlled loads include washing machines, dishwashers and dryers. To see an application example that uses a program-controlled load in the SMA Smart Home, see the "SMA SMART HOME - Load Control via MUST Time Period" technical information in the download area of Sunny Home Manager at [www.SMA-Solar.com](http://www.SMA-Solar.com).

**i Do not use relays or contactors to control program-controlled loads**

The radio-controlled socket cannot be used to measure the load's power consumption if it is controlled using a relay or contactor.

However, program-controlled loads (e.g., washing machines) have highly variable power consumption and so cannot be reasonably included in energy management without measurement data.

Non-program-controlled loads, by contrast, typically consume power at a constant rate. For that reason, SMA Solar Technology AG recommends only using non-program-controlled loads when controlling loads with relays or contactors.

## 2 Connection

The relay or contactor is switched by a radio-controlled socket. To do this, the relay or contactor has to be connected to the radio-controlled socket by a plug. The relay or contactor output then switches the load on and off.

### Requirement:

- The relay or contactor must accept a 230 V<sub>AC</sub> input signal.

### Connecting a single-phase load (> 3.6 kW)

If you have a single-phase load, the relay or contactor will switch the single-phase power supply (> 3.6 kW) on or off.

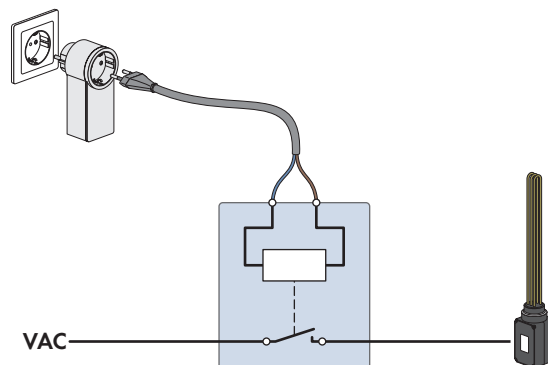


Figure 1: Connecting a single-phase load (example)

### Connecting a three-phase load

If you have a three-phase load, the relay or contactor will simultaneously switch all three phases of the power supply on or off.

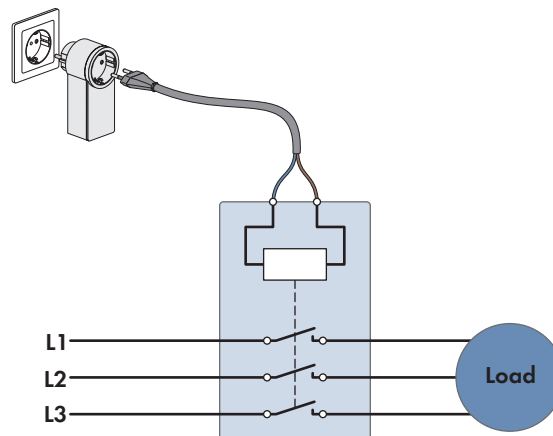


Figure 2: Connecting a three-phase load (example)

**Connecting a load with an electronic control input (e.g., SG Ready or trigger input).**

If you have a load with an electronic control input, the control input signals will be supplied by a relay with a floating switching output (e.g., from Eltako). The load is hard-wired to the power supply and always has power. When 230 V<sub>AC</sub> is applied to the relay through the radio-controlled socket, this activates the control input and starts the load.

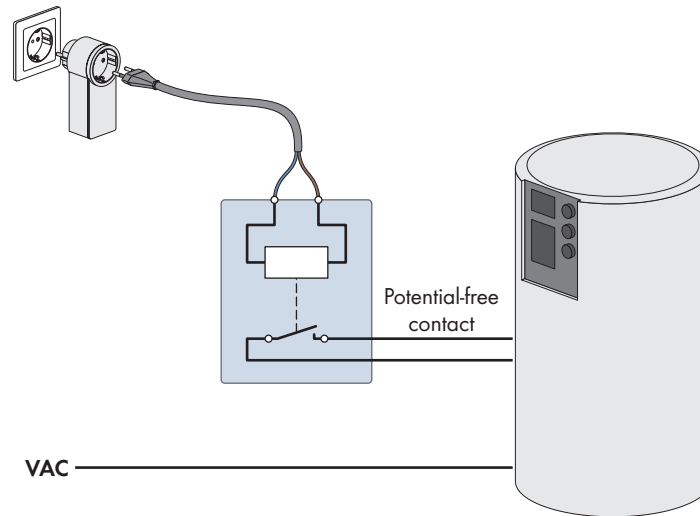


Figure 3: Connecting a load with an electronic control input (example)

## 3 Configuration

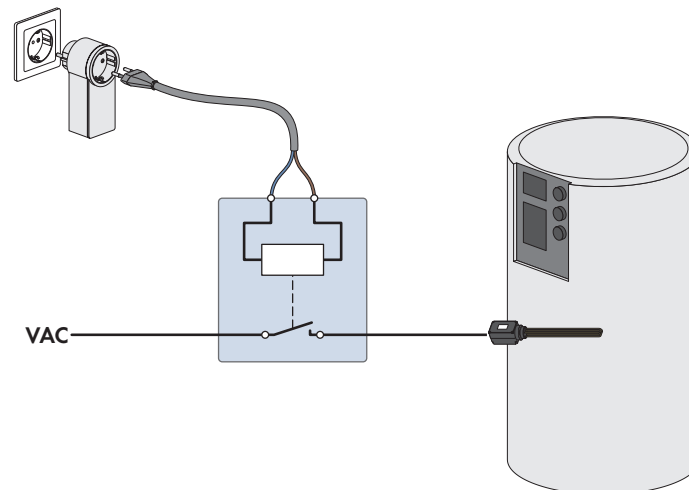
### 3.1 Configuring Load Characteristics

This document describes the settings for controlling a large heating rod with a relay or contactor.

Once the heating rod has been integrated into your SMA Smart Home with a radio-controlled socket, you will have to configure the load properties and time periods for operating the load in your Sunny Home Manager system in Sunny Portal. Sunny Portal is the user interface for Sunny Home Manager (for registration and login information, see the Sunny Home Manager installation manual).

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#### Example: Using a heating rod in the SMA Smart Home



A **high power (5000 W) heating rod** is installed in a 300 liter hot water storage tank as a supplemental heater. The main heater for the hot water storage tank is a gas heater that keeps the water temperature at 52 °C. You want to use a heating rod to heat the water another 20 K to no more than 72 °C.

In these systems, an automatic thermostatic mixer in the hot water system ensures that water comes out of the faucets, showerheads, etc. at no more than 45 °C in order to prevent scalding.

An **integrated automatic shut-off** function for the heating rod prevents the temperature from exceeding 72 °C. The automatic shut-off measures the water temperature using an integrated thermostat and disconnects the heating rod from the main power supply with an internal relay once it exceeds the preset maximum temperature.















Since the heating rod is only a supplementary heater, you want it to be powered **solely by PV energy**. This will significantly increase self-consumption of PV energy, especially in the summer months. In fact, the gas heater may stay off entirely during this time, depending on your hot water consumption.

The heating rod should run during typical sunny hours: no earlier than **6:00 am** and no later than **8:00 pm**.

To prevent the heating rod from failing prematurely from being switched on and off too frequently, it should **remain on for at least 5 minutes after being switched on** and **stay off for at least 5 minutes after being switched off**. All told, the heating rod should be on for **no more than 90 minutes per day**. During these 90 minutes, the heating rod consumes approx. 7.2 kWh. This is roughly the amount of electric energy needed to heat 300 liters of water 20 K from 52 °C to 72 °C.

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Load characteristics 

Type of Load:	Self-configured 
Programmability:	<input type="radio"/> Yes <input checked="" type="radio"/> No 
Name of Load:	Heizstab (Test)
Power Consumption:	5000 W  
Minimum Switch-on Time:	5 min 
Minimum Switch-off Time:	5 min 
Priority of the load:	low <span style="float: right;">high</span>   
Radio-controlled socket:	No assignment
After Run of Load Cycle, Radio-controlled Socket is:	Off 
Measuring and switching:	Radio-controlled socket is only to switch, not measure (fixed power consumption)  
Status during communication disturbance:	Off
Load icon:	
Load color:	




Figure 4: Configuring load characteristics

This document only describes the settings used in this example. For a detailed description, see the "Load control via CAN time period (example: pool pump)" technical information and the "Load control via MUST time period (example: washing machine)" technical information in the download area of Sunny Home Manager at [www.SMA-Solar.com](http://www.SMA-Solar.com).

Position	Setting/Explanation
-	Enter a new load called "Heating rod" in Sunny Portal.
A	<b>Type of load</b> Select <b>self-configured</b> as the type of load.
B	<b>Programmability</b> The heating rod is not program-controlled so select <b>No</b> .
C	<b>Power consumption</b> Enter the average power consumption of the heating rod during operation (see manufacturer's information on the type label for the heating rod). This value must be stated in watts (1 kW = 1000 W), example: <b>5000 W</b> . If your load has widely varying power consumption (e.g., a high inrush current and then fluctuations in power consumption over time), you will have to determine the average consumption yourself. To do this, measure the energy consumption in Wh while the load is in operation and divide this amount by the load's running time during the measurement.



Position	Setting/Explanation
D	<p><b>Minimum switch-on time</b></p> <p>This value represents the minimum number of minutes that the heating rod must stay on after being switched on.</p> <p>Loads are easier to plan in energy management if the minimum switch-on time is 5 minutes (default) or less. An average minimum switch-on time of 15 minutes is acceptable.</p> <p>Planning difficulties occur if the minimum switch-on time is long, particularly if it exceeds 30 minutes. Once the minimum switch-on time exceeds 30 minutes, Sunny Home Manager may be unable to schedule enough continuous power in its forecast over this relatively long period of time. In these cases, the load may not be switched on at all based on the CAN condition in the time period (see Section 3.2, page 10) despite the presence of enough PV energy to power the load for shorter periods.</p> <p>Also read the information about configuring the switch-on and switch-off times below this table.</p>
E	<p><b>Minimum switch-off time</b></p> <p>Enter the minimum number of minutes that the heating rod needs to stay off once it has been switched off.</p> <p>Also read the information about configuring the switch-on and switch-off times below this table.</p>
F	<p><b>Priority of the load</b></p> <p>Enter the priority that Sunny Home Manager should give to the heating rod in load control.</p> <p>Information on energy allocation:</p> <ul style="list-style-type: none"> <li>• Loads with MUST time periods receive excess PV energy first (see the "Load control via MUST time period (example: washing machine)" technical information in the download area of Sunny Home Manager at <a href="http://www.SMA-Solar.com">www.SMA-Solar.com</a>).</li> <li>• Any excess PV energy left over will be first allocated to the storage battery of any available Sunny Boy Smart Energy or Sunny Island before any loads with CAN time periods are considered.</li> <li>• Any energy left over after this step will be allocated to loads with CAN time periods based on the conditions defined for these loads.</li> <li>• If there are several loads with CAN time periods, the lowest-cost energy will be allocated to the load which you have given the highest priority using the slider. If there is not enough low-cost PV energy for all loads with CAN time periods, lower-priority loads may not be switched on at all.</li> </ul>
G	<p><b>Measuring and switching</b></p> <p>Select <b>Radio-controlled socket is only to switch, not measure (fixed power consumption)</b>. This is how you select "Only switch" mode. "Measure and switch" mode is always the default selection in the load properties so you will definitely have to change this setting.</p>
H	<p><b>Save</b></p> <p>Save the settings in order to continue configuring the time periods. An information message will appear if you have not assigned a radio-controlled socket to the heating rod. You can also assign the radio-controlled socket later while updating the load characteristics.</p>

**i Information about configuring switch-on and switch-off times**

Loads are not designed to be switched on and off an infinite number of times during their service life. Internal components such as relays can fail after several thousand switching cycles. In fickle weather conditions with highly variable PV power generation, the load may be switched on and off every few minutes because there is only enough surplus PV energy for brief periods.

You can set minimum switch-on and switch-off times when configuring the load characteristics in order to prevent loads from being switched on and off too frequently and experiencing too many switching cycles. If this is done, however, power may be drawn from the utility grid to operate the load if PV power generation drops briefly. Conversely, surplus PV energy may be "lost" during switch-off times.

If you select a long minimum switch-on time, by contrast, the load may not be switched on very often since there are very few adequately long periods in the PV power generation forecast with enough power to operate the load during the overall minimum switch-on time.

It is worth trying out different time settings in order to gradually find the best values for each load.

### 3.2 Configuring the Time Period

In the application example (see Section 3.1, page 7), the heating rod is operated as a supplemental heater for a hot water storage tank using only self-generated PV energy. The heating rod is not switched on at all if there is not enough PV energy (e.g., due to bad weather). In these cases, the gas heater keeps the hot water at a temperature of 52 °C on its own. To ensure the heating rod is only switched on when there is enough PV energy, you will have to set up a CAN time period in Sunny Home Manager.

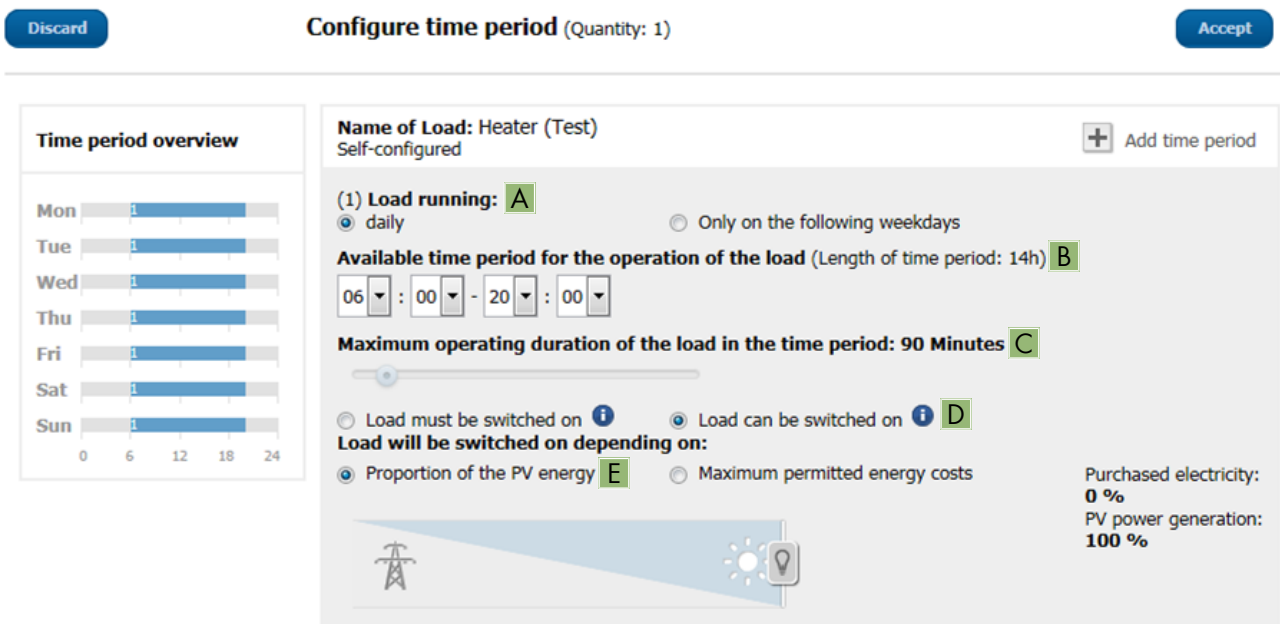


Figure 5: Configuring time periods

This document only describes the settings used in this example. For a detailed description, see the "Load control via CAN time period (example: pool pump)" technical information and the "Load control via MUST time period (example: washing machine)" technical information in the download area of Sunny Home Manager at [www.SMA-Solar.com](http://www.SMA-Solar.com).

Position	Setting/Explanation
A	<b>Load running</b> Decide whether you want the heating rod to run every day or only on certain days of the week.

Position	Setting/Explanation
B	<p><b>Available time period for the operation of the load</b></p> <p>The default time period is 8:00 am to 6:00 pm. For the heating rod in our application example, you will have to change the setting to <b>6:00 am to 8:00 pm</b> (14-hour time period). To get the most use out of your PV energy, you should select a period with relatively reliable solar irradiation so you have enough available PV energy.</p>
C	<p><b>Maximum operating duration of the load in the time period</b></p> <p>Use the slider to set the maximum operating duration of the heating rod in the time period.</p> <p><b>Information:</b></p> <ul style="list-style-type: none"> <li>• The configured value should correspond to the load's function.</li> <li>• The configured value may not exceed the total duration of the time period minus the minimum switch-off time (see Section 3.1 "Configuring Load Characteristics", page 7). In our example, this means: 14 hours - 5 minutes = 13 hours and 55 minutes. The heating rod in our example should not be on for more than 90 minutes per day, however, so the value is set to <b>90 minutes</b>. This value corresponds to the total estimated amount of energy needed to heat up 300 liters of water by 20 K.</li> </ul>
D	<p>Select <b>Load can be switched on</b>.</p> <p>To learn more about loads set to <b>Load must be switched on</b>, see the "SMA SMART HOME - Load control via MUST time window" technical information in the download area of Sunny Home Manager at <a href="http://www.SMA-Solar.com">www.SMA-Solar.com</a>.</p>
E	<p><b>Load will be switched on depending on</b></p> <p>Make the following settings to only switch on the heating rod in this example when there is enough PV energy available:</p> <ul style="list-style-type: none"> <li>• Select <b>Proportion of PV the energy</b>.</li> <li>• Use the light bulb slider to set the value to <b>100 % PV generation</b>.</li> </ul> <p>These settings ensure the following:</p> <ul style="list-style-type: none"> <li>• The heating rod is only powered by PV energy.</li> <li>• The heating rod, which consumes 5000 W of power, will only be switched on if Sunny Home Manager expects to have at least 5000 W of excess PV energy in its PV generation forecast for at least the minimum switch-on time configured for the heating rod on that day. This means that the heating rod may not be switched on at all on low-sun days.</li> <li>• The heating rod will be operated solely with excess PV energy for no longer than the specified maximum operating duration as long as the PV system is large enough, there is a lot of solar irradiation and not much power is being consumed in your home on that day.</li> <li>• The heating rod will be switched on even if you consume no hot water and the water temperature in the hot water storage tank thus stays relatively constant over the day. If this happens, the heating rod will switch off automatically due to the integrated automatic shut-off function and consume no additional energy even though the radio-controlled socket is on.</li> </ul>

## 4 Control via Sunny Home Manager

In load planning, Sunny Home Manager uses the configured load properties and time periods to identify one or more suitable times to switch on each load as well as the right duration to leave the load switched on.

The load is started or the start command is sent when Sunny Home Manager switches on the radio-controlled socket:

- The radio-controlled socket stays on for the entire "switched on" period scheduled by Sunny Home Manager even if the load does not start running immediately (switch-on delay) or switches off early after detecting an end point.
- A delayed switch-on or premature shut-off of a load can be detected by analyzing the basic household consumption, especially if the loads have high power consumption.
- Sunny Home Manager considers the load's switching behavior in load planning in order to allocate the freed-up PV energy to other loads.

The load may be switched on or off several times during the specified time period depending on your chosen minimum switch-on and switch-off times and the amount of usable PV energy calculated in the PV generation forecast.

## 5 Display on Sunny Portal

If Sunny Home Manager switched on the load, Sunny Portal will always show the preset power consumption on the **Load balance** page.

If the load actually consumes a different amount of power, switches on later due to a switch-on delay, or switches off prematurely due to an end point switch-off, this will not show up in the display. However, Sunny Home Manager will detect the switching operation and allocate the freed-up energy to other loads.

### Load Balance and Control

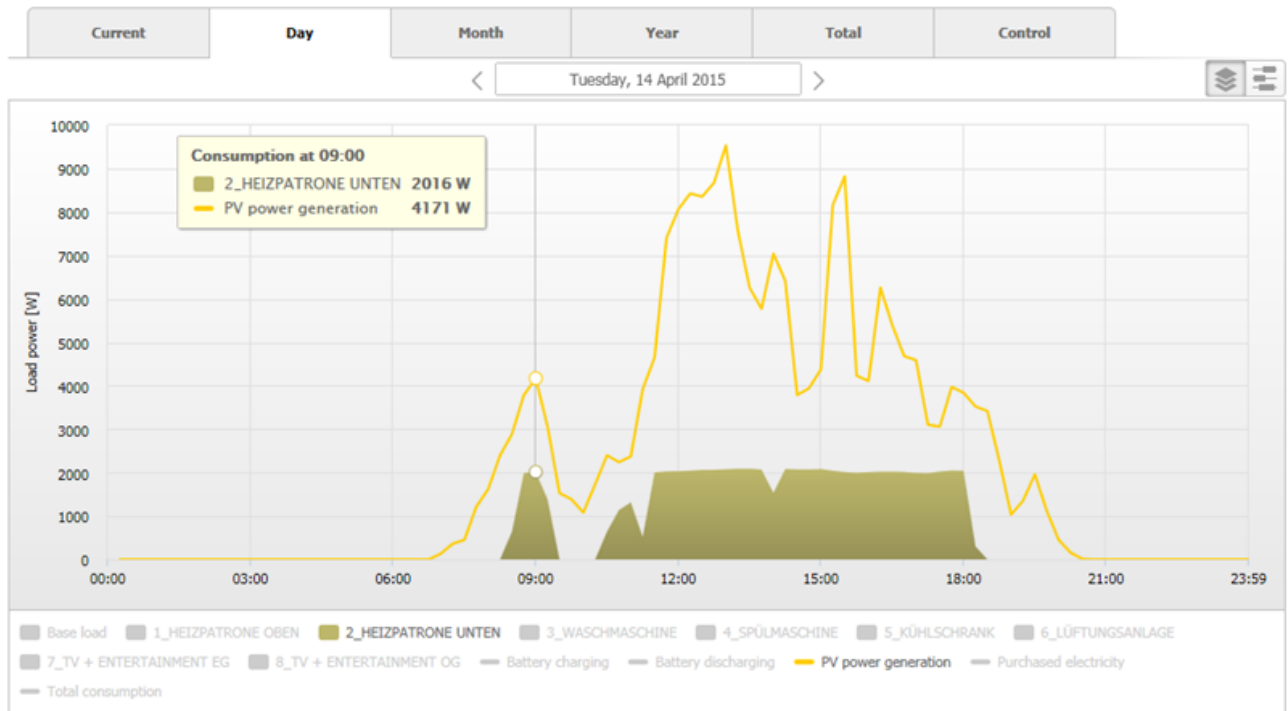


Figure 6: Chart on the **Load Balance and Control** page depicting a 2,000 W heating rod on a day with variable weather (example)

## 6 Things To Know

### **i** Loads with low power consumption

Sunny Home Manager may not detect when controlled loads with low power consumption (e.g., < 250 W) are switched on with a delay or are switched off automatically after reaching an end point. If either of these things occurs, Sunny Home Manager will be unable to allocate freed-up energy to other loads.

### **i** Do not switch three-phase loads using separate switching elements for each phase

Three-phase loads should not be switched using separate switching elements (e.g., radio-controlled sockets) for each phase. The radio-controlled sockets may not switch all three phases simultaneously. This may create brief windows of time in which the load only draws power from one or two phases.



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