

# Installation instructions for the "Smart Grid Manager" scene

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## Skills required:

- Familiarity with the FIBARO Home Center 3 environment
- Familiarity with the basics of the operation of specific devices integrated into the euLINK gateway (e.g. HVAC, PV, EV, HP, etc.).
- No knowledge of LUA or other programming techniques is required

## 1. Where to start?

The first chapters describe the 'Smart Grid Ready' concept and the basic concepts of building infrastructure. If this concept is already familiar, you can skip the initial chapters and start with the description of how the scene works in chapter 4 on page 5.

Reading the entire document - including a description of the "Smart Grid Ready" concept - will take about 20 minutes.

## 2. Basic building infrastructure abbreviations: MODBUS, HVAC, PV, EV, AC, etc.

This manual often uses abbreviations, derived from the English language, the most important of which are worth explaining at the outset:

- MODBUS - Open communication protocol using serial links (MODBUS RTU) or TCP/IP network (MODBUS TCP)
- HVAC - *Heating, Ventilation, Air Conditioning* or other indoor climate management
- AC - *Air Conditioning*, included in HVAC
- PV - *Photovoltaics*, sometimes including Energy Storage
- ES - *Energy Storage*, mainly electricity, sometimes also heat
- EV - *Electrical Vehicles* and their chargers
- HP - *Heat Pumps*, i.e. equipment for heating buildings and hot water, typically classified as HVAC
- DHW - *Domestic Hot Water*
- RES - *Renewable Energy Sources*, i.e. the extraction of energy from wind, solar radiation, waves and tides, etc.
- SG - *Smart Grid*, i.e. intelligent energy grid

## 3. The "Smart Grid Ready" concept

The best justification for the 'Smart Grid Ready' concept is modern heating equipment - **heat pumps**.

As well as heating the home cleanly, quietly, safely and ecologically, a heat pump can also provide a simple and effective store of thermal energy. We can force the heat pump to heat the water in the DHW tank to a much higher temperature than normal - which, after all, is always some kind of compromise between needs and economy. The euLINK gateway can reprogram the target temperature in the DHW tank, forcing the heat pump to dramatically increase its electricity consumption, sometimes even forcing the heat pump to switch on the immersion heater in the water tank. During the heating season, the temperature of the water pumped by the heat pump into the underfloor heating system can also be raised a little. If there is a photovoltaic installation in the building, the euLINK gateway can detect that a large overproduction of energy from the sun is being fed back into the grid and can automatically switch the

heat pump to a mode of increased electricity demand. In this way, even in the absence of householders, the self-consumption of energy can be improved, which is always more cost-effective and technically correct than feeding energy back into the grid.

For this reason, many heat pump manufacturers are equipping their latest products with the *Smart Grid Ready* function<sup>1</sup> (*SG-Ready*) for, among other things, tariff control. Using this function, the electricity supplier can remotely control the operating mode of the heat pump at the energy consumer. Four basic operating modes have been defined for the *SG-Ready* function:



1. blocking action (hereinafter: **SG-1**)
2. normal operation (**SG-2**)
3. increased energy consumption mode (**SG-3**)
4. maximum energy consumption mode (hereinafter: **SG-4**)

In the latter mode, the heat pump heats the DHW tank water with all its available capacity up to the maximum temperature allowed by the manufacturer. With some modern heat pumps, the euLINK gateway does not even need to reprogram the target DHW tank water temperature, as sending a mode change command to **SG-4** is sufficient to increase the heat pump's power requirement. However, if the heat pump is not factory-equipped to support *SG-Ready* modes, an appropriately prepared euLINK template can provide the function of setting **SG** modes as a 'multi-level switch' in HC3. This function is then implemented by the euLINK gateway in the form of a command, increasing the DHW tank water temperature set point to the maximum allowed level, e.g. 60°C.

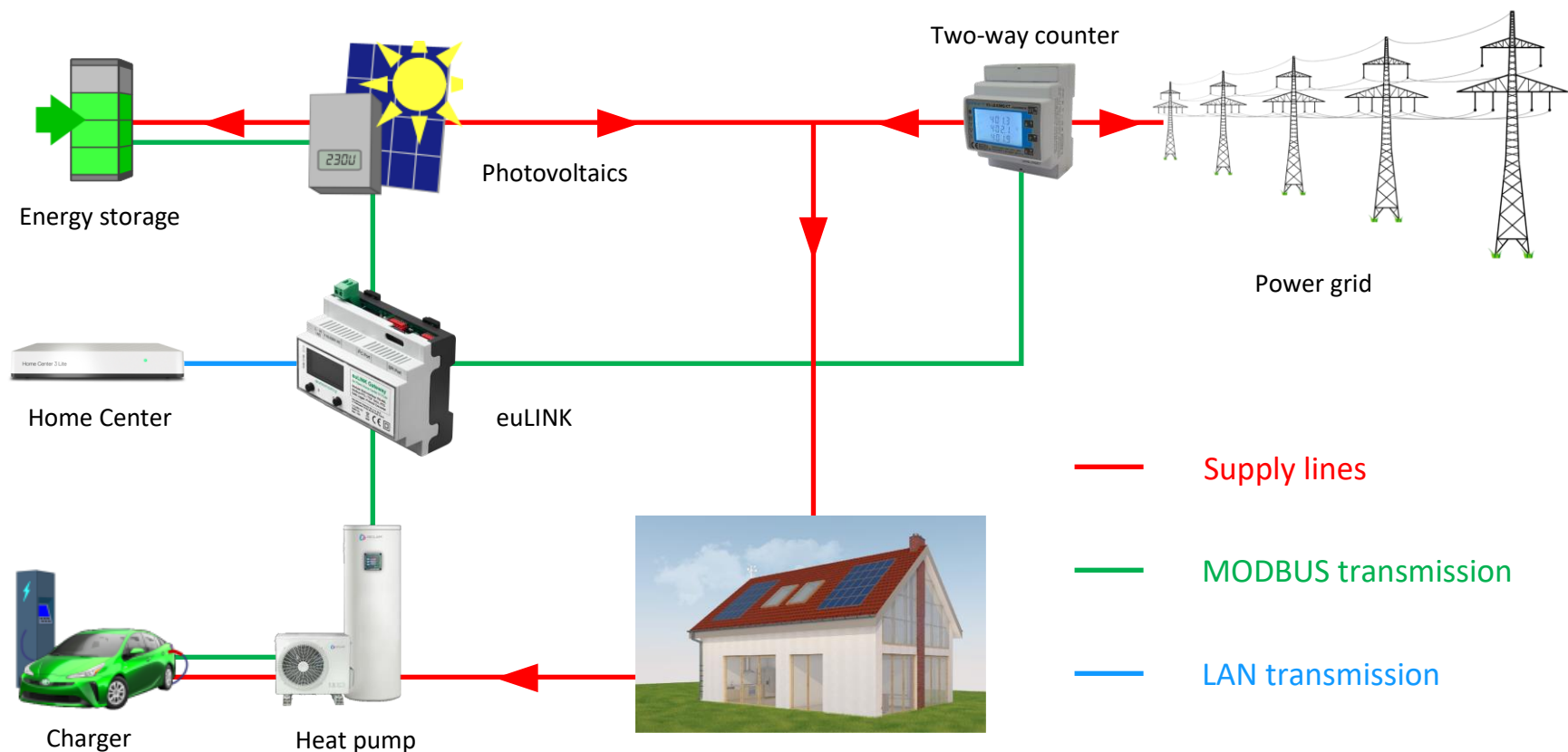
Originally, it was up to the electricity supplier to remotely control the mode of operation of home appliances. However, **the Smart Home** has relevant information (e.g. local production and current energy consumption), so in many cases the decision to change the mode of appliances can be made autonomously by the Smart Home software, without waiting for a signal from the energy supplier.

Energy produced at home by RES (e.g. photovoltaics, wind turbines, etc.) can either be fed back into the grid or consumed on site (this is the self-consumption mentioned above). Optimising the flow of this energy from the sources to the various consumer devices is not an easy task. A PV installation, even in a small house, can provide energy measured in kilowatts (5-10kW installations are the most popular), while the energy requirements of ordinary household appliances tend to be in the tens or hundreds of watts. The few appliances with higher power consumption (e.g. heat pump, air conditioners, electric car charger) reach their maximum demand when household members return home after work, i.e. in the afternoons and evenings - when photovoltaic energy production practically drops to zero. It is possible to invest in the purchase of electricity storage or to use the SG-4 function in the heat pump. However, neither of these

<sup>1</sup> The term '*Smart Grid Ready*' and the associated label was developed by the [Bundesverband Wärmepumpe \(BWP\) e.V.](#) association

devices with higher energy consumption "knows" by itself when it should go into increased power consumption mode. Some energy storages and heat pumps have the function for communicating with photovoltaics built in at the factory, but this is subject to a number of restrictions, e.g. they must be specific units from a designated manufacturer. However, it is difficult to find air conditioners or washing machines with this function on the market. And none of these appliances take into account the user's preferences in terms of a priority list. After all, if there are several energy consumers and the current surplus of energy from photovoltaics (overproduction) is insufficient, the question of which appliances should be switched off and in which order they should be switched off and on has to be answered. Of course, in the algorithm under discussion, the term 'Switch on' or 'Switch off' does not mean a straightforward disconnection of its power supply, but merely sending a subtle request via the euLINK gateway in the MODBUS protocol to smoothly change the operating mode, as far as the autonomous capabilities of the integrated HVAC/PV/EV device are concerned.

The diagram below illustrates a possible way of connecting devices to the euLINK gateway:



#### 4. Description of the operation of the "Smart Grid Manager" scene

So let us consider the following list of **four** groups of popular devices, ranked in exemplary order of attachment according to user preference:

- EV - charger (or several chargers) of an electric car
- AC - air conditioning (one or more air conditioners)
- HP - heat pump
- ES - electrical energy storage (battery bank)

Of course, another user may prefer a different order, but this can easily be changed.

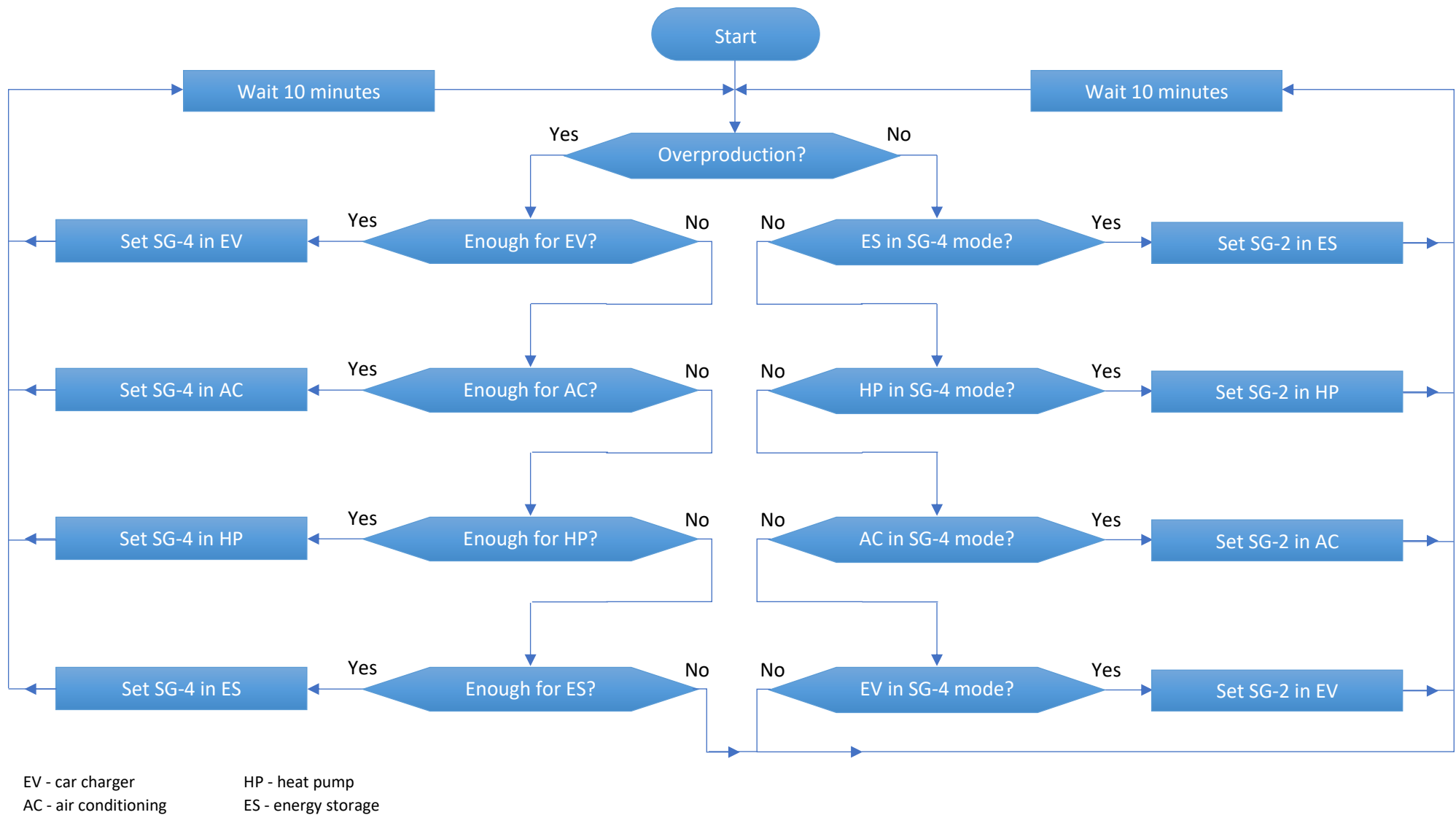
Each photovoltaic inverter knows the amount of energy currently produced, and most also work with a two-way energy meter mounted at the point of contact between the home installation and the power grid, so the amount of overproduction is known and should be included in the euLINK template.

So we can build a scene in HC3 that periodically reads the amount of overproduction from the PV or the meter and compares it with the power demand of the following devices from the list above: EV, AC, HP and ES. If the overproduction is sufficient and the unit was in the normal SG-2 mode, the unit is switched to the enhanced power demand mode (SG-4). When the unit is set to SG-4 mode, the scene returns to the start of the algorithm, waits 10 minutes, re-reads the PV overproduction value and the cycle repeats. If a device is already in SG-4 mode, it is skipped and the scene continues to the next device in sequence. It is to be expected that when SG-4 mode is activated, the overproduction value will drop by as much as the additional consumption of the device in SG-4 mode. If the counter reading indicates no overproduction, the devices are individually returned to SG-2 mode in reverse order of the defined priority list.

There is no point in waiting less than 10 minutes, as it can take several minutes for some EV/AC/HP/ES devices to start up and only then will the impact on the energy measurement result become apparent. Also, short-lived cloudiness does not cause any nervous reactions of the integrated devices. Furthermore, the *Smart Grid Ready* standard requires that changes occur no more frequently than every 10 minutes. As a result of such a scene, it is certain that, on a sunny day, the devices most important to users will operate "for free" for many hours. ☺

The scene maker just needs to remember to treat the amount of overproduction as a negative number, because a positive reading in turn indicates energy intake from the grid, not local production. Of course, it is worth adding some reasonable margin, e.g. increase the appliance demand by 10% before comparing the output, to make the system immune to minor fluctuations in overproduction from PV and momentary fluctuations in the energy consumption of individual appliances. It is worth observing the graph of overproduction in HC3 for a few sunny days, as it will be possible to deduce from this graph, for example, the need to increase the margin slightly.

The operation of the 'Smart Grid Manager' scene can be described graphically using the following algorithm:



## 5. Installation of the "Smart Grid Manager" scene

Please note that this is an example scene, which you should adapt to your own system configuration. The example given should therefore be regarded as an inspiration rather than a ready-made 'recipe' to be used indiscriminately.

### a) Preparation and prerequisites

- The HC3 software version should be as up-to-date as possible, and at least **5.142** or later.
- The euLINK gateway must be version **2.0** or later,
- You must log in to the HC3 control panel with a user account that has rights to create scenes and devices (e.g. **administrator**).
- All integrated devices (EV/AC/HP/ES) should be previously installed in the euLINK gateway, tested and imported into the HC3 control panel. A detailed description of the procedure can be found in the [Guide for Integrators - euLINK MODBUS](#) (reading time: 2h).

### b) Downloading the installation package

The installation package can be downloaded by clicking on the link below:

<https://www.eutonmy.com/download/eulink/hc3/smart-grid-mngr.zip>

You should save it on your computer in a familiar location, as it will be used several times later. It is therefore best to create a separate folder and unzip the files comprising the contents of the set there:

File name:	Purpose of the file:
smart-grid-mngr-doc-en.pdf	<b>This Manual</b>
smart-grid-mngr-setup.fqa	Definition of a QuickApp object, controlling the operation of the "Smart Grid Manager" scene, to be uploaded when creating a device from a file
smart-grid-mngr-scene-trigger.lua.txt	Scene triggers to paste in the DECLARATIONS window of the LUA editor
smart-grid-mngr-scene-actions.lua.txt	LUA code of the scene to paste in the ACTIONS window of the LUA editor
smart-grid-mngr.png	Optional icon that can be assigned to the QuickApp object

### c) Installation of the "Smart Grid Setup" tool for HC3 scene configuration

Householders should be able to configure the operation of this scene, e.g. to exclude any device from the scene (Manual Mode), to include a device in the scene (Automatic Mode) and to change the order of operation of EV/AC/HP/ES devices (priority). For this purpose, a small QuickApp panel is included as a **smart-grid-mngr-setup.fqa** file. Use this file to create a new QuickApp device by following the steps below:

- Log in to HC3 with administrator rights
- Select: *Settings => Devices => Add device => Other device => Upload from file*
- Point to downloaded file **smart-grid-mngr-setup.fqa**
- Assign the resulting device to the correct room and, if necessary, adjust its name to suit your needs
- Optionally, use the "+" button and the *Add Icon* command, point to the included **smart-grid-mngr.png** file and select the newly created icon
- Save this change to the device configuration.

At this stage, the panel is still empty, it only asks for some value to be given to the variable "Grid\_Pwr\_Mtr\_ID". There are more of these variables, by the way, and they all contain zeros at the factory, and for the scene to work correctly you need to give these variables the right values. It is therefore necessary to go to the list of device variables and fill in the individual values. The meaning of the variables is described in the table below:



Variable name	Example value	Description
Grid_Pwr_Mtr_ID	417	Identifier of the instantaneous power meter, measured at the point of contact with the power grid
EV_Device_ID	418	SG module identifier of the electric car charger
AC_Device_ID	419, 422, 425	SG module identifiers of air conditioners (may be more than 1)
HP_Device_ID	420	SG module identifier of the heat pump
ES_Device_ID	0	SG module identifier of the energy storage (value 0 means no device in the system)
EV_Power_Demand	5000	Increase in charger power demand in <b>SG-4</b> mode, expressed in watts
AC_Power_Demand	1300	Increase in power demand of a group of air conditioners in <b>SG-4</b> mode, expressed in watts
HP_Power_Demand	3500	Increase in heat pump power demand in <b>SG-4</b> mode, expressed in watts
ES_Power_Demand	4000	Increase in power demand of energy storage in <b>SG-4</b> mode, expressed in watts

When each device is created or imported, the HC3 control panel assigns it a unique numerical identifier, which scenes and other QuickApp objects will have to use when communicating with the device. In each system, these identifiers therefore have different values, depending on the list of previously installed devices. The identifier can be read from the device's panel or its configuration, and is also presented by the euLINK gateway when the device is imported into HC3. It is therefore necessary to determine the identifier of the power meter and the identifiers of the devices belonging to the EV/AC/HP/ES groups. There can be one or more devices in each of these groups (except the meter), or you can enter **zero** if any group (EV/AC/HP/ES) has no device in the system. This group will then be omitted from the scene and from the configuration panel. If there are more devices in a group, the list of their IDs must be entered as



numbers, separated by commas, semicolons, spaces or any other character that is not a digit. In contrast, there must be only one meter and it must be indicated by a single non-zero identifier.

The instantaneous power meter can be a separate device with a MODBUS interface, integrated via the euLINK gateway. It can also be a slave device of the photovoltaic inverter - it is important that it gives as its value (the 'Value' property) the instantaneous power reading (in the unit W) at the point of contact with the power grid, where a negative number is understood as giving back to the grid the energy produced by the photovoltaic or other RES source.




A '**SG module**' is understood to be a slave device imported by the euLINK gateway as part of an integrated charger, air conditioner, heat pump, energy storage or other device whose power consumption qualifies it as *Smart Grid Ready*. The developer of the template for the euLINK gateway then tries to implement the function of changing the SG mode as a command, changing the power consumption of the device. In the case of a car charger, this can be implemented by increasing the charging current. In an air conditioner, the target temperature can be lowered and the highest fan speed switched on. In a heat pump, the temperature of the DHW tank water can be increased significantly, and in the autumn/winter season, the temperature of the underfloor heating can also be raised slightly. With some energy storage units, the limitation of the battery charging current can be adjusted. In some buildings, there are also other devices that can be included in the operation of the *Smart Grid Ready* system, e.g. the water temperature in the swimming pool or sauna can be increased, or the water treatment equipment in the pool or jacuzzi can be forced to work more intensively. A suitably prepared template allows the euLINK gateway to import a slave device (the aforementioned 'SG module') into HC3, to which the HC3 scene can assign a value of 1, 2, 3 or 4, which will be transmitted to the euLINK gateway as a command to switch the device into the appropriate mode: SG-1, SG-2, SG-3 or SG-4. Reading the value of this device returns a number between 1 and 4, indicating the current SG mode of the device. This information can also be used in other scenes as the installer sees fit.

The names of the EV/AC/HP/ES groups are somewhat conventional, so if there are additional devices in the building (e.g. the aforementioned swimming pool or sauna), they can be assigned to any existing group or some empty group can be used. If, for example, there is no energy storage in the system, but there is a pool water heater, it is sufficient to assign to the variable 'ES\_Device\_ID' the identifier of the 'SG module' associated with this heater, in order to include the pool - as a specific thermal energy storage - in the operation of the scene. If there are other devices with significant power consumption (hundreds of watts or kilowatts) integrated in the building via the euLINK gateway, these should be of interest to the installer, who may consider including them in the operation of the '*Smart Grid Manager*' scene.

The last group of variables in the table above is information on the power consumption of individual EV/AC/HP/ES devices. To be more precise, it is the value expressed in watts by which the power consumption of a device will increase after switching it from mode SG-2 to mode SG-4. If there are more devices in a given EV/AC/HP/ES group, it is necessary to indicate the total increase in their power consumption, as all devices belonging to the given EV/AC/HP/ES group will be switched to mode SG-4 at the same time. Each change in the list of variables must be saved with the button under the list on the right.



















An example of a list of variables might look like the following in the HC3 configuration:


414
Smart Grid Setup
QuickApp
Other
Default Room

General
Advanced
Notifications
Variables
Edit & Preview

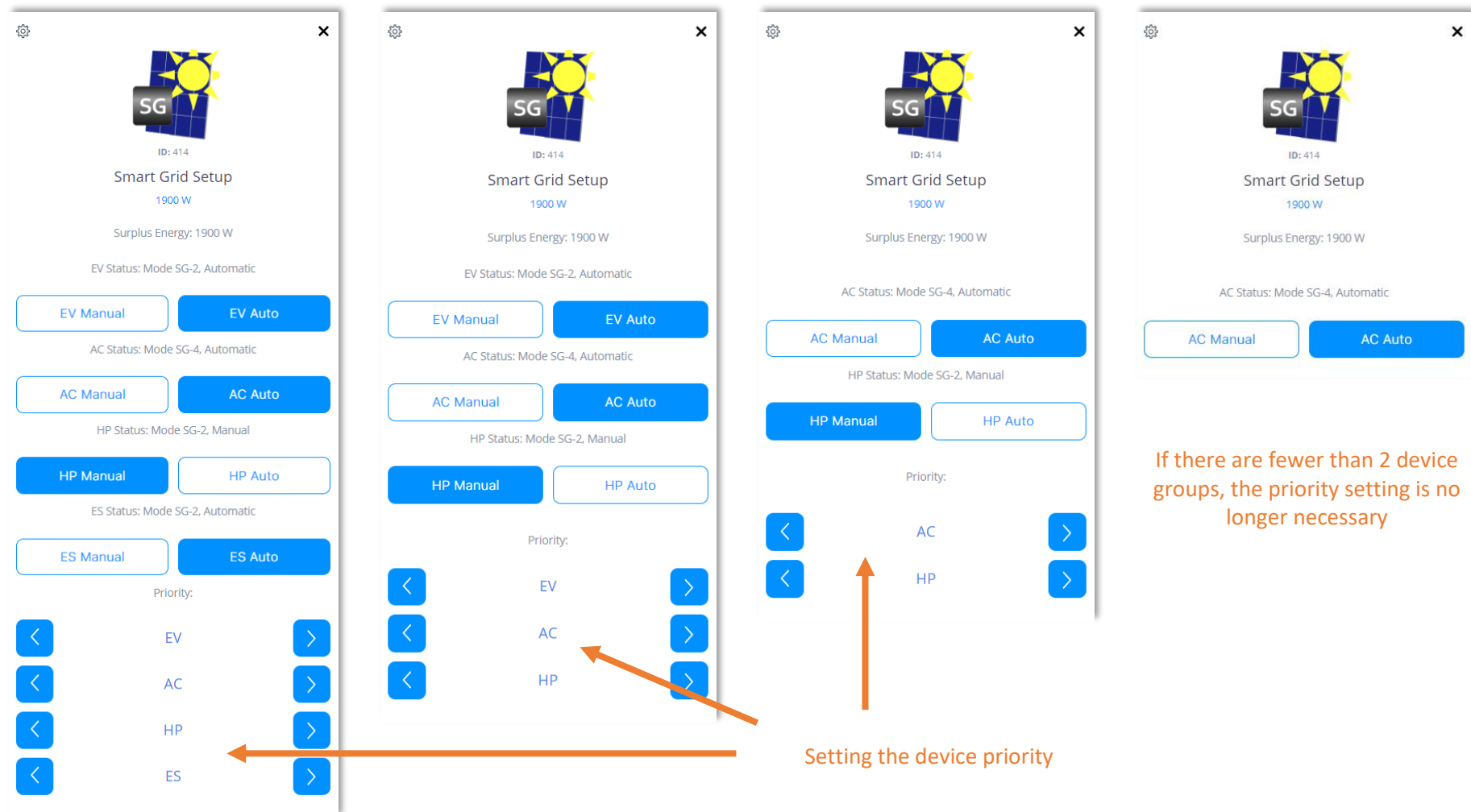
### Variables

ADD VARIABLE & VALUE

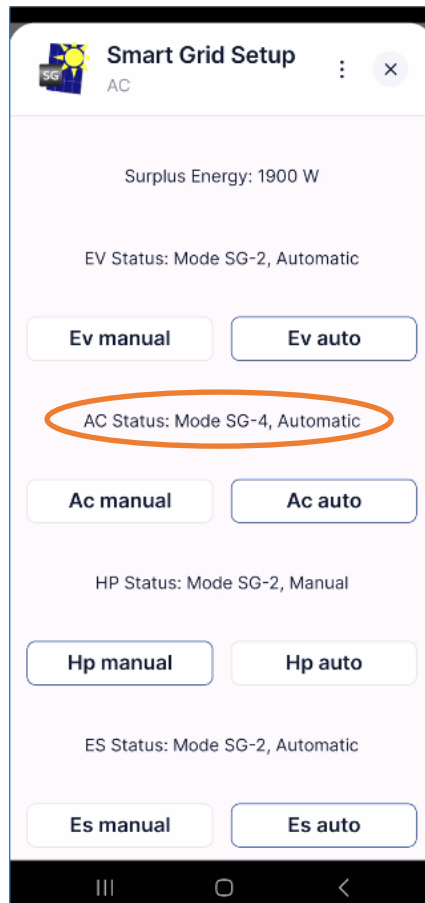
VARIABLE	TYPE	VALUE	
Grid_Pwr_Mtr_ID	String variable	417	 
EV_Device_ID	String variable	418	 
AC_Device_ID	String variable	419, 422, 425	 
HP_Device_ID	String variable	420	 
ES_Device_ID	String variable	421	 
EV_Power_Demand	String variable	5000	 
AC_Power_Demand	String variable	1300	 
HP_Power_Demand	String variable	3500	 
ES_Power_Demand	String variable	4000	 

← Three air conditioners in the AC group

Depending on the number of non-zero EV/AC/HP/ES groups, the configuration panel may look as follows:



Switching the unit to automatic mode will cover the scene, while manual mode will skip the unit. The current operating mode of the device is displayed above the buttons. The priority is important, as free energy can sometimes run out for further devices.



The configuration panel on the smartphone app looks similar (view on the left):

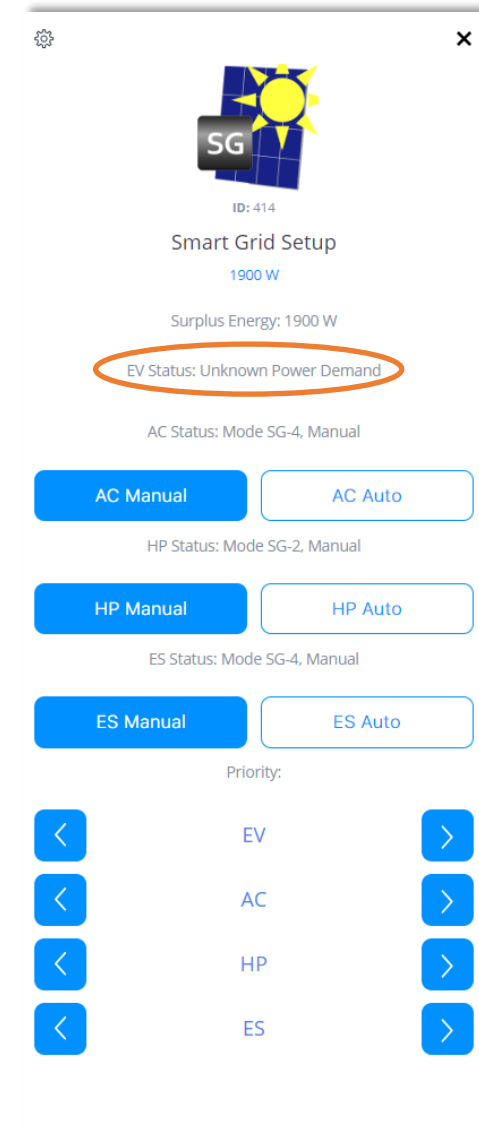
In the example shown, you can see that the AC air conditioner (or group of air conditioners) is in **SG-4 mode**, but the EV charger is still in SG-2 mode, although it is active (EV Auto) and has a higher priority. Arguably, the current over-production value (1900W visible at the top of the panel) has proved insufficient for the charger, but completely sufficient for one or several air conditioners.

If the photovoltaic installation stops producing energy (cloud cover or twilight) and the house - instead of producing - starts drawing electricity from the grid, all devices in **SG-4 mode** will be switched back to SG-2 mode in reverse order, i.e. the earliest switched on will be the latest switched off. The restoration of SG-2 mode in the absence of photovoltaic overproduction is unconditional, i.e. it occurs regardless of whether the device is in automatic or manual mode.

If, by chance, the variable storing the power consumption of the active device were to have a zero value, the buttons for switching on the device would not be shown on the panel and a message would appear instead of information on the device's operating mode: *Unknown power demand* (view on the right). A similar message will be displayed if the EV/AC/HP/ES unit is not actually installed.

When you start QuickApp for the first time, several global variables will be automatically created in HC3, through which the configuration panel will exchange information with the scene. Their names start with "SG\_".

The panel is refreshed every minute, so there are no long waits for updated status readings. Messages and button descriptions are displayed in 15 languages, depending on the default language setting for the HC3. If the language on the HC3 is changed, simply restarting the device's QuickApp "Smart Grid Setup" will update the appearance of the panel to the new language.



## d) Installing the HC3 scene LUA code

Once the configuration panel is installed, it is time to run the basic scene, periodically executing the described algorithm. This is done in the following simple steps:

- Log in to HC3 with administrator rights
- Select: *Settings => Scenes => Add scene => LUA scene*
- Give the scene a name, e.g. "Smart Grid Manager".
- Assign a scene to a room, set it to run automatically and leave the category "Other"
- Select an icon for the scene or optionally create your own as described when installing the QuickApp on page 7
- Save the scene settings using the button in the bottom right corner, which will open the LUA editor in HC3
- Open the included **smart-grid-mngr-scene-trigger.lua.txt** file in any text editor
- Select its entire contents (Ctrl-A) and copy it to the clipboard (Ctrl-C)
- Go to the LUA editor in HC3, click in the middle of the left window (DECLARATIONS), select the whole text (Ctrl-A) -and copy the text from the clipboard (Ctrl-V)
- Open the included **smart-grid-mngr-scene-actions.lua.txt** file in any text editor
- Select all its contents (Ctrl-A) and copy it to the clipboard (Ctrl-C)
- Go to the LUA editor in HC3, click in the middle of the right window (ACTIONS) and paste the text from the clipboard (Ctrl-V)
- Save the scene code using the button in the bottom right corner

From this point, the scene should start running, periodically reading the overproduction value and setting the SG modes of the individual devices. It is worth ensuring that the scene trigger interval is no shorter than 600 seconds (10 minutes), as this is required by the 'Smart Grid Ready' standard specification.

The scene code contains numerous comments, which should make possible modifications easier. If there are problems with the start-up or operation of the scene, you can change the value of the **debugMode** variable from *false* to *true* in the action code at line 21, which will result in a lot of diagnostic information appearing in the HC3 console regarding the operation of the scene.

In an analogous way, the level of detail of the logs for the QuickApp of the configuration panel can be increased, only there the variable **self.debugLevel** should be given the value *2* (i.e.: all messages enabled) in line 16.

If you have more serious problems running the scene, please send a description and logs to: [support@economy.com](mailto:support@economy.com)

## 6. Summary

The euLINK gateway, in cooperation with the FIBARO Home Centre, can become a so-called "Energy Manager" in accordance with the aforementioned *Smart Grid Ready* standard, i.e. it can adapt the operating modes of all HVAC/PV/EV household devices to the commands sent out by grid operators - even when individual HVAC/PV/EV devices do not have such functions built-in at the factory. Even if a heat pump is state-of-the-art enough to support *SG-Ready* mode, an electric car charger or air conditioners may not have this mode. And yet, the total energy consumed by these devices can be really significant. These devices should therefore be taken into account by an energy flow optimisation mechanism - and thanks to the euLINK gateway, this is already possible.

The scene discussed in the previous chapter reacts to a reading of the local PV overproduction value, increasing the power demand of the integrated equipment. Work is also already underway to equip the euLINK gateway with a function that would react to the sending of **SG-3** or **SG-4** commands by the power grid operator, affecting the power consumption of all equipment in the building.

The ability of the euLINK gateway to influence the power consumption of HVAC/PV/EV equipment can be particularly beneficial in those power networks where so-called 'Hourly Energy Billing' is already in force. It is hoped that the example scene presented will help to optimise energy consumption from the grid at different times of the day, resulting in noticeable savings in electricity bills 😊

*Maciej Skrzypczyński*

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