SolarEdge Smart Energy Management - Introduction

To improve grid stability, electrical utilities or local regulations may limit the amount of PV power that can be fed-in to the grid or allow no feed-in whatsoever, while allowing the use of PV power for self-consumption. Increasing demand from utilities to have such limitations in place and introduction of regulations limiting the amount of feed-in power has led to the development of the SolarEdge Smart Energy Management (SEM) solution.

The SolarEdge Inverter as System Energy Manager

With the SEM feature, a SolarEdge device - inverter or Control and Communication Gateway (CCG)[1] - dynamically adjusts the PV power production in order to ensure feed-in power does not exceed a preconfigured limit. If power reduction is needed to ensure that the feed-in limit will not be exceeded, the inverter will limit the energy harvested from the modules. Besides an energy meter, no additional control hardware or electro-mechanical disconnects are needed.

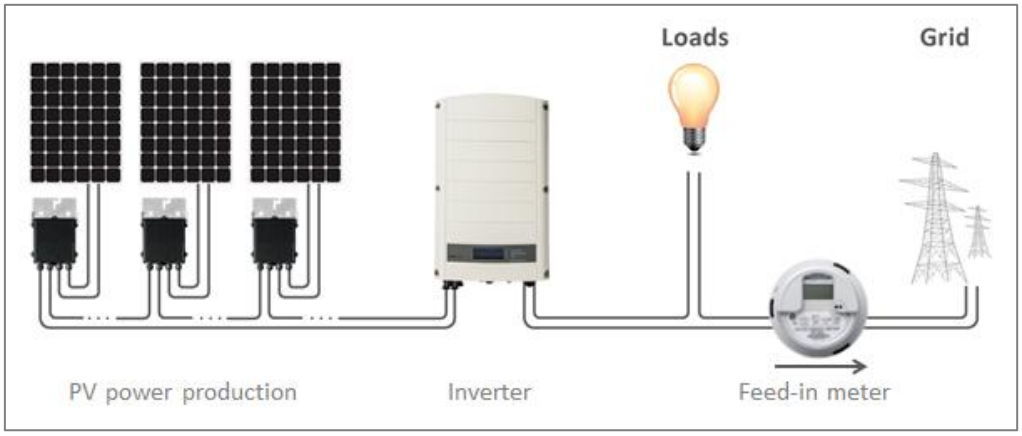


Figure 1a – Typical installation with meter measuring feed-in

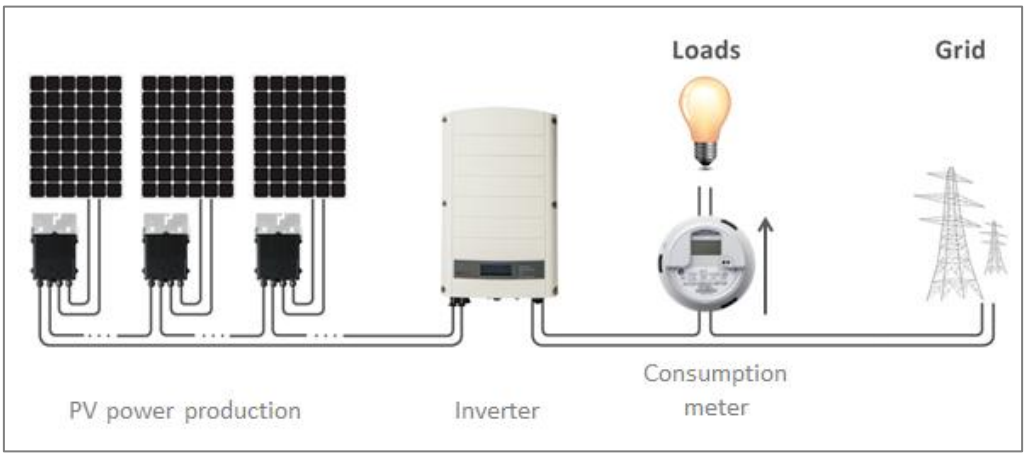


Figure 1b – Typical installation with meter measuring consumption

The feed-in limit is configured in the inverter using the inverter user interface; optionally this limit can be locked after setting to prevent configuration by unauthorized personnel. The inverter reads the feed-in power from a meter installed at the grid connection point or reads the consumption from a meter installed at the load consumption point and adjusts PV power production according to the preconfigured limit. The inverter has a response time of 2sec.

In accordance with EEG2012 and the technical recommendations by FNN ("Hinweise zur technisch/ betrieblichen Umsetzung des Einspeisemanagements", FNN, June 2012) in Germany, SEM complies with the 10min average value.

In a multi-inverter system, one inverter will serve as the SEM master, ensuring that the total system feed-in power is below the preconfigured limit.

SolarEdge single and three phase inverters can operate as system energy managers. Inverters sold or installed prior to SEM availability can be firmware upgraded to support this functionality.

[1] The document refers to an inverter as the SolarEdge device, but is applicable to the CCG as well.

Maintaining the Feed-in Power below the Limit

Fast Response Time

The SEM operates with a fast response time, ensuring that even with rapid changes in load consumption and PV production the feed-in power does not exceed the limit. The inverter reads the meter and if needed adjusts the modules' operating point within 2sec, ensuring that the feed-in power limit is not exceeded for longer than 2sec from the moment of increase above the limit.

The inverter maintains the output power limit with accuracy equal to that of the meter used.

Failsafe Operation

The SEM operation is failsafe, guaranteeing that even if there is a communication failure, the feed-in power will never exceed the preconfigured limit. Examples:

- If communications between the SEM master and the meter fail, the system will limit the PV power production to the feed-in power limit, ensuring that regardless of the loads' behaviour the feed-in power limit will not be exceeded.
- If communications between the SEM master and another inverter fail, that inverter will limit PV power production to its relative portion of the feed-in power limit, while the SEM master will maintain system feed-in power at or below the limit.

Meter Support

Two types of meters may be used: meters with an S0 interface and meters with an RS485 interface.

Meters with an S0 Interface

Meters with an S0 interface transmit energy measurements with pulses, using a dry contact relay. The pulses are then counted and represented as kWh values.

Any meter with an S0 interface may be used. It will connect directly to a SolarEdge inverter using an interface cable available from SolarEdge. In a multi-inverter system, the inverters are connected on an RS485 bus and the meter is connected via the interface cable to the inverter that serves as the SEM master.

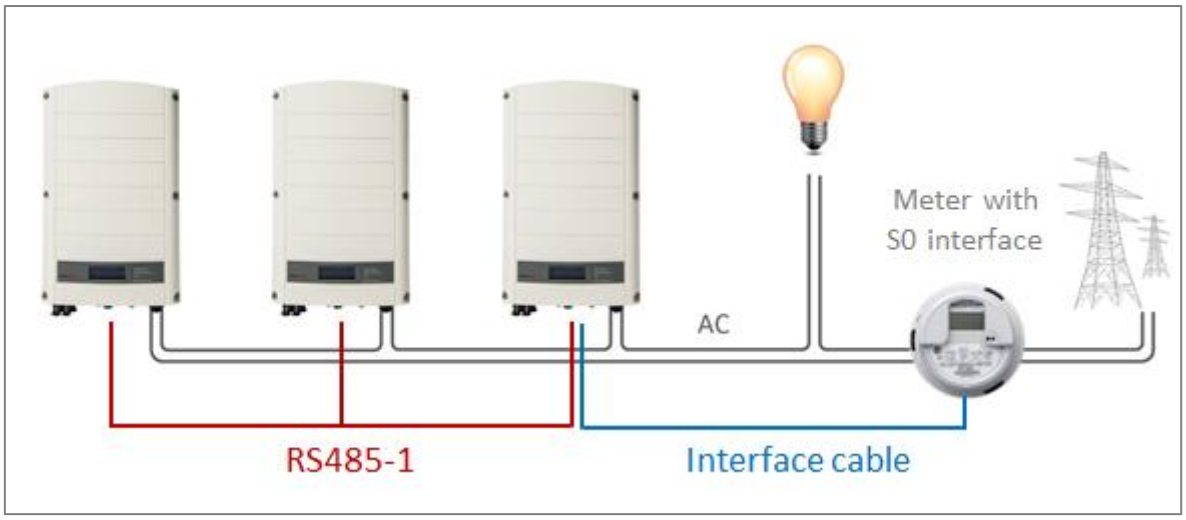


Figure 2[1] – multi-inverter connection with S0 meter

[1] The following figures show systems with a meter measuring feed-in, but are applicable to systems with meters measuring consumption as well.

Meters with an RS485 Interface

Meters with an RS485 interface connect to the RS485 terminal block of the SolarEdge inverter or CCG. For a list of supported RS485 meters, refer to the Application Note “Connecting a Revenue Grade Meter to SolarEdge Devices ROW” available here, which details which supported meters can be used for SEM.

In a single-inverter system, the meter is connected directly to the inverter’s RS485 connector. Optionally, the inverter and the meter can each be connected to a CCG, which will serve as the SEM master instead of the inverter.

In a multi-inverter system, the inverters are connected on an RS485 bus together with a CCG, and the meter is connected to the CCG on a second RS485 bus (RS485-2).

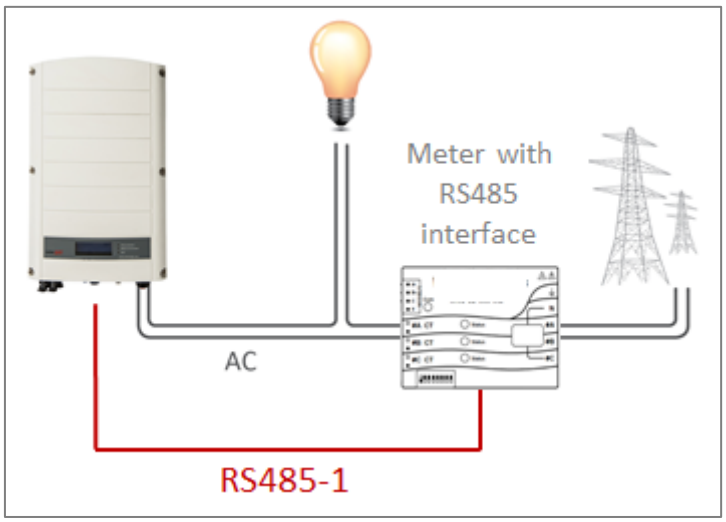


Figure 3 – single-inverter connection with RS485

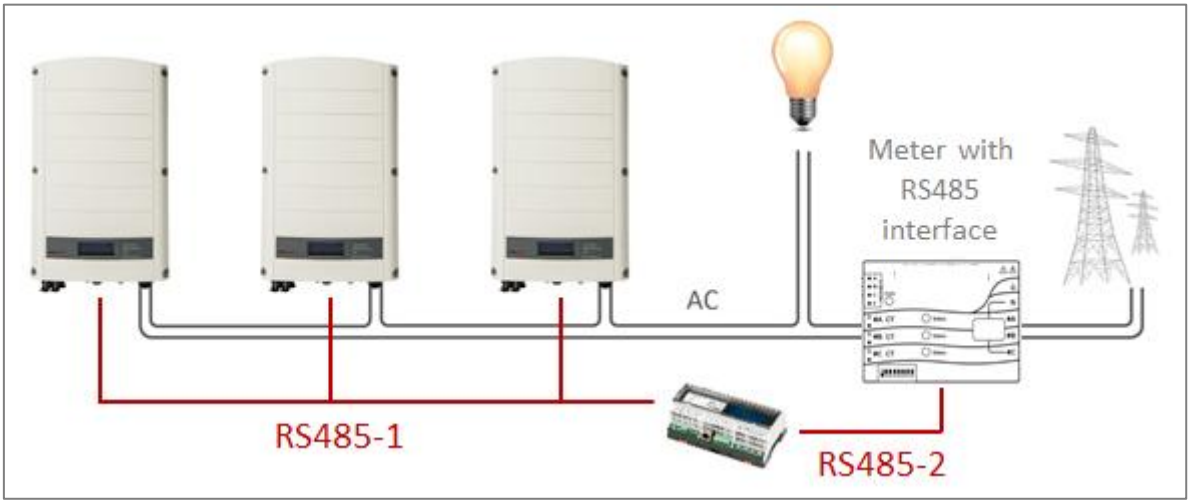


Figure 4 – multi-inverter connection with RS485 meter and CCG

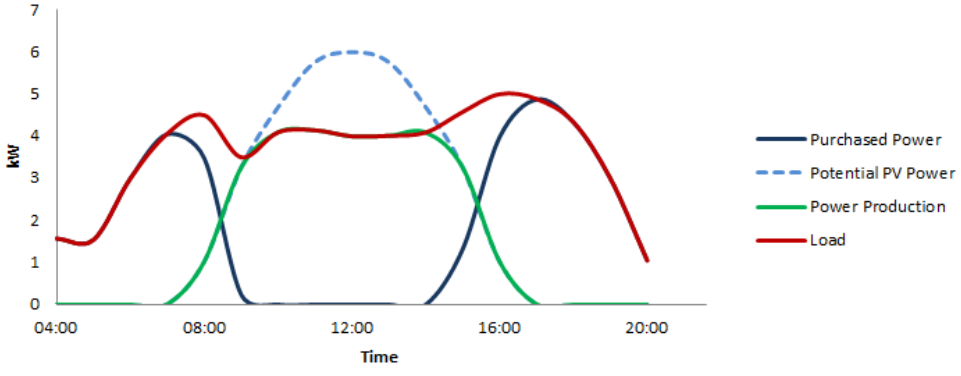
SEM – Operation Example 1

The following example illustrates the behavior of a SEM system with an inverter that has a maximum AC output power of 6kW. The system feed-in power limit is set to 0W – no feed into the grid.

	Potential PV Power	Power Production	Load	Feed-in Power*
6AM **No PV production** **Loads powered from grid**	0kW	0kW	3kW	-3kW
8AM **PV production lower than loads** **Loads powered from PV & from grid**	1kW	1kW	4.5kW	-3.5kW
9AM **PV production equal to load** **No power to/from grid**	3.5kW	3.5kW	3.5kW	0kW
12PM **PV potential greater than load** **PV production limited to maintain feed-in limit** **No power to/from grid**	6kW	4kW	4kW	0kW

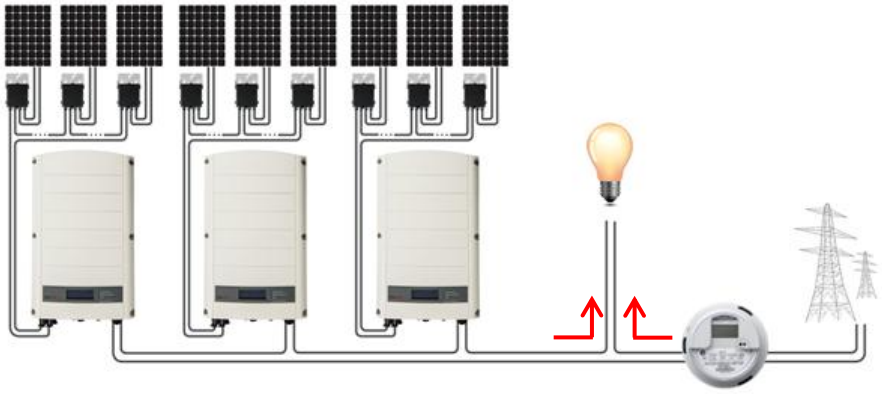
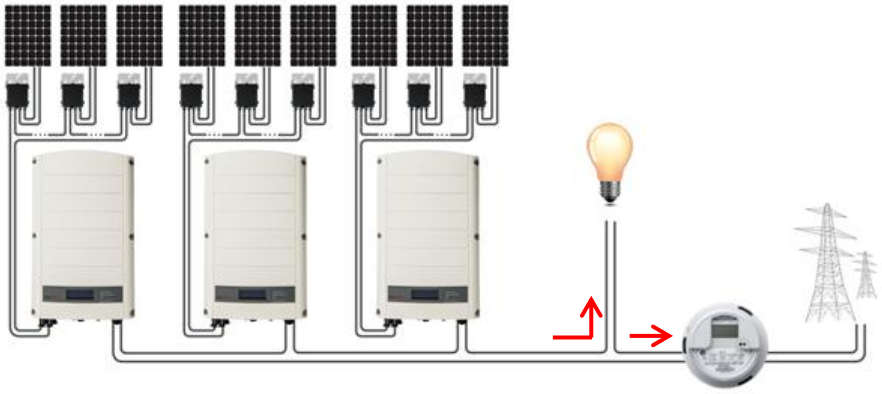
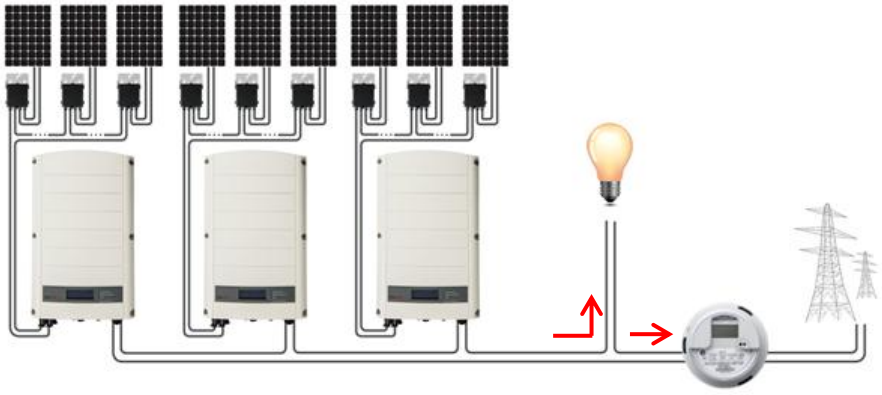
* Minus sign indicates power is purchased from the grid

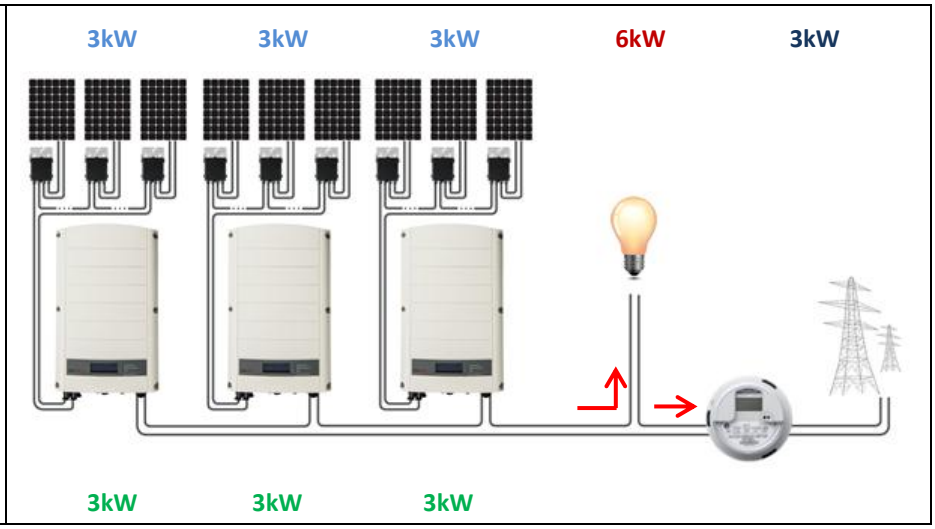
The overall behavior of the system throughout the day can be seen in the following chart:



SEM – Operation Example 2

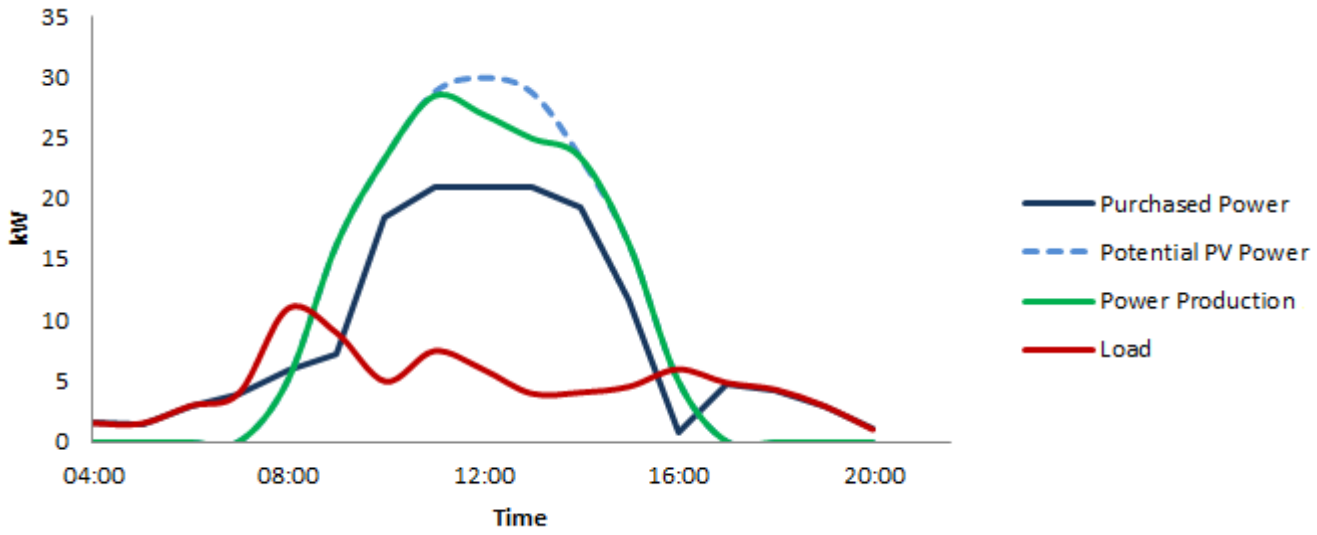
The following example illustrates the behavior of a SEM system with 3 inverters. Each inverter has a maximum AC output power of 10kW, and the system is connected to 30kW DC power. The system feed-in power limit is set to 70% of max DC power, i.e. to 70% x 30kW = 21kW.

	Potential PV Power Power Production	Load	Feed-in Power*
8AM **PV production lower than loads** **Loads powered from PV & from grid**	3kW 3kW 3kW  3kW 3kW 3kW	11kW	-2kW
9AM **PV potential greater than load** **Loads powered from PV** **PV feed-in to grid**	6kW 6kW 6kW  6kW 6kW 6kW	5kW	13kW
12PM **PV potential greater than load** **PV production limited to maintain feed-in limit**	10kW 10kW 10kW  9kW 9kW 9kW	6kW	21kW

4PM **PV potential greater than load** **Loads powered from PV** **PV feed-in to grid**	

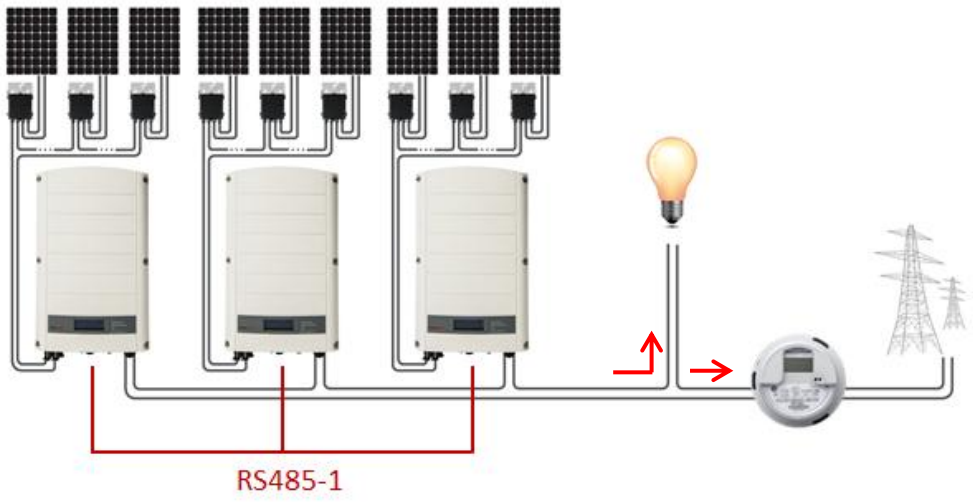
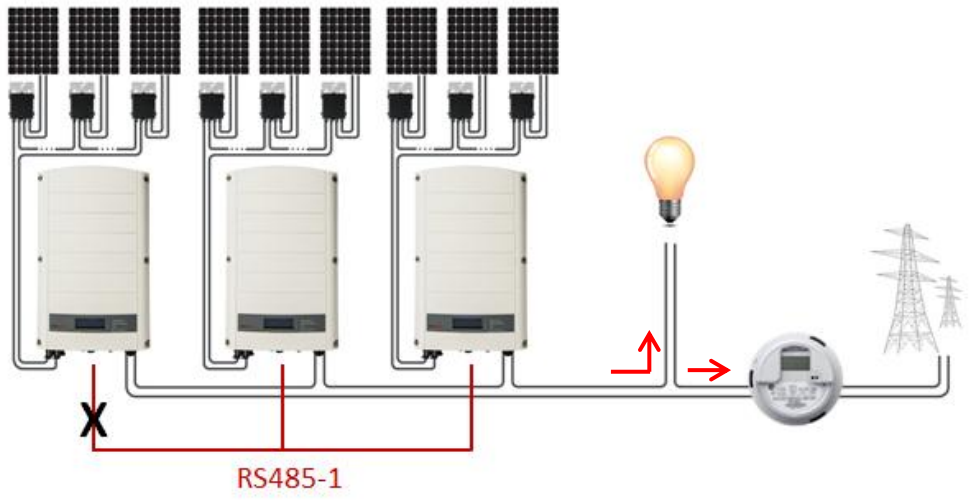
* Minus sign indicates power is purchased from the grid

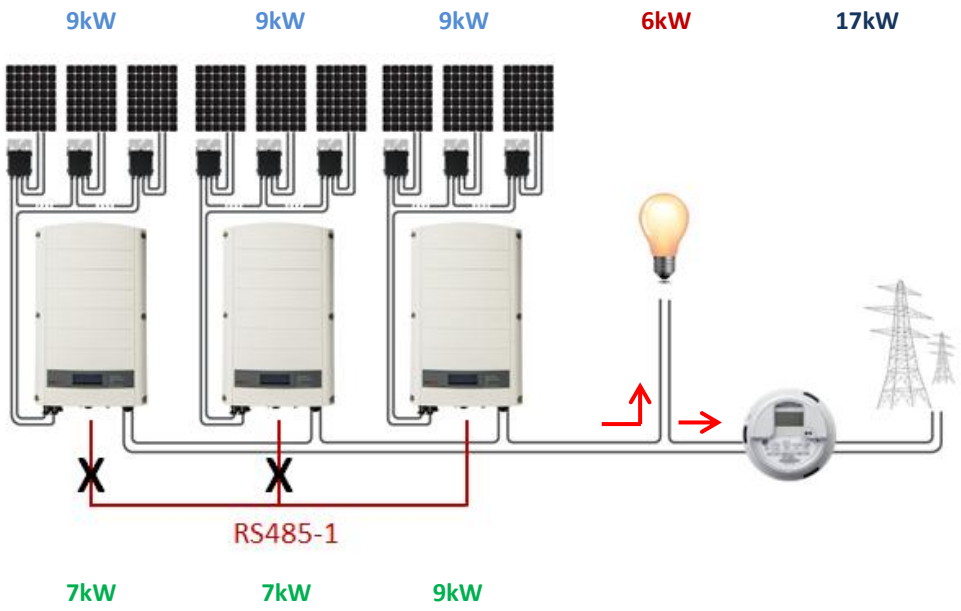
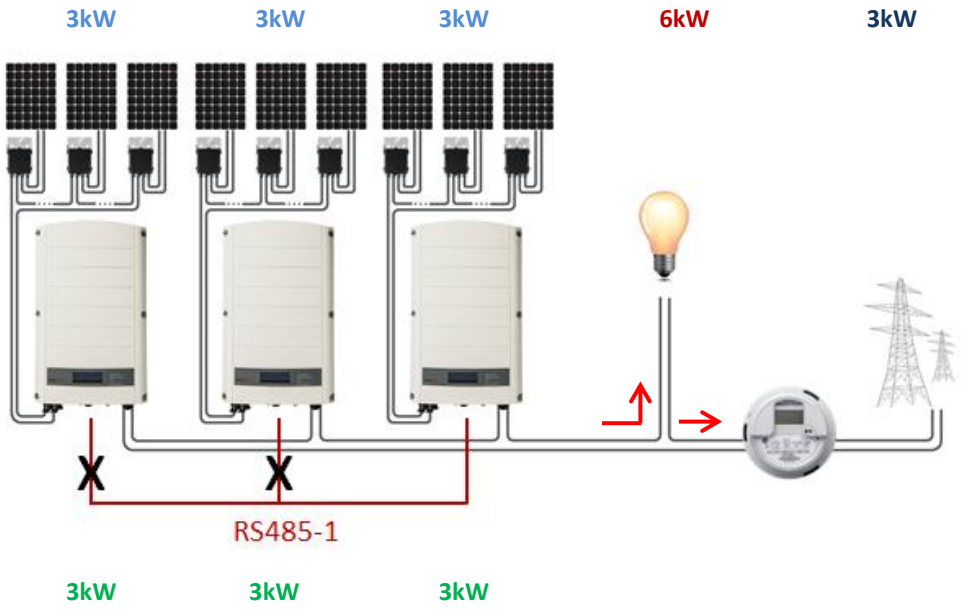
The overall behavior of the system throughout the day can be seen in the following chart:



SEM – Operation Example 3 – Failsafe Function

The following example illustrates the behavior of the same system as in Example 2, during a communication failure. In such a case the non-communicating inverter will limit its power generation to the pre-configured limit, in this case 70% of its maximum power.

	Potential PV Power Power Production	Load	Feed-in Power
8PM **PV potential greater than load** **Loads powered from PV** **PV feed-in to grid**	6kW 6kW 6kW  6kW 6kW 6kW	11kW	7kW
9PM **1 inverter has disconnected comm. and reverts to the power feed-in limit** **PV potential greater than load** **Loads powered from PV** **PV feed-in to grid**	9kW 9kW 9kW  7kW 9kW 9kW	5kW	20kW

12PM **2 inverters have disconnected comm. and revert to the power feed-in limit** **PV potential greater than load** **Loads powered from PV** **PV feed-in to grid**	
4PM **2 inverters have disconnected comm. but are producing less than the default power feed-in limit and therefore no power is lost** **PV potential greater than load** **Loads powered from PV** **PV feed-in to grid**	

The overall behavior of the system throughout the day can be seen in the following chart. Power production with no communication failure (i.e. the power production shown in Example 2) is displayed for reference. It can be seen that during a communication failure very little power is lost, and the feed-in power limit is never exceeded: