6. Controlling depth of discharge

In this section

(Note: All absolute voltages mentioned in the example below refer to a 12V s
Voltages should be multiplied by x2 or x4 for a 24V or 48V system, respective

6.1. Overview

Mains present

When there is less PV power available than is required to power the loads (at
example), energy stored in the battery will be used to power the loads. This w
continue until the battery is depleted (ie. has reached it user-defined minimur

When mains power is available, any one of the following three parameters wil
the system that the battery-storage has been depleted:

1. Battery State of Charge: Minimum SoC as configured in the CCGX has b
reached. When set to 60%, all capacity between 60% and 100% will be u
optimize self-consumption. And 0% to 60% will be used in case of a ma
outage. Note that the minimum SoC parameter - as configured in the C(
be amended on a daily basis by the BatteryLife algorithm[controlling-dep
discharge.html#UUID-af4a7478-4b75-68ac-cf3c-16c381335d1e].
2. Battery Voltage. See Dynamic Cut-off section[controlling-depth-of-
discharge.html#UUID-b628c51f-379e-c806-6073-cacbc9fc3fdd], further down
3. Battery Voltage. See Dynamic Cut-off section, further down below.
   - Victron VE.Bus BMS
   - 3rd party CAN-bus enabled BMS

Mains outage

When no mains power is available, and the system is in inverter mode, the fol
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 CAN-bus enabled BMS's are ignored. The s
relies on the automatic protection inside Lithium cells to trip.

What about the Sustain mode?

The Sustain voltages have no effect on *when* the system stops discharging th
battery: Sustain is activated only after the battery has been flagged as empty.
See Sustain[https://www.victronenergy.com/media/pg/Energy_Storage_System/en/

depth-of-discharge.html#UUID-6b8f380a-3e19-c040-9dad-673577d775d5] section be
more information.

6.2. BatteryLife

What does BatteryLife do?

The *BatteryLife* feature prevents a harmful 'low battery state-of-charge' from l
allowed to continue for an extended period of time. For example in winter, if t
insufficient PV power available to replace the stored battery energy which is c
every day, without the BatteryLife feature the battery SoC will fall to its low-lin
stay at or near that level - continually failing to become fully-charged.

BatteryLife tries to ensure that the battery will always be recharged to 100% S
every day. This is how it works:

During periods of poor weather when solar energy is reduced, *BatteryLife* will
dynamically raise the *Low SoC limit* which has been set. This has the effect o
less power available for consumption. It raises this level by 5% each day until
energy which the system draws from the batteries during a 24hr period matcl
energy being replaced. The aim is for the battery to operate at or near 100% S

When weather conditions change, and more solar energy becomes available,
system will once again lower the *Low SoC limit*, day by day, making more batt
capacity available for use (it will eventually return to the user-preset limit) - wl
ensuring that the battery SoC ends each day at or close to 100%.

The strength of this feature becomes apparent when you ask yourself, “Why s
battery be allowed to remain fully discharged for long periods of time, leaving
reserve power in case of mains failure …and with the possible result of dama
battery?”.

Details

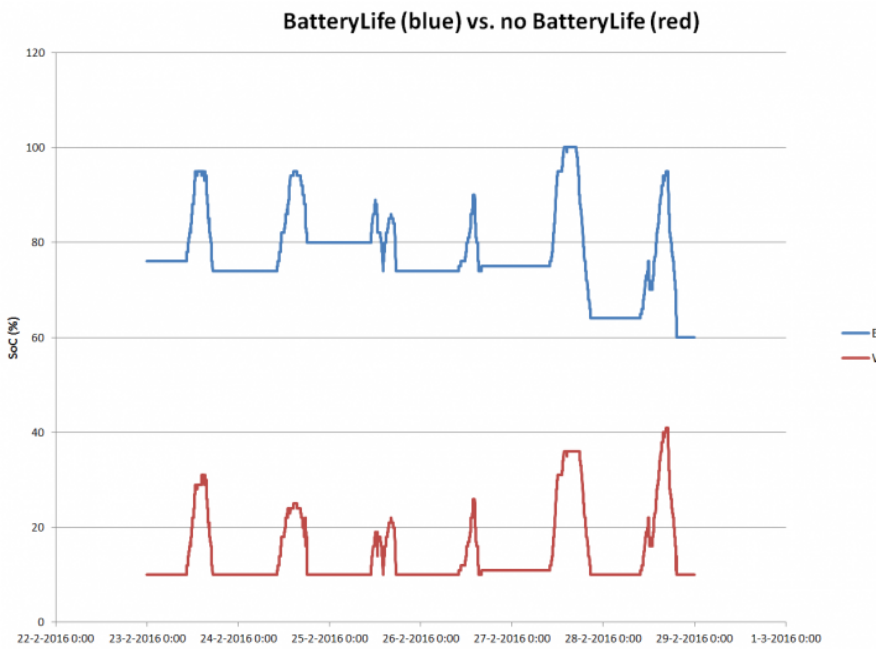
This feature has several advantages:

- Operating around a low state of charge shortens the life of lead/acid batte
- Certain lithium batteries also need to be fully charged regularly in order to
  their cells. This includes the Victron 12.8V lithium
  batteries[https://www.victronenergy.com/batteries/lithium-battery-12-8v], for wh
  mandatory to enable *BatteryLife*.
- In case of mains failure - having no spare energy available from the batteri
  power the loads defeats the whole purpose of having a battery back-up.

If the battery SoC falls below the SoC *low-limit* for more than 24 hours, it will
charged (from an AC source) until the lower limit has been reached again.

The dynamic *low-limit* is an indication of how much surplus PV power we exp
during the day; a low-limit indicates we expect a lot of PV power available to c
the battery and that the system is not expected to discharge more energy at r
it receives the following day.

The graph below shows two identical systems - one (the blue line) is using the *BatteryLife* feature; the other (the red line) isn't. It's spring, and the battery *charge* for each system is graphed for one week. As the week progresses and solar energy is becoming available, notice how *BatteryLife* makes its system at or near full charge, and how it allows the depth of discharge to be increase solar power harvest increases. Notice, too, the red line which shows what hap without BatteryLife.



Technical details

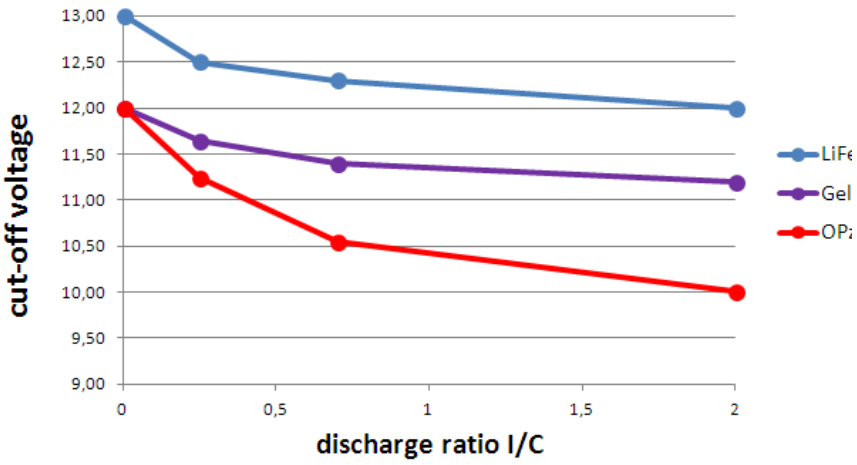
On a technical level, BatteryLife increases the dynamic lower charge limit by 5 each day that a good state of charge was not reached. The value is increased day when the battery reaches the lower limit for the first time. When the batte reaches 85% SoC on the day, the increment for that day is canceled and the li remains the same as the previous day. If the battery reaches 95% on any day, dynamic discharge limit is lowered by 5%. The result is that the battery reach healthy charge of between 85% and 100% SoC every day.

6.3. Dynamic cut-off

The Dynamic Cut-off feature works 'intelligently'. Instead of merely cutting off when a low-voltage threshold has been reached, it takes into account the amo of *current* being drawn from the battery. When the current being drawn is high shut-down voltage might be 10V, for example; whereas if the current being dra small one, the shut-down might be 11.5V.

This compensates for the internal resistance in the battery, and makes *Batter Voltage* a much more reliable parameter to indicate whether a battery is beco critically discharged.

The graph below shows the default 'Discharge' vs. 'DC input low shut-down vo curves for 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 e
  OPzV and OPzS; but is less relevant for LiFePO4 batteries because of their
  internal-resistance. See how the graph shows a much flatter curve for the
  current vs disconnect voltage.
- None of the three DC input low parameters (-shut-down, -restart and -pre-a
  the Inverter tab are operative. They are overridden by the Dynamic cut-off l
  together with the restart levels - which are all configured in the ESS Assista
- The Dynamic cut-off mechanism effective both when mains is available ar
  a mains-failure (system is in Inverter mode).

6.4. Sustain mode

Sustain Mode prevents the damage caused by leaving batteries in a deeply-di
state.

Sustain Mode is entered after the battery has been flagged as discharged, an
conditions which trigger it are:

- When the battery voltage has fallen below Dynamic cut-off
- A Low-cell signal from the VE.Bus BMS

While Sustain is active, the battery voltage will be maintained at the *sustain-v*
level - which is set at:

- Lithium batteries: 12.5V
- Other batteries: 11.5 V for the first 24 hours, and after that it is raised to 12

When the battery voltage has fallen below the sustain level it will be charged
to the *sustain-voltage-level* using power from the grid. The charger will ensure
voltage level is maintained - using power from the grid when necessary. The r
charge current it uses for this is 5 Ampére per unit. (5 A applies to all installat
regardless of system voltages (12 / 24 / 48 V).

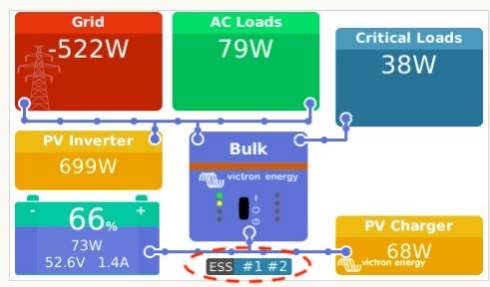
Excess solar power will also be used for battery charging.

Sustain mode is exited when solar-charging has been able to raise the battery
0.1 V above the *sustain-voltage-level*. Normal operation will then continue - w
battery providing power when insufficient energy is harvested from the PV arr

(This 0.1 V is the threshold for 12 V systems; for 24 V the threshold is 0.2 V a
for 48 V it is 0.4V above.)

6.5. ESS battery status reason code numbe

In addition to the charger states (Bulk/Absorption/Float), there are additional
Discharging and Sustain codes that provide at-a-glance information on the Pa
Overview of GX display.



The key for these codes is:

- #1: SOC is low
- #2: BatteryLife is active
- #3: BMS disabled charging
- #4: BMS disabled discharge
- #5: Slow Charge in progress (part of BatteryLife, see above)
- #6: User configured a charge limit of zero.
- #7: User configured a discharge limit of zero.

Prev[https://www.victronenergy.com/media/pg/Energy_Storage_System/en/commissioning.h

Next[https://www.victronenergy.com/media/pg/Energy_Storage_System/en/multiphase-regulation---further-information.html]

English ▲