ESS System manual

(rough draft, this manual will be very similar to the Hub-4 Assistant manual, but then ofcourse adding all the extra features.

1. Introduction

- Works the two types of ESS systems
  - with grid meter: A full or partial grid-parallel system.
  - without grid meter: All loads connected to AC-out. And in case of PV Inverters, also connected to AC out.
- Power from an MPPT can now also be fed back to the grid. Enabled/disabled by a user setting on the CCGX: Settings → Energy storage system.
- Added Fronius Zero feed-in option
- PV Inverter Assistant is now built-in: no need to add that separately in case of AC-Coupled loads

For details in the improvements, see the draft blog:
https://www.victronenergy.com/blog/?p=7656&preview=1&_ppp=2216339b68

2. Migrating from other Assistants

2.1 Hub-1 Assistant -> ESS Assistant

Policies

Hub-1 policies that are deprecated in favor of ESS:

- Policy 1: Connected to mains, feedback: use ESS and enable solar charger feed-in.
- Policy 2: Keep batteries charged: Use ESS, select the “Keep batteries charged” mode. And enable “Feed-in excess solarcharger power”
- Policy 4: Prevent feeding energy to the grid: two options, one use ESS and do not enable Solarcharger excess feed-in and it will be always be connected to the grid. Or, use the Virtual Switch with ignore AC-Input.
- Policy 5: Connected to mains, no feedback: Use ESS, select the “Keep batteries charged” mode.

Above leaves us one policy where the Hub-1 Assistant can do things that ESS cannot.

- Policy 3: Disconnect from the mains when possible: Keep Hub-1 Assistant or, often a simpler and therefor better solution, use the Virtual Switch with Ignore AC-Input.

Load shedding feature: deprecated

Loadshedding is a feature in Hub-1 that is not often used, and therefore we did not implement it in

the ESS Assistant. Instead of sticking to Hub-1, which we do not recommend and also not support(1), consider using other options.

For example (mis-)use the genset/start stop in CCGX.

2.2 Hub-2 (v3) Assistant -> ESS Assistant

Policies

- Disconnect at night: disconnecting at night is not possible with the ESS Assistant, but why would you want to do that? Disconnecting only causes problems with overload, flickering, etc. With the ESS Assistant you can obtain the same or a better level of self-consumption without having to disconnect.
- Invert priority: use the virtual switch instead.
- Connect to AC input when available: use ESS Assistant, and select one of the two Optimized modes.
- Connect to AC when available, keep batteries charged: use ESS Assistant, and select the “Keep batteries charged” mode.

Make use of 'off peak tariffs'

Not available in the ESS System yet, but coming somewhere in 2017.

Winter mode

Replaced by battery life, and the (soon coming) Keep batteries charged option in the CCGX.

Load shedding

Load shedding is a feature in Hub-2 that is not often used, and therefore we did not implement it in the ESS Assistant. Instead of sticking to Hub-2, which we do not recommend and also not support(!), consider using other options.

For example (mis-)use the genset/start stop in CCGX.

Prevent feeding energy back to the grid

The ESS can do this when you have a Fronius inverter. See the Zero feed-in option.

For other brands of PV Inverters, you'll have to keep using the Hub2 v3 Assistant. Please do read my section in the blog post. [TODO: ADD LINK]

2.3 Hub4 Assistant -> ESS Assistant

- Battery capacity is no longer asked by the Assistant. Instead, enter the capacity on the General tab.
- It will ask for the grid code as a first thing, instead of giving an error after almost completing the Assistant
- The PV Inverter Assistant is included in the ESS Assistant: it is no longer necessary to separately add it.
- Fixed a overload and high temperature bugs

8. Controlling depth of discharge

(Note: All absolute voltages mentioned in the text below are for a 12V system and should be multiplied by 2 or 4 for a 24V or 48V system.)

Mains present

When there is less PV power available than needed by the loads (a PV shortage, at night for example), energy stored in the battery will be used to power the loads. This continues until the battery is considered empty.

While mains is available, there are three parameters that check if the battery is empty:

1. Battery State of Charge: Minimum SOC as configured in the CCGX. When set to 60%, all capacity between 60% and 100% will be used for to optimize self-consumption. And 0% to 60% will be used in case of a mains outage. The minimum SOC is parameter is configured in the CCGX. And it is also being updated daily by the BatteryLife algorithm.
2. Battery Voltage. See Dynamic Cut-off section, further down below.
3. Low cell signal from a BMS:
    - Victron VE.Bus BMS
    - 3rd party Canbus enabled BMS

Mains outage

When there is no mains, and the system is in inverter mode, these parameters control the depth of discharge:

- Dynamic cut-off
- Low cell signal from the VE.Bus BMS is still active
- Low cell signals from 3rd party canbus enabled BMS-es are ignored. System relies on the protection inside such a Lithium battery to trip.

What about the Sustain mode?

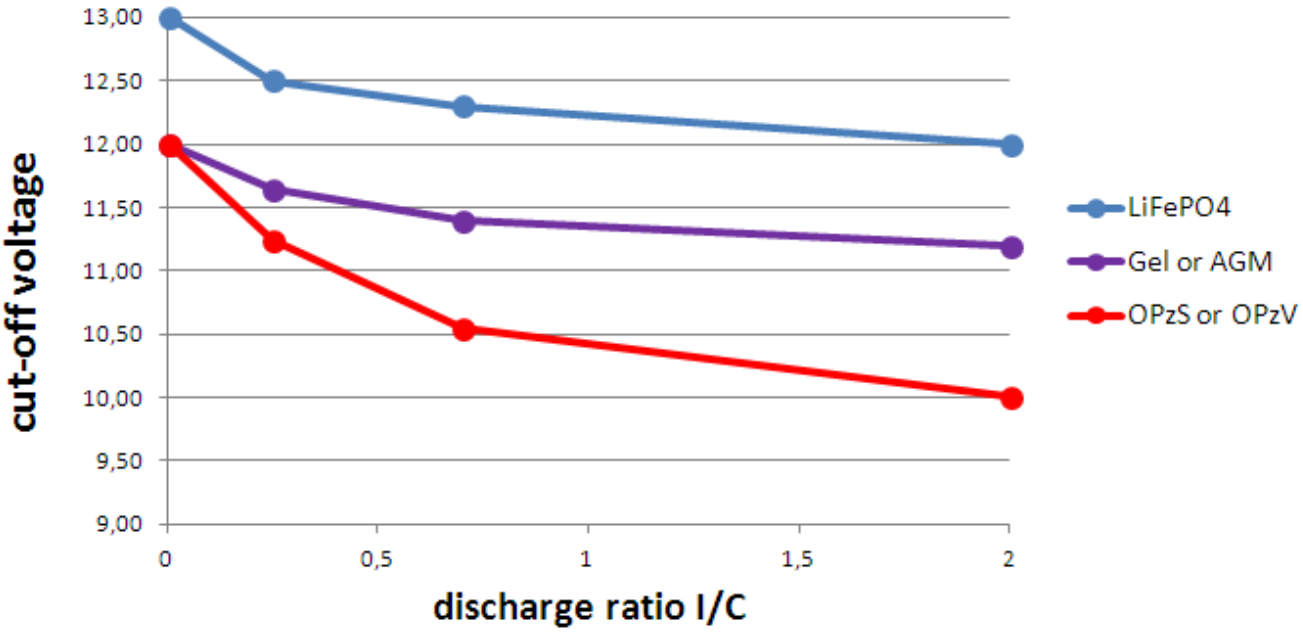
The Sustain voltages do not effect when the system stops discharging the battery: Sustain is activated only after the battery has been flagged as empty. See Sustain section below for more information.

Dynamic Cut-off

The ESS Assistant includes Dynamic Cut-off. This feature makes the DC-input low shut-down level a function of the battery current drawn from the battery. When a high current is being drawn from the battery, a lower shut-down voltage threshold is being used. For example 10 V. And similarly, when the battery is only being discharged slowly, a high DC cut-off voltage is used, for example 11.5 V.

This way, voltage drop caused by the internal resistance in the battery is compensated. Making battery voltage a much more reliable parameter to stop discharging when a battery is empty.

The picture below shows the default 'Discharge' vs. 'DC input low shut-down voltage' curves for the different battery types. The curve can be adjusted in the assistant.



Notes:

- Dynamic cut-off is useful for batteries with a high internal resistance. For example OPzV and OPzS. And it is less relevant for LiFePO4 batteries, because of their low internal resistance. See graph, showing a much flatter curve for the charge current vs disconnect voltage.
- All three DC input low parameters (-shut-down, -restart and -pre-alarm) on the Inverter tab are not effective. They are overridden by the Dynamic cut-off levels, together with the restart level. Which are all configured in the ESS Assistant.
- The Dynamic cut-off mechanism is in effect both when mains is available, and during a mains failure (system is in Inverter mode)

Sustain Mode

The purpose of the Sustain Mode is to prevent battery damage caused by leaving batteries in a deeply discharged state. The Sustain Mode is entered after the battery has been discharged, see above.

During Sustain Mode, the batteries will slowly be charged from the grid; maximum charge current is 5 Ampére. The Sustain level is 12.5V for lithium batteries. For non-lithium batteries, the sustain level is

11.5 V for the first 24 hours, and after that it is raised to 12.5 V.

Excess solar power will also be used to charge the batteries. Sustain stops as soon as there has been sufficient excess solar power available to raise the battery voltage 0.1 V above the sustain level. Normal operation will then continue: solar deficits are complemented with power from the battery again.

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