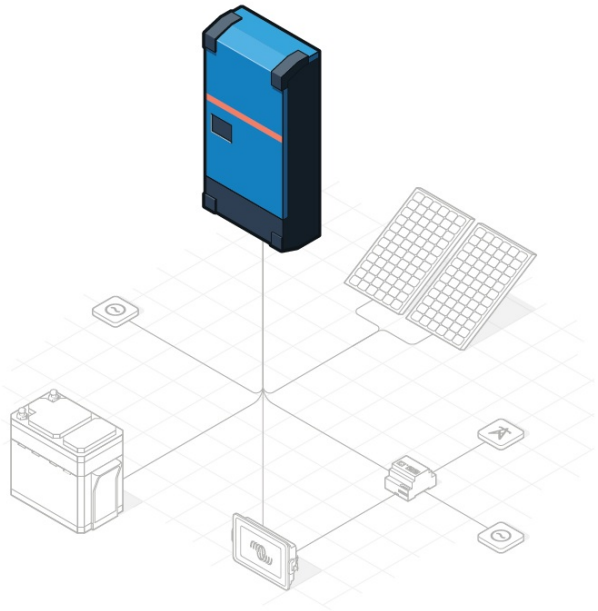
ENGLISH



ESS Design and Installation Manual - VE.Bus

Rev 12 - 11/2026

This manual is also available in HTML5.

Table of Contents

1. Safety instructions 1

2. ESS introduction and features 3
2.1. What is ESS? 3
2.2. ESS features and capabilities 3
2.3. When to use ESS 5
2.4. When not to use ESS 5
2.5. Components 5
2.6. Minimum requirements 6

3. System design 7
3.1. Grid arrangement 7
3.2. Single-phase or multiphase 8
3.3. Inverter/charger selection 8
3.4. Battery bank capacity 8
3.5. Connecting PV 9
3.6. Feed-in 10
3.7. Anti-islanding 11
3.8. Victron Click & Design 11

4. Installation 12

5. Configuration 13
5.1. Update to latest firmware 13
5.2. VEConfigure / ESS Assistant 13
5.3. AC System 15
5.4. Mode 16
5.5. Grid metering 16
5.6. Self-consumption from battery 17
5.7. Multiphase regulation 17
5.8. Minimum SOC and Active SOC limit 17
5.9. BatteryLife state 18
5.10. Limit charge power 18
5.11. Limit inverter power 19
5.12. Grid setpoint 19
5.13. Grid feed-in 20
5.14. Peak shaving 20
5.15. Scheduled charge levels 22
5.16. Dynamic ESS 23
5.17. Opportunity Loads 23
5.18. Solar charge controllers (SmartSolar or BlueSolar MPPT) 24
5.19. Zero and limited feed-in with PV inverters 24
5.19.1. Fronius PV inverters 24
5.19.2. ABB/FIMER PV inverters 25
5.19.3. Other PV inverters 25

6. Controlling depth of discharge 26
6.1. BatteryLife 26
6.2. Dynamic cut-off 27
6.3. Sustain 28
6.4. Battery reason codes 28

7. Multiphase regulation 29
7.1. Introduction 29
7.2. Single-phase system with a three-phase grid connection 29
7.3. Three-phase system 30

8. Commissioning 31
8.1. LED codes during ESS operation 32

9. Frequently asked questions 33

1. Safety instructions

SAVE THESE INSTRUCTIONS

This manual contains important safety and operating guidelines that must be followed during design, installation, configuration, commissioning, use, and maintenance.

READ INDIVIDUAL PRODUCT MANUAL BEFORE YOU BEGIN

An energy storage system combines several products into a single grid-connected system. Each product is supplied with its own manual containing the full safety instructions for that device. Read the safety instructions in the manual of every product used in the installation before starting work, and keep those manuals available for future reference. Always ensure you are using the latest version of the manuals. The most recent versions are available on the relevant product pages. The instructions in this section address the hazards that arise from operating these products together as a grid-connected energy storage system; they do not replace the product-specific instructions.

ELECTRIC SHOCK

The battery is a permanent energy source. Hazardous voltage is present at the terminals and wiring of the installation even when the equipment is switched off, and contact with live parts can cause death or serious injury. Before working on any part of the installation, isolate it from the grid, switch off and disconnect the AC loads, and disconnect the battery.

UNEXPECTED RE-ENERGISATION

The system is connected to the utility grid and, when configured to do so, feeds power back into it. Anti-islanding protection disconnects the system during a grid failure and reconnects when the grid returns, so the installation can become live again without warning, and contact with live parts can cause death or serious injury.

IMPROPER INSTALLATION

Design, installation, configuration and servicing carried out by unqualified persons can result in death or serious injury. This work must be carried out by qualified personnel only, in accordance with local and national wiring regulations. Fit the fuses and circuit breakers specified in each product manual, and never replace a protective device with a component of a different type.

INCORRECT BATTERY TYPE

Recharging a non-rechargeable battery can cause it to burst, resulting in serious injury and equipment damage. Never attempt to recharge non-rechargeable batteries.

FIRE AND EXPLOSION

Unsuitable installation locations can result in fire, causing death or serious injury. Install each product in a heat-resistant location, away from chemicals, plastic parts, curtains, textiles and other flammable materials. Keep sufficient free space around each product for ventilation and do not block the ventilation openings. Never operate the equipment where gas or dust explosions may occur.

ACCESS BY UNAUTHORISED PERSONS

Access to the installation by unauthorised persons can result in death or serious injury. Locate the installation where it is not accessible to unauthorised persons. This equipment is not intended for use by persons, including children, with reduced physical, sensory or mental capabilities, or lacking experience and knowledge, unless they are supervised or have been instructed in its use by a person responsible for their safety.

HEAVY EQUIPMENT

Lifting components without help or without correct technique can cause muscle strain or back injury. Use suitable lifting aids and proper lifting techniques, and do not lift heavy objects unassisted.

REGULATORY COMPLIANCE

A grid-connected installation is subject to national regulations and to the requirements of the local grid operator. Confirm that the installation is permitted and that any required approval has been obtained before connecting to the grid. Operating the equipment outside the conditions specified in the product manuals can damage it.

HIGH AMBIENT TEMPERATURE

Excessively high ambient temperature will result in reduced service life, reduced performance, reduced peak capacity, or shutdown of the equipment.

2. ESS introduction and features

2.1. What is ESS?

A grid-connected energy storage system combines several **Victron Energy** products: an inverter/charger, a GX device, and a battery, usually together with solar. It stores energy, most often harvested from solar, and makes it available later, for example to power loads in the evening once solar production has stopped. The battery can also be charged from the grid, and a system can run without solar at all.

ESS is the Victron feature that makes those components work together as one. It coordinates the inverter/charger, the battery, the solar and the grid connection, deciding when to charge the battery, when to discharge it, and how much power to draw from or feed into the grid.

With ESS, the system can:

- time-shift power, storing energy and using it when it is most useful,
- charge the battery from solar,
- support the grid by shaving peaks in grid consumption, and
- export surplus power back to the grid where this is permitted.

When the system has more power than the loads need and the battery is full, it can sell the surplus to the grid. When it cannot meet demand from the battery and solar alone, it draws the shortfall from the grid automatically.

ESS is configured in two places: the ESS Assistant, loaded into the inverter/charger with VEConfigure, and the ESS menu on the GX device. Both are described in Configuration [13].

2.2. ESS features and capabilities

Backup during a grid failure

When the utility grid fails, the inverter/charger disconnects from the grid and continues to power the loads on its AC output from the battery, and from solar when available. The loads are not interrupted. When the grid returns, the system reconnects and resumes normal operation without intervention.

How much of the battery capacity is held in reserve for a grid failure is set with Minimum SOC. The system respects that limit while the grid is present and ignores it during a failure, so the reserve remains available. Which loads stay powered depends on how they are wired, covered in System design.

PV: DC-coupled, AC-coupled, or both

The system can use solar in two ways. With DC-coupled PV, a SmartSolar or BlueSolar MPPT solar charger feeds the battery directly on the DC side. With AC-coupled PV, a grid-tie PV inverter feeds the AC side. A system can use either, or a mix of both. (How to choose is covered in System design [7].)

With or without a grid meter

The system can run with or without an external grid meter. With a meter, it can run alongside the grid as a full or partial grid-parallel installation. Without a meter, all loads, and any PV inverter, are connected to the AC output of the inverter/charger. (See System design [7].)

Generator backup

A generator can be used as backup during extended grid failures. The GX device can start and stop the generator automatically, ensure it is properly loaded, and shut it down once the battery is charged. Grid code and loss of mains (LOM) settings need particular attention in generator systems.

Feeding solar back to the grid

Surplus PV power can be exported to the grid where local regulations allow. Feed-in is possible regardless of how the PV is connected, whether it is DC-coupled, AC-coupled on the AC-In, or AC-coupled on the AC-Out.

Zero feed-in

With a supported grid-tie PV inverter, export to the grid can be prevented or capped at an agreed level. The system reduces the PV inverter's output as soon as export is detected. The supported PV inverters, and the settings each requires, are listed in Zero and limited feed-in with PV inverters [24].

Peak shaving

The power drawn from, or fed into, the grid can be capped at the grid connection point. When demand exceeds the limit, the battery supplies the difference, so the installation can support loads beyond the capacity of the grid connection and operate within a contracted or physically limited connection. See Peak shaving [20].

Scheduled charging

The battery can be charged from the grid during defined time windows, for off-peak tariffs, to prepare for a known outage, or to give the battery a regular maintenance charge. See Scheduled charge levels [22].

Dynamic ESS

Dynamic ESS optimises the system against a variable or dynamic energy tariff, scheduling battery charging and discharging to minimise energy costs while respecting the configured battery and grid limits.

Opportunity Loads

Surplus solar can be directed into flexible loads such as heat pumps, EV chargers, water heating and pool pumps, rather than being curtailed or exported. The power each load draws is configured, and the load is switched on once the available surplus is enough to cover it. Loads are served in a priority order, so the surplus is allocated to the most important load first.

EV charging

The Victron EV Charging Station connects to the GX device, where it is monitored and controlled alongside the rest of the system, both locally and through VRM. It can also be charged from surplus solar as an opportunity load.

2.3. When to use ESS

Use ESS in a self-consumption system, a backup system with solar, or a combination of the two. What separates them is how much of the battery capacity is held in reserve for a grid failure. In a combined system, for example, 30% of the capacity is used for self-consumption and the remaining 70% held in reserve.

Self-consumption

When there is more PV power than the loads need, the surplus is stored in the battery. That stored energy is then used to power the loads when PV is insufficient.

The percentage of battery capacity used for self-consumption is configurable. Where utility grid failures are very rare, it can be set as high as the battery allows, making the full battery available for everyday use. Where grid failures are common, even a daily occurrence, a smaller share is used, for example 20% for self-consumption with the remaining 80% held in reserve for the next failure.

Backup

Where the battery is intended as backup rather than for daily cycling, it is held at a high state of charge and discharged only when the utility grid fails. Once the grid returns, it is recharged from the grid, or from solar when available.

The operating strategy that carries this out is selected with the Mode setting [16].

2.4. When not to use ESS

Do not use ESS in:

- off-grid systems, with or without a generator,
- marine systems,
- automotive systems, or
- inverter-priority systems, also known as "intentional islanding" or "ignore AC input" systems.

ELECTRIC SHOCK HAZARD

Removing the AC-In plug leaves its terminals live at grid voltage (110/230 VAC) for a short time. When the plug is removed, the inverter/charger needs a moment to detect the loss of mains and open the back-feed relay. Until the relay opens, contact with the plug's terminals can cause death or serious injury.

Do not use ESS in any installation where the AC supply can be unplugged by the user, including marine and automotive systems.

2.5. Components

Inverter/charger

The core of the system is a MultiPlus or Quattro bidirectional inverter/charger. ESS can be installed only on VE.Bus models with the second-generation microprocessor (26 or 27); all VE.Bus inverter/chargers currently shipping have this.

GX device

A GX device manages the system and provides monitoring, both locally and remotely through the VRM Portal and the VRM app.

Battery

The system works with:

- Victron lithium batteries
- A range of compatible third-party batteries (see the Battery Compatibility list)
- Lead batteries. The high internal resistance of OPzS and OPzV types should be considered in the design, and standard AGM and GEL batteries are not recommended for systems that cycle the battery every day.

Battery monitor

In most systems a separate battery monitor is not needed:

- Victron Lithium NG batteries when used with a Lynx Smart BMS NG . This combination handles state-of-charge monitoring itself, so no separate battery monitor is required.
- Intelligent batteries connected via CAN-bus (BYD, Pylontech, ZYC and others) already include a battery monitor. Use the CAN-bus connection for state-of-charge data. A separate battery monitor can be added, for example if the battery's own BMS has some communication issues, but the battery's own monitor should be used wherever possible to avoid confusion.

- For batteries without an internal battery monitor, the inverter/charger's own monitor can be used. With ESS this also accounts for the charge current from SmartSolar and BlueSolar MPPT solar chargers.

A separate monitor is required only when a battery without an internal battery monitor (such as lead batteries) is combined with an additional power source, for example a DC wind generator. Where one is needed, use a SmartShunt, BMV-700, BMV-712, or Lynx Shunt VE.Can.

Grid meter (optional)

A grid meter is optional. It is installed in the main distribution board, between the grid and the installation, and is used in full or partial grid-parallel systems. A grid meter is needed only when AC loads or sources are present on the input side of the inverter/charger; when everything is on the output side, it is not required. (See System design [7].)

PV (optional)

The system can use grid-tie PV inverters, SmartSolar and BlueSolar MPPT solar chargers, or a mix of both. It can also run with no PV at all, which is typical of virtual power plants, where many small storage systems supply the grid at times of peak demand.

2.6. Minimum requirements

ESS requires at least:

- one VE.Bus inverter/charger, a MultiPlus or Quattro,
- one GX device, such as the Cerbo GX or Ekrano GX, and
- a battery.

Everything else, solar, a grid meter, additional inverter/chargers, is optional and added as the design requires. See System design [7].

This manual covers ESS on VE.Bus inverter/chargers, the MultiPlus and Quattro. It does not apply to the RS range, such as the Multi RS Solar, which uses a VE.Can interface rather than VE.Bus. For ESS setup on these models, see the relevant RS product manual.

3. System design

Designing the system is a matter of making a few decisions in sequence. Each decision narrows the design, and together they determine the topology and the components needed. This chapter takes those decisions in order: how the installation connects to the grid, whether it is single-phase or multiphase, which inverter/charger suits the loads, how large the battery bank needs to be, how solar is integrated, whether surplus solar is fed back to the grid, and what the local grid connection requires for anti-islanding.

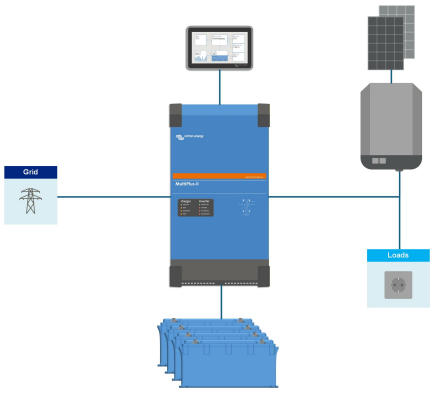
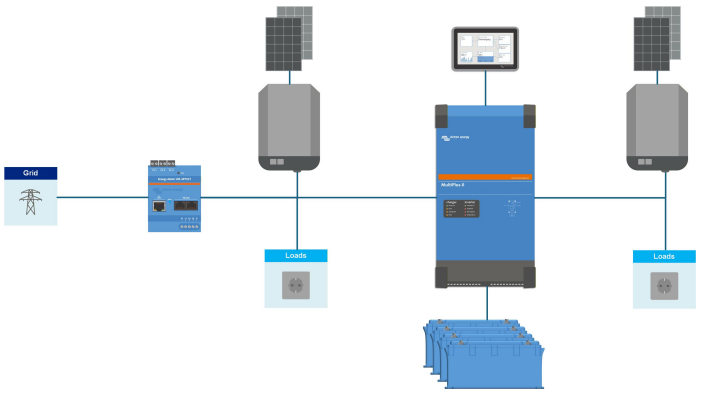
3.1. Grid arrangement

The first design decision is how the installation connects to the grid. It comes down to where the loads and any PV inverters are connected, and that in turn determines whether a grid meter is needed.

The principle behind the decision is straightforward: the inverter/charger can only measure and regulate the power that flows through it.

- When everything is connected to its output, all power exchanged with the grid passes through the inverter/charger, so it can meter that exchange itself. No grid meter is needed.
- When loads or PV inverters are also connected on the input (grid) side, that power bypasses the inverter/charger. A grid meter is then needed; without one, self-consumption and grid setpoint regulation work from incomplete information and give incorrect results.

This gives two arrangements.

All loads on the output (no grid meter) All loads and PV inverters connect to the AC-Out of the inverter/charger (MultiPlus or Quattro). When the grid is lost, all loads can be backed up by the battery. The grid-tie inverter feeds the microgrid created by the inverter/charger .	
Grid-parallel (grid meter required) Loads or PV inverters are also connected on the AC-In side. When the grid is lost, only the loads on the AC-Out can be backed up by the battery. The grid-tie inverter on the AC-In will not work until the grid is restored.	

Where a grid meter is required, use a Victron Energy Meter and set it up as described in Configuration.

3.2. Single-phase or multiphase

The system can be set up in different phase configurations, depending on the inverter/charger model:

- **230V models:** single-phase or three-phase.
- **120V models:** single-phase, split-phase, or three-phase.

For details on configuring each, see Multiphase regulation [17] in the Configuration chapter.

3.3. Inverter/charger selection

The required size depends on the type of installation and the appliances that will be powered from the inverter/charger.

DC input voltage range

Choose a model that matches the battery voltage.

AC input voltage and frequency

Choose a model that matches the grid voltage and frequency.

Number of AC inputs

Where a generator is part of the installation, consider an inverter/charger with two independent AC inputs, such as the Quattro.

Maximum AC input current

Inverter/chargers have an adjustable AC input current limit. This value defines how much current the unit draws from AC-In, so select a model whose limit suits the grid connection.

Continuous output power

This is the power the inverter can supply on a continuous basis. The continuous output power varies with temperature. The total power demand of the loads should not exceed this.

Maximum battery charge current

Maximum battery charge current is the highest charge current the unit will push to the battery. When AC-In is available from the grid, a generator, or surplus solar from a grid-tie inverter, the battery is charged at up to this current.

3.4. Battery bank capacity

The size of the battery bank is a trade-off between cost, battery life, and autonomy. It also affects how much benefit can be taken from variable electricity prices.

A smaller battery bank:

- is more cost-effective, but the energy used is high relative to its rated capacity.
- is charged and discharged at higher C-rates, which can shorten battery life, lead batteries in particular.

A larger battery bank:

- combined with a relatively large PV array, can store surplus power on sunny days, keeping power available through several consecutive days of poor weather.
- provides longer autonomy during a power outage.
- allows more energy to be stored when electricity prices are low and used when prices are high (see Configuration [13]).

Sizing for peak shaving

Where the system is used for peak shaving, the battery and the inverter/charger must together be able to supply the demand above the grid limit for the full duration of the peak. The inverter/charger determines how large a peak can be covered, and the battery how long it can be covered for, so a longer or larger peak requires a larger battery bank. Note that in the Optimized modes only the capacity above the minimum SOC is available for shaving peaks. Further explained in Peak shaving [20].

For the minimum battery size when a grid-tie PV inverter is connected on the AC output (AC-coupled PV), see the Victron document AC-coupling and the Factor 1.0 rule.

3.5. Connecting PV

The second design decision is how solar is integrated. There are two ways to connect PV to the system, DC-coupled and AC-coupled, and a system can use one or both. The choice affects efficiency, how the system behaves during a grid failure, and, for AC-coupled PV, some sizing rules.

DC-coupled PV

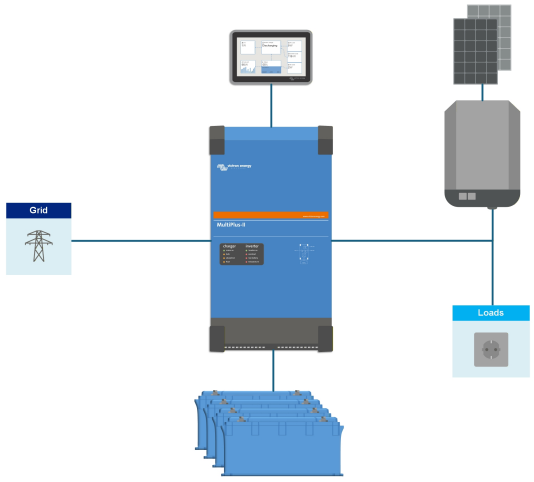
In a DC-coupled system, a SmartSolar or BlueSolar MPPT solar charger connects the PV array to the DC side and charges the battery directly. This is the most efficient path into the battery, because the energy reaches the battery in a single conversion. An MPPT solar charger is up to 99% efficient.

DC-coupling is the better choice when most energy is consumed outside daylight hours, for example a house where the cooking, laundry and lighting happen in the evening, since the solar energy is stored in the batteries with minimal loss for use later.

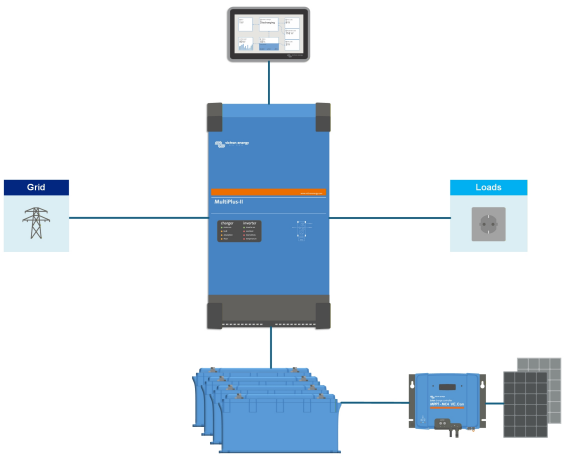
AC-coupled PV

In an AC-coupled system, a grid-tie PV inverter connects on the AC side. Its power is used first to supply the loads, then to charge the battery, and any surplus can be exported. Reaching the battery takes two conversions, DC to AC at the PV inverter, then AC to DC at the inverter/charger, with losses of up to 30%.

AC-coupling is therefore the better choice when most energy is consumed during the day, for example an office running air-conditioning, where the PV powers the loads directly after a single efficient conversion. It also suits large arrays and the retrofitting of an existing grid-tie installation.



AC-coupled PV feeding the AC-Out side of the MultiPlus-II with a grid-tie inverter



DC-coupled PV directly charging the battery with a SmartSolar MPPT

Using both

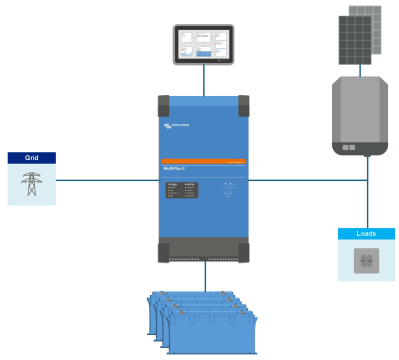
A system can combine DC-coupled and AC-coupled PV, for example DC-coupled MPPT charging on a system that is retrofitted onto an existing AC-coupled array.

In a backup system that must ride through extended grid failures, always include some DC-coupled PV (an MPPT solar charger), even if most of the PV is AC-coupled. An AC-coupled-only system can reach a deadlock: the grid-tie PV inverter needs the microgrid formed by the inverter/charger in order to run, but if the battery is empty the inverter/charger cannot form that microgrid, so neither can start and the system cannot recover on solar alone. A DC-coupled MPPT solar charger, however, charges the battery directly from PV, with no AC involved, and breaks the deadlock.

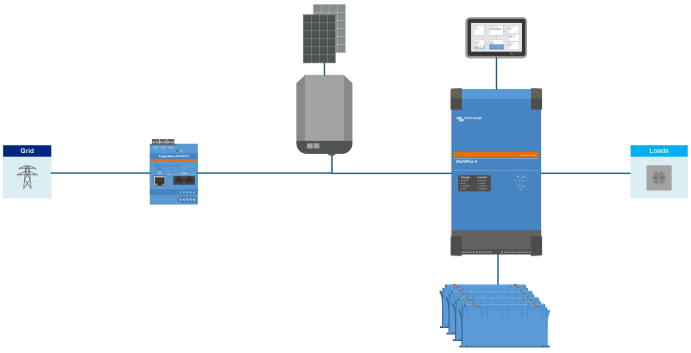
Connecting AC-coupled PV: on the input or the output

AC-coupled PV can be connected in one of two places, and the choice changes how it behaves when the grid fails:

- On the AC-Out. The PV inverter stays running during a grid failure, because the inverter/charger forms a local microgrid that the PV inverter synchronises to, so solar remains available in a blackout. PV connected here is subject to the factor 1.0 rule, which is further explained below.
- On the AC-In (grid side). The PV inverter behaves like an ordinary grid-tied installation. Because this PV sits on the input side, the system needs a grid meter to see it (see Grid arrangement [7]). This PV inverter will not work during a blackout, because there is no grid that it can synchronise to.



Grid-tie inverter on the AC-Out of the MultiPlus-II



Grid-tie inverter on the AC-In of the MultiPlus-II

The factor 1.0 rule

For AC-coupled PV connected on the AC-Out, the nominal power of the PV inverter must not exceed the VA rating of the inverter/charger. This is the factor 1.0 rule, a 1:1 limit:

- A 3000 VA MultiPlus allows up to 3000 W of PV inverter power.
- An 8000 VA Quattro allows up to 8000 W.
- Two paralleled 8000 VA Quattros allow up to 16000 W.

Take the lower of the two figures: the PV inverter's nominal AC output power, or the installed array Wp. An oversized array does not raise the limit, because the PV inverter caps what reaches the AC output. An undersized array becomes the limit, because the array caps what the PV inverter can deliver.

The reason is what happens at the moment of a sudden load loss. During a grid failure the inverter/charger forms the microgrid that the PV inverter runs on. If a large load switches off while the PV inverter is at full power, that surplus power has nowhere to go for a brief instant except into the battery, until the inverter/charger throttles the PV inverter by shifting the AC frequency upward. The inverter/charger must be able to absorb that surplus. Keeping PV inverter power at or below the inverter/charger rating guarantees it can. Exceeding it risks a battery voltage spike, a related spike on the AC output that can damage the PV inverter, the inverter/charger and connected loads, and protective shutdowns.

This limit is strict. It applies to all AC-coupled PV on the output, in both grid-connected and off-grid systems, with no exceptions, including in countries where the grid rarely fails, and when a Fronius PV inverter on the AC-Out is used with zero feed-in.

DC-coupled PV through a Victron MPPT solar charger is not subject to the factor 1.0 rule.

Two related points: AC-coupled PV also has a minimum battery capacity requirement (see Battery bank capacity [8]), and the frequency shifting that enforces this rule is applied automatically by the ESS Assistant (see Configuration [13]). Full background is in the Victron document AC-coupling and the Factor 1.0 rule.

3.6. Feed-in

The third design decision is whether the system feeds surplus solar back to the grid. Whether you can, and whether you should, depends on local regulations, which differ widely from country to country.

Feed-in rules vary by country

Around the world, feed-in is treated in different ways:

a. Feed-in is rewarded: energy can be sold back to the grid, or used to reduce the bill by running the meter in reverse.

b. Feed-in is allowed but not rewarded: the utility does not pay for energy fed back, though it remains an ecologically sound contribution.

c. Feed-in is not tolerated, even for a few seconds: some prepaid meters, for example in South Africa, disconnect from the grid when feed-in is detected.

d. Feed-in inflates the bill: where the meter counts in one direction only, every kWh fed back is wrongly counted as consumption and charged for.

Confirm the local regulations before enabling feed-in.

With feed-in

- DC-coupled PV (an MPPT solar charger): feed-in can be enabled or disabled by a setting on the GX device. When it is disabled, the PV power is still used to supply the AC loads.
- AC-coupled PV (a grid-tie inverter): feed-in is set with the **AC-coupled PV - feed in excess** setting on the GX device (see Grid feed-in [20]). It makes no difference whether the grid-tie inverter is connected on the input or the output side.

No feed-in

- DC-coupled PV (an MPPT solar charger): the same GX device setting disables feed-in, and the PV power still supplies the loads.
- AC-coupled PV (a grid-tie inverter): Zero or limited feed-in is possible with supported Fronius or ABB grid-tie inverters.

With other brands of grid-tie inverter, the system cannot prevent feed-in.

3.7. Anti-islanding

Anti-islanding ensures that the system disconnects from the grid and ceases power export upon loss of grid supply, preventing unintentional energisation of isolated network sections. ESS always requires anti-islanding.

This also applies to systems without feed-in.

For several countries the built-in anti-islanding in Victron products can be used. See certificates on the Victron Energy website for details.

In case there is no certified product available for the country of installation, install an external anti-islanding device.

More details here: VEConfigure: grid codes & loss of mains detection.

3.8. Victron Click & Design

Click & Design is an online tool for building and simulating a 48V system. It estimates how a system would perform in real-life conditions, using actual solar data from the past year. A step-by-step guide covers several stages.

The first step is to locate the system and choose either a Multi RS or a MultiPlus-II with MPPT as the base. Next come the AC input, the priority and non-priority loads, the PV array, and the battery specifications. The tool then simulates system performance hour by hour over a full year, showing how these parameters affect the overall result. Designs are saved automatically and can be reopened later to adjust the parameters, or duplicated to explore and compare different scenarios.

This is not a sizing tool that recommends components. It gives the freedom to design a system and see how well it performs. For example, where a design cannot meet the loads, the tool shows how much energy must come from the grid. The input parameters can then be adjusted to better match performance or budget goals.

With Click & Design it is possible to:

- build systems using the Multi RS or MultiPlus-II with split MPPT architecture,
- simulate single-phase or three-phase setups,
- manage priority loads and optional non-priority loads (in systems with a grid meter),
- define the PV array in detail, including orientation and tilt up to 90°, with the full range of Victron MPPT chargers, including MPPT RS (up to 6 MPPT chargers),
- add up to six PV inverters for AC-coupled PV, connected on either the AC input or the AC output,
- enter custom solar panel parameters instead of choosing a panel from the database,
- allow and simulate excess PV export to the grid,
- export a detailed PDF report, and
- save, edit, and duplicate designs.

For AC-coupled PV, Click & Design uses a generic PV inverter model for the energy calculations. Unlike MPPT solar chargers, the maximum PV voltage and input current are not checked, so the array layout must suit the actual PV inverter used. Warnings are shown where the factor 1.0 rule or the minimum battery capacity is not respected.

4. Installation

Each component has its own detailed installation instructions. Read the individual product manuals before beginning installation, and follow them for all mounting, wiring, fusing, and protection requirements. This chapter covers only the considerations specific to ESS.

Single-phase system with a three-phase grid connection

When installing a single-phase system with a three-phase connection to the utility grid, install the inverter/charger on phase L1.

Communication cabling between the devices

Stable communication between the devices is crucial for system performance and reliability. Make sure to connect the communication cables as described in each product's manual.

Temperature-compensated charging

Temperature-compensated charging adjusts the charge voltage to the battery temperature, raising it when the battery is cold and lowering it when warm. This protects the battery from being over- or undercharged as its temperature changes. If it is needed, refer to the manual of the inverter/charger for how to connect the temperature sensor. Solar chargers automatically use this temperature information from the inverter/charger as well. In systems using DVCC, this sharing of battery temperature is handled by Shared Temperature Sense (STS).

Voltage-sense wiring

Voltage-sense lets the charging device measure the voltage directly at the battery terminals, so it can compensate for the small voltage drop across the cables and regulate the charge to the true battery voltage rather than the voltage at its own output.

- For the inverter/charger, wire the voltage sense according to the instructions in its manual.
- For SmartSolar or BlueSolar MPPT solar chargers with a VE.Can port, connect a voltage-sense wire according to the instructions in the solar charger manual.
- SmartSolar or BlueSolar MPPT solar chargers with a VE.Direct port do not use voltage sense.

In systems using DVCC, voltage sensing is handled by Shared Voltage Sense (SVS).

Monitoring PV power from third-party grid-tie inverters

Certain grid-tie PV inverters from Fronius, SMA, ABB and SolarEdge can be monitored directly by the GX device over the network. See the Connecting a PV Inverter section in the product manual for the GX device in use.

For a grid-tie inverter of any other brand, install a measurement device to report its output: a Victron current sensor, or a Victron Energy Meter. Position it to measure the output of the grid-tie inverter, and connect it as described in its manual.

5. Configuration

Configuration turns the installed hardware into a working energy storage system. It happens in two places: VEConfigure, which adds the ESS Assistant to the inverter/charger, and the ESS menu on the GX device, which holds the operating settings. This chapter follows that order, starting with firmware and the Assistant, then each setting in the ESS menu, and ending with the PV inverter settings needed for zero and limited feed-in.

5.1. Update to latest firmware

Update all system components to the latest firmware version:

- **GX devices:** Venus OS v2.15 or newer.

  Older Color Control GX units on v1.74 require a one-time manual upgrade, which cannot be done automatically. Instructions are in Upgrading a CCGX to v2.00.

- **Multi, MultiPlus or Quattro:** Firmware version xxxx422 or newer. The inverter/charger can be updated in two ways:
  - Using VictronConnect, described in the VE.Bus configuration guide.
  - Using remote VE.Bus firmware updates, described in the Remote VE.Bus firmware updates guide.
- **Solar charge controllers, battery monitors, energy meters and other Victron products:** Update to the latest firmware version. Refer to the product's user manual for instructions.

5.2. VEConfigure / ESS Assistant

The following settings must be made in VEConfigure before the system will operate correctly. For general guidance on using this tool, see the VEConfigure manual.

1. **Grid tab: configure the country/grid code.**

   A password is required, available from the supplier. See VEConfigure: grid codes & loss of mains detection for more information.

   > Where this setting is left as **None**, the system will not supply battery energy to support local AC loads while the grid is connected. It must be changed even where there is no intention to export DC energy to the grid.

2. **Virtual switch tab: do not use VS.**

   This enables adding an assistant.

3. **Assistants tab: add the ESS Assistant.**

   Under the Assistants tab, add the ESS (Energy Storage System) Assistant and click on the Start assistant button. Read the text on the Welcome page carefully, and make sure the notes and remarks are understood before proceeding. The Assistant then prompts for details about the battery, and about whether an AC-coupled PV inverter is connected to the AC-Out side of the inverter/charger. Answer the prompts according to the system.

   See How to add an Assistant for the full procedure.

4. **General tab.**
   - Select the system frequency.
   - Adjust the AC input current limits based on the grid connection. Note that the current limiter applies to both directions of current flow.
   - The dynamic current limiter is ignored when the ESS Assistant is installed.
   - The ESS Assistant activates the integrated battery monitor of the inverter/charger. Leave it enabled even if a BMV or an intelligent battery connected via CAN-bus is present in the system.
5. **Inverter tab.**
   - Adjust inverter output voltage.
   - The DC-input low shut-down, restart and pre-alarm levels on the Inverter tab do not apply. They are ignored when the ESS Assistant is installed, as further explained in Dynamic cut-off [27].
   - The PowerAssist setting in VEConfigure is disabled and ignored when the ESS Assistant is installed.
6. **Charger tab: verify the charge settings.**

The ESS Assistant will already have selected the correct battery type and disabled Storage mode. Verify the remaining settings and change where necessary: charge voltages and maximum charge current.

In systems with the ESS Assistant installed, the MPPT solar chargers follow the charge curve set in VEConfigure. The charge parameters configured in the solar chargers themselves are ignored.

General notes

- PV power from a grid-tie inverter, whether connected on the AC-In or the AC-Out side, is used to charge the battery through the inverter/charger. Charge current and other charge parameters are configured on the Charger tab in VEConfigure.
- Keep the lithium-batteries checkbox on the Charger tab consistent with the battery type selected in the Assistant.
- When using a VE.Bus BMS with a Multi Compact, check the DIP switches: DIP switch 1 must be on, and DIP switch 2 must be off.

Low battery warning levels

- The low-battery warning becomes active when the battery voltage drops below the dynamic cut-off level plus the restart offset, which defaults to 1,2 V for a 48V system. Like the cut-off voltage, this warning level is dynamic.
- There is no hysteresis: the warning clears as soon as the voltage rises again.
- During this warning (also called a pre-alarm), the red LED on the inverter/charger blinks, and the GX device can optionally show a notification. In most systems it is recommended to disable this notification on the GX device.

The low-battery warning pop-up on the GX device is disabled from the inverter/charger menu: select Setup, then Alarms, and set the Low DC voltage alarm to Alarm only.

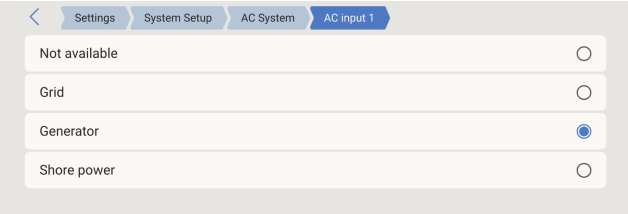
5.3. AC System

Before configuring the ESS menu, set up the AC system so the inverter/charger knows what is connected to each AC input and where the loads are located. These settings are found under **Settings → System Setup → AC System**.

AC input 1:

Set the role of the first AC input: Not available, Generator, Grid, or Shore power.

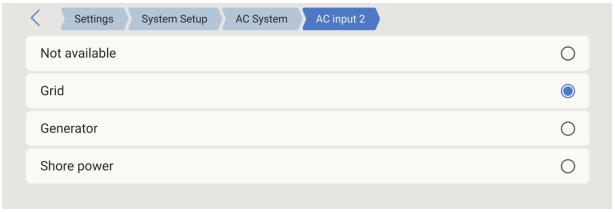
Set the input to **Generator** when a generator is connected. The system will then enable generator charging and load the generator correctly while it is running. Additional configuration is required to complete the setup of these options.



AC input 2:

Set the role of the second AC input, using the same options as AC input 1.

On a Quattro, AC-In 1 has priority over AC-In 2, so the usual arrangement is the grid on AC-In 1 and the generator on AC-In 2. Reverse it, wiring the generator to AC-In 1 and the grid to AC-In 2, only where the generator must take priority over the grid, which allows forced generator intervention even when the grid is available.

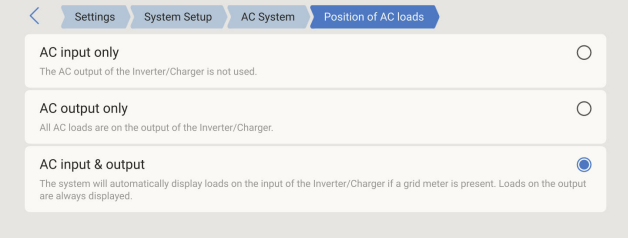


Only the Quattro has two AC inputs. This setting does not apply to inverter/chargers with a single AC input, such as the MultiPlus.

Position of AC loads:

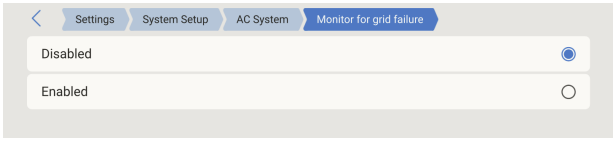
Tell the system where the AC loads are connected relative to the inverter/charger, so they are displayed and accounted for correctly:

- **AC input only** : the AC output of the inverter/charger is not used.
- **AC output only** : all AC loads are on the output of the inverter/charger.
- **AC input & output** : the system automatically displays loads on the input of the inverter/charger if a grid meter is present. Loads on the output are always displayed.



Monitor for grid failure:

When enabled, the system monitors for loss of the AC input and triggers an alarm if it is detected. The alarm clears when the AC input is reconnected.



5.4. Mode

The Mode setting determines the overall strategy the system uses to manage the battery, grid, and solar. It is found under **Settings → System Setup → ESS → Mode**. Four modes are available.

Mode:

Select the operating strategy for the system.

Keep batteries charged

The battery is discharged only during a failure of the utility grid. Once the grid is restored, the battery is recharged from the grid, and from solar when available. Use this mode where the battery's primary purpose is backup rather than self-consumption.

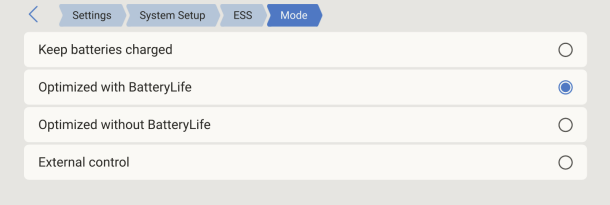
Optimized with BatteryLife and **Optimized without BatteryLife**

When excess PV power is available, it is stored in the battery. That stored energy is used later to power the loads when there is a shortage of PV power. The two Optimized modes differ only in whether the BatteryLife algorithm is active:

- **Optimized with BatteryLife** dynamically manages the minimum SOC so the battery is regularly recharged to a healthy level, protecting battery life. This is the recommended mode for most systems. See BatteryLife [26] for a full explanation.
- **Optimized without BatteryLife** holds the minimum SOC fixed at the configured value, without the daily adjustment.

External control

The ESS control algorithms are disabled. Use this mode where the system is driven by an external controller running its own control loop.



5.5. Grid metering

Grid metering:

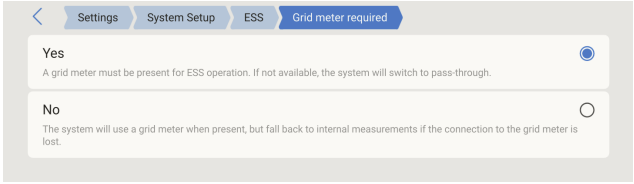
Selects how the system measures grid power exchange. Leave this at 'Inverter/Charger' if no external grid meter is used. Set it to 'External meter' only when a supported external energy meter is actually installed in the system. In a system without a Victron energy meter, all loads and any grid-tie inverters must be installed on the AC output.

If Grid metering is set to External meter without an external meter installed, the battery will not charge from the grid, even when a positive grid setpoint is configured.

Grid meter required:

This option becomes available only when Grid metering is set to 'External meter'. It sets how the system responds if the external grid meter is lost.

- **Yes** (default) : a grid meter must be present for ESS operation. If the meter is lost, the system switches to pass-through.
- **No** : the system uses the grid meter when present, but falls back to internal measurements if the connection to the grid meter is lost.



5.6. Self-consumption from battery

Determines whether the battery is used to supply loads on the AC-In side of the inverter/charger while the grid is connected. It has an effect only when loads are present on the AC-In side; in a system where all loads are on the AC-Out, there is nothing on the AC-In for it to act on.

Self-consumption from battery:

- **All system loads** : the battery supplies both the loads on the AC-Out and the loads on the AC-In. Power is drawn from the battery to cover the whole system, so self-consumption extends to loads on the grid side of the inverter/charger.
- **Only critical loads** : the battery supplies only the loads on the AC-Out. Loads on the AC-In are still covered by solar when it is available, with any shortfall taken from the grid, but the battery is not discharged to cover them.

For the battery to supply AC-In-side loads, Position of AC loads must be set to include the AC input (see AC System [15]).

5.7. Multiphase regulation

Multiphase regulation:

Defines how the system interacts with the individual phases in an installation with a three-phase connection to the utility grid. It has no effect on single-phase systems, and no effect when Mode is set to Keep batteries charged.

- **Total of all phases** (default): the system regulates the combined power of all phases (L1 + L2 + L3) to zero and loads the inverters symmetrically. This makes the full system capacity available and is optimal for billing.
- **Individual phase:** the system regulates each phase to zero independently. This can cause the system to discharge on one phase while charging on another through the DC bus, which is significantly less efficient.

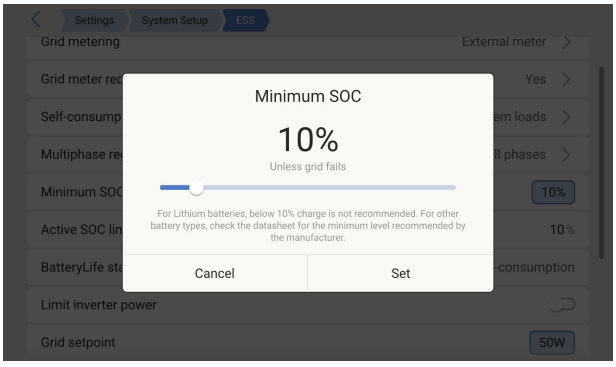
For a full explanation, including worked examples and notes on charge current and energy meters in three-phase systems, see Multiphase regulation - further information [29].

5.8. Minimum SOC and Active SOC limit

Minimum SOC (unless grid fails):

The configurable minimum state of charge. While the grid is present, the system supplies loads from the grid once the SOC has fallen to this setting, preserving the remaining capacity as a reserve. The exception is a grid failure: when the grid has failed and the system is in inverter mode, the battery continues to discharge below this value to keep powering the loads.

In *Optimized with BatteryLife* mode, this is the configured floor; BatteryLife may temporarily raise the effective limit above it (see Active SOC limit below). In *Optimized without BatteryLife* mode, this value is used directly and is not adjusted.



Active SOC limit:

Shows the minimum SOC limit currently in force. This is only relevant in *Optimized with BatteryLife* mode, where BatteryLife dynamically adjusts the working minimum SOC day by day. The Active SOC limit is therefore the value BatteryLife is applying right now, which may be higher than the configured Minimum SOC. It represents the maximum usable capacity of the system and will never be more than 80%. See BatteryLife [26] for how this value changes.

5.9. BatteryLife state

BatteryLife state:

Displays the current BatteryLife state. This is only shown in *Optimized with BatteryLife* mode. The possible states are:

- **Self-consumption:** normal operation, discharging is allowed.
- **Discharge disabled:** the battery has reached the Active SOC limit; discharging stops until the SOC rises 5% above the limit.
- **Slow charge:** the battery has been below the Active SOC limit for more than 24 hours and is being slowly charged back up to it.
- **Sustain:** the inverter/charger has entered sustain mode after the battery reached the dynamic cut-off voltage during discharge.
- **Recharge:** the system is recharging the battery after the SOC dropped more than 5% below the configured minimum.

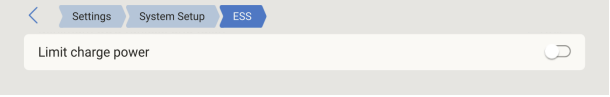
See BatteryLife [26] for a full explanation of these states.

5.10. Limit charge power

Limit charge power:

Limits the charge power, in watts, that the inverter/charger draws to charge the battery. When enabled, the field 'Maximum charge power' appears. Set the maximum power the inverter/charger uses to charge the battery.

This setting is available only when DVCC is disabled. When DVCC is enabled, it is not shown, and the system-wide maximum charge current is configured instead under **Settings → System Setup → Charge Control → Limit charge current**, which applies to all charging devices together.



5.11. Limit inverter power

Limit inverter power:

Limits the power that the inverter/charger converts from DC to AC. When enabled, a field appears to set the limit.

- While the grid is connected, the limit applies to all power converted from DC to AC, including the power supplied to loads on the AC-Out. If the limit is set too low, the inverter/charger draws the remainder from the grid.
- The limit has no effect during a grid failure. When the system is inverting because the grid is not available, the loads determine how much power is converted, regardless of this setting.
- The limit applies to the total of all phases.

Conversion losses in the inverter/charger are not included in the limit. To limit the power drawn from the battery, set the limit slightly lower than the figure required.

Power coming from the Solar Charger MPPTs is not included in the limit. Using this setting in a system with solar chargers can cause the output power from the solar charger to be reduced.

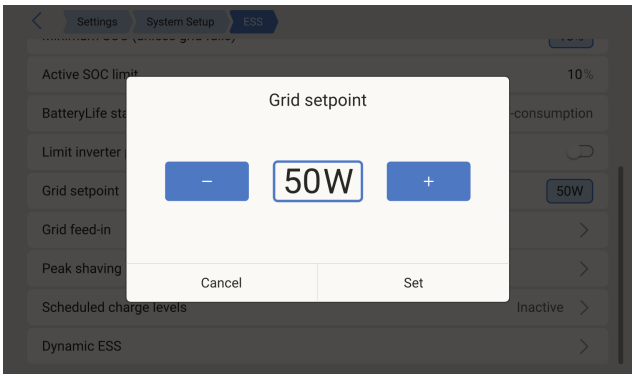
5.12. Grid setpoint

Grid setpoint:

Defines the target power flow at the grid connection point. The system regulates to this value continuously.

The default is 50 W, a small positive value. Setting it slightly above zero, rather than at 0 W, provides a buffer that helps prevent unintentional energy export during sudden drops in load. A system regulating to exactly 0 W will tend to overshoot into export when a large load switches off before the system can react; a small positive setpoint keeps the flow drawing slightly from the grid instead.

A higher setpoint means the system continuously imports that amount from the grid. A negative setpoint means the system continuously exports, which is not normally desired.

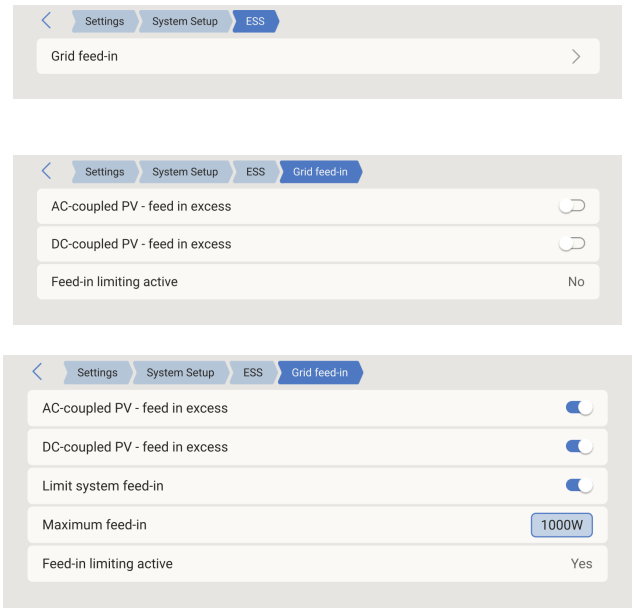


5.13. Grid feed-in

Grid feed-in:

Configures how excess solar power is fed into the grid. This is a submenu containing the following items:

- **AC-coupled PV - feed in excess:** when enabled, excess power from AC-coupled PV inverters is fed into the grid instead of being curtailed. Enable this where the grid connection permits export of AC-coupled PV.
- **DC-coupled PV - feed in excess:** when enabled, excess power from DC-coupled solar chargers is fed into the grid instead of being curtailed. Enable this where the grid connection permits export of DC-coupled PV.
- **Limit system feed-in:** appears when AC-coupled or DC-coupled feed-in is enabled. When on, the total power fed into the grid is capped at the Maximum feed-in value.
- **Maximum feed-in:** appears when Limit system feed-in is on. Sets the maximum power the system is allowed to feed into the grid.
- **Feed-in limiting active:** a read-only status showing whether the system is currently limiting feed-in.



'Limit system feed-in' is a system target. Under some conditions, such as a large load disconnecting or a sudden increase in solar production, the actual feed-in may briefly exceed the target until the system regulates the inverter output back within the limit.

5.14. Peak shaving

Peak shaving limits the power drawn from, or fed into, the utility grid at the grid connection point. When demand exceeds the configured limit, the battery supplies the difference; when export would exceed the limit, the system reduces solar production and battery discharge. This allows a system to support loads that exceed the capacity of the grid connection, and to operate within a contracted or physically limited grid connection.

With and without a grid meter

Peak shaving is available in two forms, depending on whether the system has a grid meter.

Without a grid meter, peak shaving is performed by the inverter/charger itself, using the AC input current limit. That limit is the threshold for the AC current at the AC-In of the inverter/charger, and it applies to current in both directions, so it also caps the current fed back into the grid. When the loads exceed the limit, the battery supplies the difference. Use this method for peak shaving in any system without a grid meter, including systems that use AC current sensors connected directly to the inverter/charger.

The AC input current limit does not take loads connected in parallel with the inverter/charger into account. In a system that relies on the AC input current limit for peak shaving, install all loads on the AC-Out of the inverter/charger.

With a grid meter, peak shaving acts on the current measured at the grid connection point, using the import and export current limits set on the GX device. It therefore applies to the whole system, including high-power loads installed on the AC-In of the inverter/charger, such as EV chargers and heat pumps. This is the form to use when there are loads on the AC-In side.

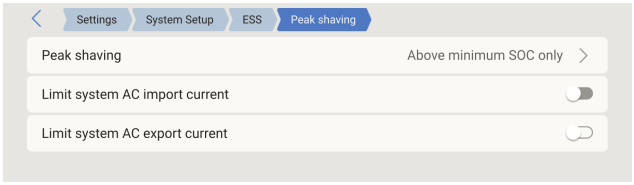
Peak shaving: determines when the battery is used to shave peaks.

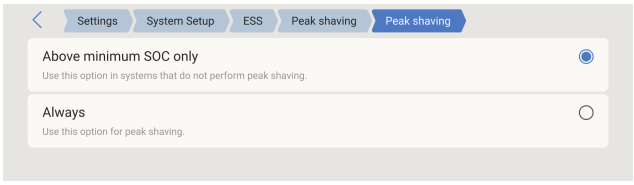
- **Above minimum SOC only** (default in the Optimized modes): peak shaving operates only while the battery is above the minimum SOC. Below the minimum SOC, the battery is not discharged to shave peaks.
- **Always:** peak shaving operates regardless of SOC, so the battery is used to shave peaks even below the minimum SOC.

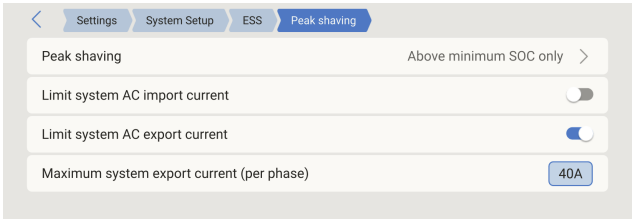
The following two settings act on the current measured at the grid connection point and require a grid meter.

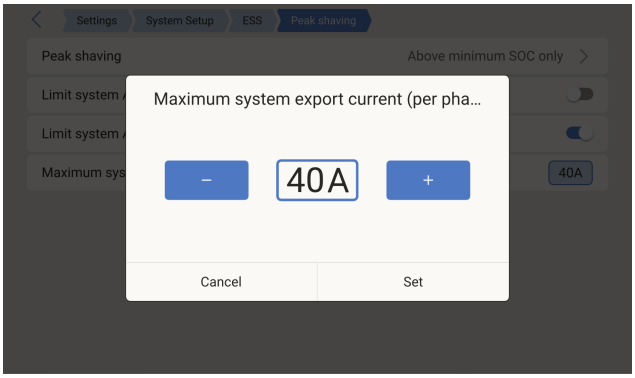
Limit system AC import current: when enabled, the field 'Maximum system import current (per phase)' appears. Set the maximum current to be drawn from the grid per phase. When demand would exceed this limit, the battery supplies the difference.

Limit system AC export current: when enabled, the field 'Maximum system export current (per phase)' appears. Set the maximum current to be fed into the grid per phase. When production would exceed this limit, solar production and battery discharge are reduced.









How peak shaving works

In an installation with a grid meter, the system continuously monitors the current at the grid connection point and acts to keep it within the configured limits:

- To prevent the import limit being exceeded by the loads, the battery assists by supplying the additional power the loads require, for as long as the battery permits.
- To prevent the import limit being exceeded, battery charging is reduced.
- To prevent the export limit being exceeded, solar production and battery discharge are reduced.
- When the SOC has dropped more than 5% below the configured minimum SOC, the battery is recharged from the grid as soon as the loads drop sufficiently to allow charging.

Peak shaving and the Mode setting

Peak shaving operates in all modes, but the way the battery is managed around it differs.

In the Optimized modes, the battery is also used for self-consumption, so its state of charge varies with daily solar and load. Peak shaving draws on the capacity available above the minimum SOC. When the battery reaches the minimum SOC, the system does not force a recharge from the grid; it draws from the grid to cover the loads and relies mainly on solar to bring the state of charge back up.

In Keep batteries charged mode, the battery is held at a high state of charge and is discharged only to shave peaks or during a grid failure. This keeps the full battery capacity available for peak shaving at all times.

Requirements

- Peak shaving is part of ESS and is supported on the MultiPlus, Quattro, MultiPlus-II and EasySolar inverter/chargers.
- The system requires ESS Assistant version 018C or later. The Assistant is configured in VEConfigure, which requires a trained installer.

- The PowerAssist setting in VEConfigure is disabled and ignored when the ESS Assistant is installed.
- The Limit system feed-in setting is configured in watts, while the export current limit is configured in amps. When both are set, the lower of the two is applied to the feed-in of DC-coupled PV.
- The GX device does not limit PV inverters in response to the export current limit. The PV-inverter system must be configured so that it cannot, by itself, exceed the rating of the grid connection.
- Peak shaving with a grid meter works with all grid meters supported by ESS.

Three-phase systems

In three-phase systems, peak shaving interacts with the way the system regulates power across the individual phases. For details of this behaviour, see Multiphase regulation [29].

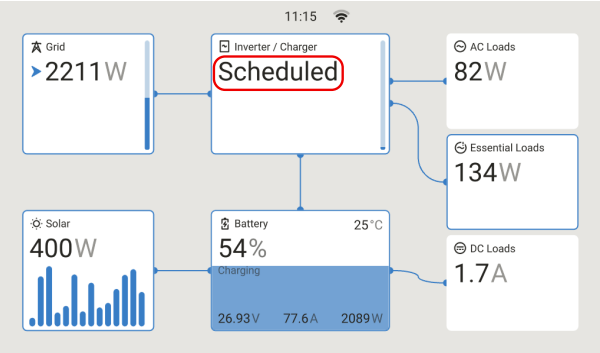
5.15. Scheduled charge levels

Scheduled charge levels allow the battery to be charged from the grid during defined time windows. Up to five schedules can be configured, each defining a day or day pattern, a start time, a duration, and a target state of charge. This is typically used to charge the battery during off-peak tariff windows (time-of-use tariffs), to prepare the battery ahead of a known grid outage, or to give the battery a regular maintenance charge.

Scheduled charge levels are only available when Mode is set to one of the Optimized modes. They have no effect in Keep batteries charged mode, where the battery is already held at a high state of charge.

How it works

At the start time, the inverter/charger begins charging the battery from the grid. Charging continues until the duration elapses or the SOC limit is reached, whichever comes first. The period defined by the day, start time and duration is referred to as a scheduled charge window.

While a scheduled charge window is active, the ESS state on the Overview page indicates that scheduled charging is in progress.	

Planning multiple schedules

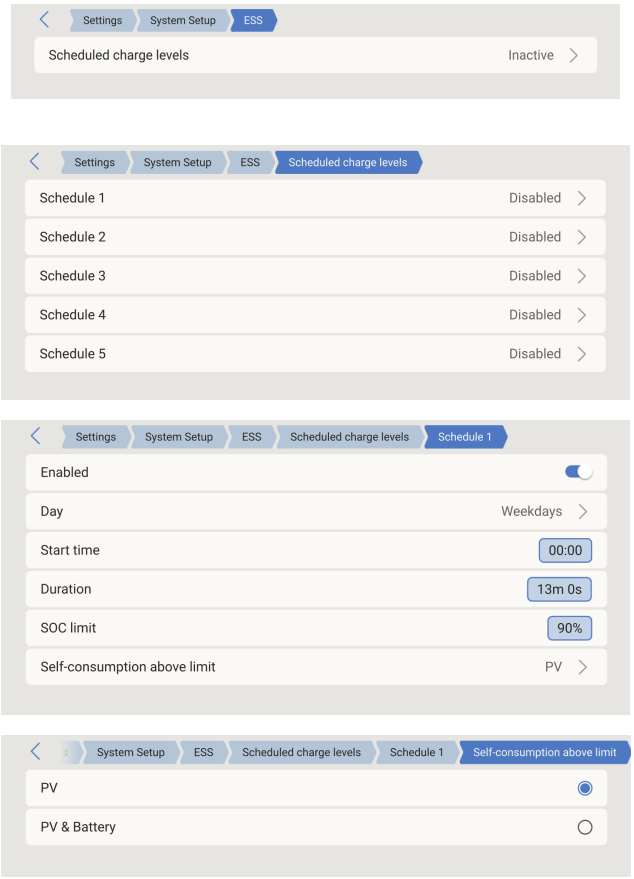
Schedules can be combined to shape battery use across the day. For example, a schedule with a lower SOC target following one with a higher target allows the battery to be used down to the lower state of charge between the two windows.

This is useful when planning around known outages, such as published load-shedding schedules. For example, with outages scheduled at 8pm and again at 4am, the battery can be recharged after the 8pm outage but left to rely on PV after the 4am outage, since solar production will resume shortly afterwards.

Configuring a schedule

Each schedule contains the following settings:

- **Enabled:** turns the schedule on. The remaining settings appear only when the schedule is enabled.
- **Day:** the day or day pattern on which the schedule runs. Options are Every day, Weekdays, Weekends, Monthly (the first day of each month), or an individual day of the week.
- **Start time:** the time at which grid charging begins.
- **Duration:** the length of the charging window.
- **SOC limit:** the state of charge the battery is charged to during the window, using power from the grid.
- **Self-consumption above limit:** appears when the SOC limit is set below 100%. Determines how the battery behaves once the SOC limit is reached:
  - **PV:** the battery is not discharged until the window ends; available PV is used to power the loads.
  - **PV & Battery:** the battery is discharged for self-consumption down to the SOC limit, after which only PV is used.



5.16. Dynamic ESS

Dynamic ESS optimises the system against a variable or dynamic energy tariff, scheduling battery charging and discharging to minimise energy costs while respecting the configured battery and grid limits.

For configuration and full details, see the Dynamic ESS manual.

5.17. Opportunity Loads

Opportunity Loads increases self-consumption by automatically using surplus solar energy to power flexible AC loads, such as EV charging, heat pumps, water heating and thermal storage, pool pumps and e-bike charging. Rather than curtailing excess PV, or exporting it when feed-in is limited or unattractive, the GX device directs that surplus into useful work.

The GX device acts as a system-level energy coordinator. It continuously reacts to PV production, battery charging requirements, household consumption, available inverter capacity and grid availability, and allocates whatever surplus is available across the supported devices on a priority basis.

How a load is driven depends on the device. The charge current of a supported EV charging station is adjusted to track the surplus available. Other loads are switched on and off: the power the load draws is configured, and the load is switched on once the surplus is enough to cover it.

Because control is centralised in the GX device, several loads can be coordinated together, including multiple EV chargers. This avoids the conflicts that arise when devices run their own independent surplus-charging algorithms.

Supported devices are the Victron EV Charging Station and EV Charging Station NS, and Shelly devices that provide switching and energy measurement. A load with no control interface of its own is switched through one of these devices.

To be used with Opportunity Loads, an EV Charging Station must be connected to the GX device over the MQTT integration. Existing installations that use Modbus TCP can be migrated.

Opportunity Loads requires Venus OS v3.80 or later. The controls are available only in the new GX user interface.

Opportunity Loads and Dynamic ESS cannot be enabled at the same time. Both manage energy at the system level and need control over how energy is allocated, so only one can be active: Dynamic ESS optimises energy flows against electricity prices and forecasts, while Opportunity Loads optimises the local use of surplus solar by controlling flexible loads.

For supported devices, requirements, and configuration, see the product manual for the GX device in use.

5.18. Solar charge controllers (SmartSolar or BlueSolar MPPT)

With ESS, the solar charge controllers:

- follow the charge curve set in VEConfigure, or
- are externally controlled by an intelligent battery connected via CAN-bus.

Any charge parameters configured on the controllers themselves are ignored.

When using a SmartSolar MPPT with a VE.Can port, ensure the Device instance is set to 0 (the default). Solar charge controllers on the VE.Can network that are set to a different Device instance are not managed by ESS.

5.19. Zero and limited feed-in with PV inverters

Some utilities do not permit export to the grid, or cap it at an agreed level. Where the PV is AC-coupled, keeping within that limit means reducing the output of the PV inverter itself. Limit system feed-in caps the total power fed into the grid, for both AC-coupled and DC-coupled feed-in. For that cap to take effect on AC-coupled PV, the PV inverter must be one the GX device can control, and it must be configured to accept that control. The sections that follow describe the supported PV inverters and the settings each requires.

5.19.1. Fronius PV inverters

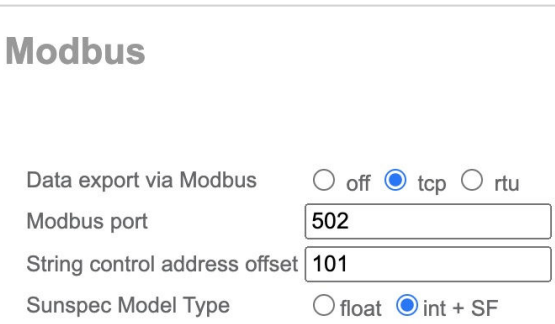
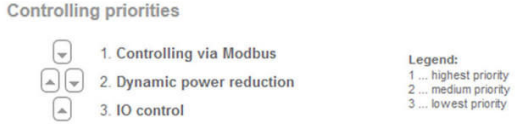
The AC-coupled PV zero and limited feed-in feature is specifically designed and most rigorously tested with Fronius AC PV inverters. By using the Power Reduction feature in Fronius grid-tie inverters, the system can automatically reduce the output of the Fronius inverter to prevent or limit export to the grid.

Note the following:

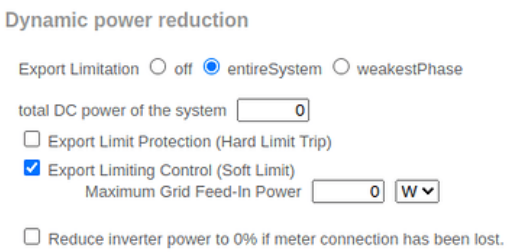
- The earliest Fronius firmware version that can be used is 3.7.3-2.
- If more than one Fronius PV inverter is present in the system, all of them are limited.
- Zero feed-in is not supported on Fronius IG Plus inverters.

Connect the Fronius PV inverter and add it to the GX device. See AC-coupled PV with Fronius PV Inverters for detailed guidelines.

Change the following settings in the Fronius Datamanager web interface:

• In the Fronius setup menu, set Data export via Modbus to tcp. • In the same menu, set Sunspec Model Type to int + SF.	
• In Settings → DNO Editor, in the Controlling Priorities section, set Controlling via Modbus to priority 1.	

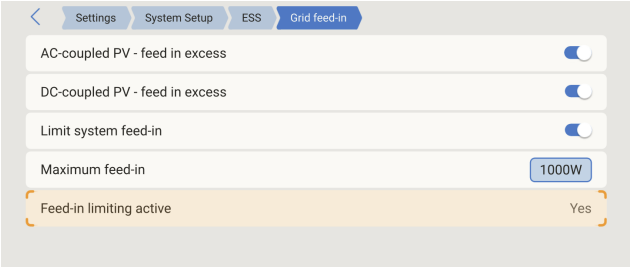
- By default, in Settings → DNO Editor, Dynamic Power Reduction is set to off. If the Fronius should stop generating when communication is lost, and it no longer receives instructions from Modbus control, Dynamic Power Reduction must also be configured. For this behaviour, set Export Limitation to entireSystem and DPL_SOFTLIMIT_POWERLIMIT to the export power limit, or to 0.



Checking operation

When the feature is working correctly, the Feed-in limiting active status in the ESS menu shows Yes.

If it shows No, check that all of the above criteria are met. Feed-in limiting active shows No if the firmware requirement, the data export, or the Sunspec Model Type settings are incorrect, if the units are shut down (no available PV), or if the AC input is disconnected or unavailable.



Do not use a Fronius Smart Meter for limiting export where ESS is used. ESS already provides the required metering. For details of when a Fronius Smart Meter can and cannot be used, see AC-coupled PV with Fronius PV Inverters.

5.19.2. ABB/FIMER PV inverters

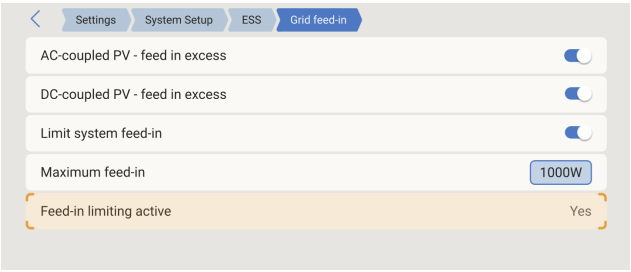
Compatible ABB/FIMER PV inverters can also be controlled by the system so that the export to the grid can be prevented or limited.

Connect the ABB/FIMER PV inverter and add it to the GX device. See CCGX & ABB/FIMER PV Inverters for detailed guidelines.

Checking operation

When the feature is working correctly, the Feed-in limiting active status in the ESS menu shows Yes.

If it shows No, check that the PV inverter is configured properly. Feed-in limiting active shows No if the firmware requirement, the data export, or the Sunspec Model Type settings are incorrect, if the units are shut down (no available PV), or if the AC input is disconnected or unavailable.



5.19.3. Other PV inverters

A number of SunSpec-compliant PV inverters can also be controlled by the system. Contact a Victron Energy dealer / installer or see Victron Community for details.

6. Controlling depth of discharge

Several mechanisms decide how deeply the battery is allowed to discharge, and they act together. BatteryLife manages the minimum SOC over time, the dynamic cut-off sets the voltage at which the inverter stops as a function of discharge current, and sustain protects the battery once it is empty. This chapter explains each of them, and the reason codes shown while any of them is active.

6.1. BatteryLife

Purpose

In a system where the battery is used every day, there are times when daily energy consumption exceeds the daily solar production. This happens during poor weather, in the winter months, or when the PV array is undersized relative to the loads.

During these periods, the battery state of charge falls a little further each day until it reaches the configured minimum SOC. Without intervention, the battery would then remain at or near this low state of charge for an extended period. Operating a battery at a prolonged low state of charge can reduce battery lifetime, cause the state-of-charge estimation to drift, prevent the regular full charge that some lithium cells need to stay balanced, and leave little reserve capacity for a grid failure.

How it works

BatteryLife automatically manages the minimum allowed state of charge so that the battery is regularly recharged to a high level.

If the battery does not reach a sufficiently high state of charge during the day, BatteryLife takes this as a sign that more energy is being consumed than solar PV is replacing, and raises the minimum SOC by 5% for the following day. Raising the minimum SOC reduces the amount of energy drawn from the battery overnight, so more of the load is supplied by the grid, and the battery starts the next day at a higher state of charge. This continues, 5% per day, until the available solar energy is enough to recharge the battery to at least 85%.

When solar production recovers and the battery reaches 95% state of charge, BatteryLife begins lowering the minimum SOC again, by 5% per day, until it returns to the configured value. More battery capacity then becomes available for overnight use once more.

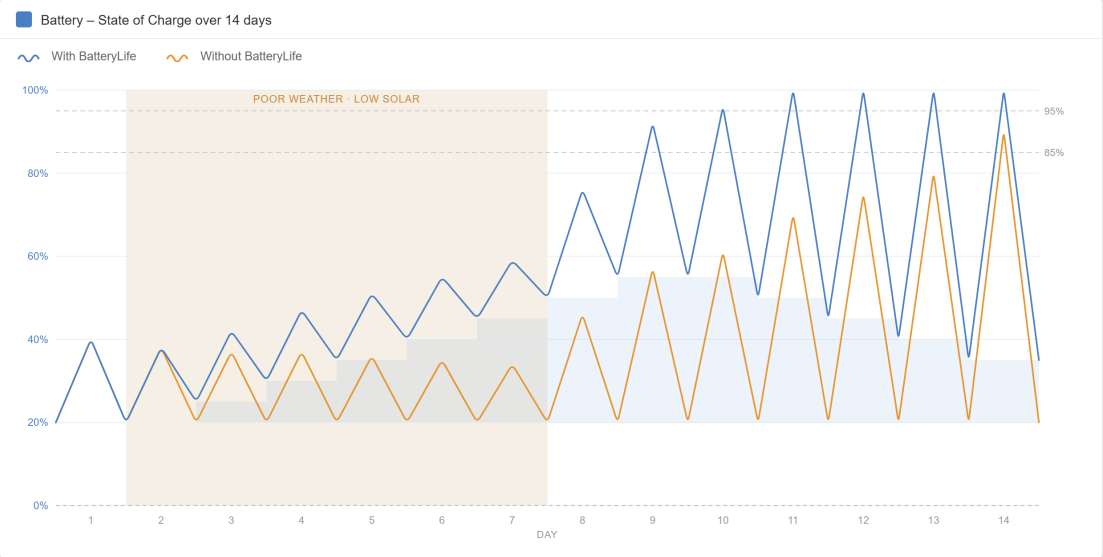
Example

The following example illustrates how BatteryLife behaves over a period of poor weather, assuming a configured minimum SOC of 20%.

During the energy-negative days, the battery repeatedly fails to reach 85% by the end of the day. BatteryLife therefore raises the minimum SOC by 5% each day, taking it from 20% up to 55%. As the minimum SOC rises, the battery is discharged less overnight, more of the load is supplied by the grid, and the battery rests at a progressively higher state of charge.

When solar production recovers and the battery again reaches 85%, the daily increase stops. Once the battery reaches 95%, BatteryLife begins lowering the minimum SOC by 5% each day, from 55% back down to 35%, and onward to the configured 20% over the following days. More battery capacity becomes available for overnight use as the minimum SOC returns to its configured value.

BatteryLife therefore keeps the battery operating within a healthy charge range even when solar energy is temporarily insufficient. Frequent BatteryLife intervention is a sign that daily consumption is regularly exceeding the available solar generation.



BatteryLife states

The current BatteryLife state is shown in the ESS menu and reflects what the system is doing at any moment:

- **Self-consumption:** normal operation. The battery is discharged to supply the loads down to the Active SOC limit.
- **Discharge disabled:** the battery has reached the Active SOC limit and is no longer discharged for self-consumption. Discharging resumes once the SOC rises 5% above that limit.
- **Slow charge:** the battery has remained below the Active SOC limit for more than 24 hours. The system slowly charges it from the grid back up to that limit, to protect the battery from prolonged low SOC.
- **Sustain:** the inverter/charger has entered sustain mode after the battery reached the dynamic cut-off voltage during discharge. See Dynamic cut-off [27] and Sustain [28].
- **Recharge:** the SOC has fallen more than 5% below the configured minimum SOC, and the system recharges the battery from the grid until it returns above that level.

6.2. Dynamic cut-off

Dynamic cut-off determines when the system stops discharging the battery, based on battery voltage. Rather than using a single fixed low-voltage threshold, it takes the current being drawn from the battery into account.

How it works

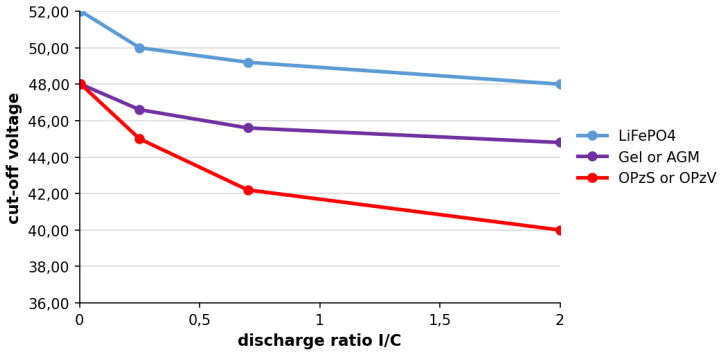
The voltage at which the system stops discharging depends on the discharge current. At high discharge currents the cut-off voltage is lower; at low discharge currents it is higher. The cut-off voltage is defined at four discharge ratios, and the default values depend on the battery type:

Discharge ratio	LiFePO4 (16S)(1)	LiFePO4 (15S)	Gel or AGM(1)	OPzS or OPzV(1)
0,005 C	52,00 V	48,80 V	48,00 V	48,00 V
0,25 C	50,00 V	46,90 V	46,60 V	45,00 V
0,7 C	49,20 V	46,10 V	45,60 V	42,20 V
2 C	48,00 V	45,00 V	44,80 V	40,00 V

(1): The values are for a 48V system. For a 24V system, divide them by two; for a 12V system, divide them by four.

This compensates for the internal resistance of the battery. Under load, the battery's terminal voltage drops in proportion to the current drawn and its internal resistance, so a fixed voltage threshold would misjudge the true state of the battery. By adjusting the cut-off voltage to the current, dynamic cut-off makes battery voltage a more reliable indicator of when the battery is becoming critically discharged.

The discharge-current-versus-cut-off-voltage curve is configured per battery type in the ESS Assistant and can be adjusted there.



Notes

- Dynamic cut-off is most useful for batteries with high internal resistance, such as OPzV and OPzS. It is less significant for LiFePO4 batteries, which have low internal resistance; their curve of discharge current versus cut-off voltage is much flatter.
- The three DC input low parameters on the Inverter tab (shut-down, restart, and pre-alarm) are not used. They are overridden by the dynamic cut-off levels and the corresponding restart levels, all configured in the ESS Assistant.
- Dynamic cut-off is active both when the grid is available and during a grid failure, when the system is in inverter mode.

6.3. Sustain

Purpose

Sustain mode prevents the damage caused by leaving a battery in a deeply discharged state. After the battery has been flagged as discharged, sustain mode holds the battery at a safe voltage rather than allowing it to sit empty.

How it works

Sustain mode is entered after the battery has been flagged as discharged. Either of the following conditions triggers it:

- the battery voltage has fallen below the dynamic cut-off level, or
- a low-cell signal is received from the VE.Bus BMS.

While sustain is active, the battery voltage is maintained at the sustain voltage level. The level depends on the battery type and the system voltage:

	12V system	24V system	48V system
Lithium batteries	12,5 V	25 V	50 V
Other batteries, first 24 hours	11,5 V	23 V	46 V
Other batteries, after 24 hours	12,5 V	25 V	50 V

If the battery voltage falls below the sustain level, the battery is charged back up to it using power from the grid when necessary. The maximum charge current used for this is 5 A per unit, regardless of system voltage. Excess solar power is also used for charging.

Sustain mode is exited once solar charging has raised the battery voltage above the sustain level, by 0,1 V in a 12V system, 0,2 V in a 24V system, or 0,4 V in a 48V system. Normal operation then resumes, with the battery supplying power when insufficient energy is harvested from the PV array.

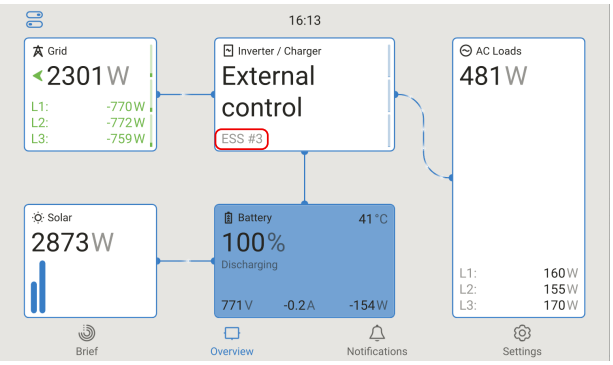
6.4. Battery reason codes

In addition to the charger states (Bulk, Absorption and Float), the system shows Discharging and Sustain reason codes. These appear on the Overview page of the GX device and give at-a-glance information on why the battery is being charged or discharged, or why it is not.

Reason codes:

The reason codes and their meanings are:

- **#1** : SOC is low.
- **#2** : BatteryLife is active.
- **#3** : the BMS has disabled charging.
- **#4** : the BMS has disabled discharging.
- **#5** : slow charge is in progress (part of BatteryLife).
- **#6** : a charge limit of zero has been configured.
- **#7** : a discharge limit of zero has been configured.
- **#8** : the battery is being discharged to shave a peak.



7. Multiphase regulation

In a system with more than one phase, the way power is balanced across the phases affects both the capacity available to the loads and what the utility meter records. This chapter explains the two regulation options, then works through the two arrangements in which the difference matters: a single-phase system on a three-phase grid connection, and a three-phase system.

7.1. Introduction

Use the multiphase regulation setting in systems with a three-phase connection to the utility grid. The setting defines how the system interacts with the individual phases.

By default, Total of all phases is selected. All phases are adjusted to convert the same power to and from DC, dividing the work equally across the phases. This makes the full system capacity available and is optimal for billing.

The setting has no effect on single-phase systems and can be ignored. It also has no effect when Mode is set to Keep batteries charged.

The two options behave differently depending on whether the system itself is single-phase or three-phase:

- In a single-phase system connected to a three-phase grid, Total of all phases regulates the combined power of L1, L2 and L3 to zero, while Individual phase regulates only the power of L1 to zero. See Single-phase system with a three-phase grid connection [29].
- In a three-phase system, Total of all phases loads the inverters symmetrically and keeps the combined power of all phases to zero, while Individual phase regulates each phase to zero independently. See Three-phase system [30].

7.2. Single-phase system with a three-phase grid connection

A single-phase system uses a single inverter/charger. In an installation with a three-phase connection to the utility grid, the two multiphase regulation options behave as follows:

- **Total of all phases** : the system uses the battery to balance the combined power of all phases to 0 W.
- **Individual phase** : the system uses the battery to balance only L1 to 0 W. L2 and L3 are visible on the GX device, but are not used in any way.

In the following example the inverter/charger is connected to L1. By compensating for phases L2 and L3 as well, it regulates the total power at the distribution panel to 0 W.

	L1	L2	L3	Total
Load	100 W	400 W	200 W	700 W
System	-700 W	0 W	0 W	-700 W
Distribution box	-600 W	400 W	200 W	0 W

Install the inverter/charger on L1. If it is installed on another phase, the visualisation will be wrong and the function impaired.

7.3. Three-phase system

A three-phase system has at least one inverter/charger installed on each phase. Leave the multiphase regulation setting at its default, Total of all phases.

Total of all phases (default and recommended)

The system balances the total power of all phases (L1 + L2 + L3) to a net 0 W at the meter, loading the inverters symmetrically.

In the example below the loads on L1 are 6000 W, exceeding the capacity of the inverter on that phase, while L2 and L3 have no load. Taking the sum of all three phases, the system provides surplus from L2 and L3 to displace the load on L1. This is optimal for billing efficiency.

	Load	System	On the meter
L1	6000 W	2000 W	4000 W
L2	0 W	2000 W	-2000 W
L3	0 W	2000 W	-2000 W
Sum	6000 W	6000 W	0 W

Similarly, in a situation with both PV and load: if there is 6 kW of excess PV on L1 with the same inverter/charger configuration, all inverter/chargers charge at approximately equal power.

	PV + Load	System	On the meter
L1	-6000 W	1800 W	-4200 W
L2	600 W	1800 W	2400 W
L3	0 W	1800 W	1800 W
Sum	-5400 W	5400 W	0 W

Excess PV power from solar chargers is not actively made symmetrical across the phases.

	PV + Load	System	On the meter
L1	-6000 W	0 W	-6000 W
L2	0 W	0 W	0 W
L3	0 W	0 W	0 W
Sum	-6000 W	0 W	-6000 W

Individual phase

The system balances the power of each separate phase to 0 W. Using the system this way causes significant losses, as power flows from one AC phase to another through the DC connection. This incurs the losses of converting from AC to DC on one phase and back from DC to AC on the other.

Maximum charge current

In a multiphase system, the charge current is configured per phase, rather than for the whole system. A limitation of this arrangement arises, for example, where a relatively small battery bank is installed and a significant over-supply of AC-coupled PV power is available on L1 but not on the other phases: only part of that excess PV power on L1 is then used to charge the battery.

8. Commissioning

Commissioning confirms that a correctly installed and configured system behaves as intended under real operating conditions. Before starting, complete the installation and configuration described in the previous chapters. Work through the checks below that apply to the system, simulating each scenario and confirming the expected result.

Communication of the devices

Check and validate that all installed devices are displayed properly on the GX device.

Initial check - normal operation

With the grid connected and the system configured, confirm on the GX device that:

- each MPPT solar charger shows External control in its state, and its blue Bulk LED flashes briefly every four seconds, confirming it is remotely controlled by the system;
- if a grid meter is fitted, it appears in the Device list;
- the battery charges when surplus PV is available, and the grid power reading sits close to the grid setpoint. A slight fluctuation is acceptable.

Scenario - grid outage

Switch off the grid supply at the breaker or isolator to simulate a grid failure. Confirm that:

- the system switches to inverter mode without interrupting the loads on AC-Out;
- the loads on AC-Out continue to be powered from the battery, and from PV when available, as long as the battery has sufficient charge;
- the loads on AC-In are no longer powered. For anti-islanding safety, loads on the AC-In side are always disconnected during a grid outage.

Switch the grid back on and confirm that the AC-In loads are powered again and the system returns to normal operation.

Scenario - self-consumption of AC-In loads (grid connected)

This check verifies how the battery supplies loads on the AC-In side while the grid is connected. The behaviour depends on **Settings → System Setup → ESS → Self-consumption from battery** and **Settings → System Setup → AC System → Position of AC loads**. With the grid connected and a load running on the AC-In side:

- with Self-consumption from battery set to All system loads, confirm that the battery discharges to supply the AC-In load;
- with Self-consumption from battery set to Only critical loads, confirm that the AC-In load is supplied from the grid and the battery is not discharged to supply it.

For the battery to supply AC-In-side loads, Position of AC loads must be set to include the AC input.

Scenario - loss of PV power

Simulate a sudden drop in solar production, for example by covering the array or waiting for cloud cover. Confirm that:

- the system smoothly increases the power drawn from the battery, and from the grid if required, to continue supplying the loads;
- there is no interruption to the loads as PV production falls.

Scenario - high load / peak demand

Switch on a load larger than the available PV and grid setpoint. Confirm that the battery supplies the additional power required and that the loads remain fully powered.

Scenario - reaching minimum SOC

Allow the battery to discharge to the configured minimum SOC, or simulate this condition. Confirm that discharging stops at the minimum SOC and the loads are then supplied from the grid.

Keep batteries charged mode

If the system is set to Keep batteries charged mode, confirm that the battery begins charging immediately after the mode is configured, and that it charges from both the grid and PV.

Backup generator

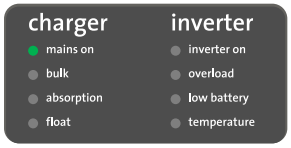
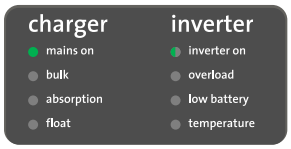
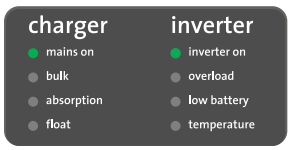
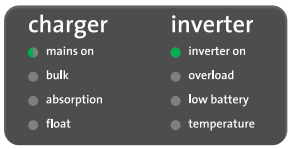
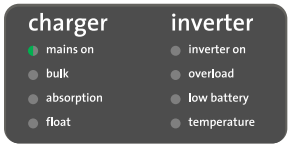
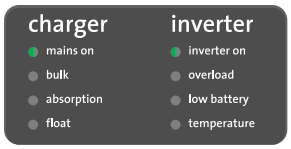
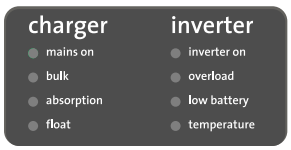
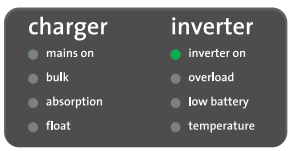
If a generator is fitted, start it and confirm that the system begins charging the battery.

Zero feed-in with supported PV inverters

If the system uses a supported PV inverter with zero feed-in, confirm that Feed-in limiting active shows Yes in the **Settings → ESS menu**.

8.1. LED codes during ESS operation

When the inverter/charger operates in parallel with the grid, as it does when ESS is used, the Mains and Inverter LEDs indicate the direction of power flow. The table below describes the relevant LED codes, including some combinations that are not specific to parallel operation with the grid. LED indications not listed here are covered in the inverter/charger manual.

Mains and Inverter LED states	Description and power direction
	Power flowing to the battery (normal charging)
	Power flowing to the loads (similar to PowerAssist)
	Around the balance point
	Power flowing to the grid
Remaining combinations, not specific to parallel operation with the grid	
	The unit is set to charger-only mode but is still off. Grid voltage is detected but has not yet been accepted.
	The unit is a slave (LEDs blink slowly and alternately)
	The unit is off
	Inverter mode
	LED on LED blinking LED off

9. Frequently asked questions

This section answers common questions about ESS behaviour in normal operation and during fault-finding.

Q1 Can ESS operate without solar?

Yes. Solar is optional. ESS works with grid-tie PV inverters, MPPT solar chargers, a mix of both, or no PV at all. A system without PV is typical of virtual power plants, where many small storage systems support the grid at times of peak demand.

Q2 Can standard AGM or GEL batteries be used in a system that cycles daily?

Standard AGM and GEL batteries are not recommended for systems that cycle the battery every day. For lead batteries, the high internal resistance of OPzS and OPzV types should also be considered in the design.

Q3 When is a grid meter needed?

A grid meter is needed only when AC loads or sources are present on the input (grid) side of the inverter/charger. When everything is connected to the output side, all power exchanged with the grid passes through the inverter/charger, which meters the exchange itself, so no grid meter is needed.

Q4 Can ESS be used in a vehicle or a boat?

No. After the shore cord is unplugged, the system needs a moment to detect the loss of mains and open the back-feed relay. During those seconds the shore-power plug is live, with 110/230 VAC on the terminals. The exact time depends on local grid-code requirements. The same applies to any installation where the wiring is not protected against accidental disconnection, such as a cable with a user-removable plug, or a portable power supply.

Q5 Does AC-coupled PV keep working during a power cut?

It depends where it is connected. AC-coupled PV on the AC-Out keeps running during a grid failure, because the inverter/charger forms a local micro-grid for it to synchronise to. AC-coupled PV on the AC-In stops, because it behaves as an ordinary grid-tied installation with no grid to synchronise to.

Q6 Does the grid-tie inverter's feed-in need configuring?

Feed-in for both AC-coupled and DC-coupled PV is set in the Grid feed-in menu on the GX device. See Feed-in [10] for what each setting can do, and Zero and limited feed-in with PV inverters [24] for which PV inverters can be limited.

Q7 Why does the grid setpoint default to 50 W rather than 0 W?

A small positive setpoint provides a buffer that prevents unintentional export when a large load switches off before the system can react. A system regulating to exactly 0 W tends to overshoot into export at that moment; a slight positive value keeps the flow drawing lightly from the grid instead.

Q8 Why does the battery not charge from the grid even with a positive grid setpoint?

Check the Grid metering setting. If it is set to External meter but no external meter is installed, the battery will not charge from the grid, even with a positive grid setpoint. Set Grid metering to Inverter/charger when no external meter is present.

Q9 What is the difference between the two Optimized modes?

Both modes store surplus PV in the battery for later use. They differ only in how the minimum SOC is handled: Optimized with BatteryLife dynamically manages it so the battery is regularly recharged to a healthy level, while Optimized without BatteryLife holds it fixed at the configured value. Optimized with BatteryLife is recommended for most systems.

Q10 Why is the Limit charge power setting missing from the menu?

It appears only when DVCC is disabled. When DVCC is enabled, the setting is hidden, and the system-wide maximum charge current is configured instead under Settings → System Setup → Charge Control → Limit charge current, which applies to all charging devices together.

Q11 Can feed-in briefly exceed the configured limit?

Yes. Limit system feed-in is a target. Under some conditions, such as a large load disconnecting or a sudden rise in solar production, the actual feed-in may briefly exceed the target until the system regulates the inverter output back within the limit. If the system is not feeding in at all, or is feeding in less than expected, see Q26 instead.

Q12 Can Opportunity Loads and Dynamic ESS run at the same time?

No. Both manage energy at the system level and need control over how energy is allocated, so only one can be active at a time. Dynamic ESS optimises energy flows against electricity prices and forecasts, while Opportunity Loads optimises the local use of surplus solar by controlling flexible loads.

Q13 An Optimized mode is selected, but grid power is not being used to charge the battery. Why?

In the Optimized modes, the battery is charged only from PV, except in two circumstances, both related to protecting battery health:

- Sustain: the battery has been discharged deeply enough to trigger the sustain mechanism. See Sustain [28].
- Slow charge: BatteryLife is active and raising the minimum SOC. See BatteryLife [26].

Q14 The battery discharges and is then recharged every night. Why?

The nightly recharge may be part of the Sustain protection. Consider raising the minimum SOC, for example by 5%, and observe the effect. Alternatively, the sustain voltages can be lowered in VEConfigure, but with caution, especially for lead batteries, as the sustain levels are designed to prevent early battery damage.

Q15 What is auto-recharge?

The system automatically recharges the battery from the grid when the SOC drops 5% or more below the Minimum SOC set in the ESS menu. Recharging stops once the battery reaches the Minimum SOC level.

Q16 Why must a single-phase system on a three-phase grid connection be installed on phase L1?

The system regulates against the phase the inverter/charger is installed on and expects that phase to be L1. On L1, with Multiphase regulation set to Total of all phases, the single-phase system balances the combined power of all three phases correctly, and the system visualisation on the GX device reflects the true state of each phase. If the inverter/charger is installed on L2 or L3 instead, the phase visualisation is shown against the wrong phase and the regulation is impaired, so the system does not compensate the phases as intended. Installing on L1 is therefore required, not merely recommended.

Q17 Why does VRM data for split-phase and three-phase systems not match the utility bill?

This does not apply to systems that use a VM-3P75CT, EM24, EM530 or EM540 energy meter.

In an installation with no dedicated energy meter, or one that uses an ET340 meter, energy imports and exports are accumulated per phase, and the total imported and exported energy is the sum across all phases. The utility meters in many countries use a different method, billing on the total net energy imported across all phases. Because of the difference between the two methods, the data shown on VRM and on the utility meter may vary.

With Multiphase regulation set to Total of all phases, the default, the variation is more pronounced. That setting specifically makes full use of the billing arrangement in which energy exchange between phases is not billed, but it appears as simultaneous import and export in systems that count total import and export rather than total net energy. This causes the "to grid" and "from grid" counters on VRM to increase while multiphase regulation is operating. It can also occur where PV inverters are used, even with regulation set to Individual phase. Systems using a VM-3P75CT, EM24, EM530 or EM540 energy meter, which accumulate total net energy, are not affected. The energy meter selection guide identifies which meters accumulate energy in this way. See also Multiphase regulation [29].

Q18 What happens to loads on the AC-In during a grid outage?

They are not powered. For anti-islanding safety, loads on the AC-In side are always disconnected during a grid outage. Only loads on the AC-Out are backed up, from the battery and from PV when available.

Q19 Even when the battery is full, the system stays connected to AC-In. Why?

This is normal in the Optimized modes. The question is often raised by those familiar with the earlier Hub-1 or Hub-2 configurations in a series installation, where the system switched to inverter mode once the battery was full enough. That approach had disadvantages, because an inverter provides a weaker voltage supply than the grid, which could lead to flickering lights, or to inverter shutdown on overload when a large load was switched on. In the Optimized modes the system always remains connected to the grid, even when the battery is full. The power drawn while connected is not substantial, so the configuration offers the stability of the grid without significant additional grid consumption.

Q20 Why is the VE.Bus state showing pass-through?

With ESS, the VE.Bus system is in pass-through (VE.Bus state: passthru) under the following conditions:

- The GX device is no longer receiving data from the grid meter. This applies only to systems configured to use an external grid meter, and relates to the Grid meter required setting.
- In a system with a CAN-bus-connected lithium battery, the GX device is no longer receiving information from the battery over the CAN-bus.
- Charging the battery is not allowed (BMS maximum charge current is 0 A, or maximum charge power is 0 W) and there is excess PV power.
- Discharge is not allowed and the loads on AC-Out would force the inverter/charger to exceed the AC input current limit. Discharge may be blocked because the BMS blocks it (DCL = 0), or because the battery SOC is below the minimum SOC setting; discharge is allowed again once the SOC is at least 3% above the set level.
- A grid code is in use that requires battery discharging to be enabled through the aux inputs. Check the grid code in VEConfigure against the electrical signals provided to the inverter/charger's aux inputs.
- Loss of Mains (LOM) detection is causing problems, often in combination with a high-impedance connection to the utility. For details, see VEConfigure: grid codes and loss of mains detection.

Q21 How can low-battery warnings be suppressed?

In an off-grid or backup system, a warning when the battery is almost empty is useful. In a system where the battery is used to optimise self-consumption and is normally depleted every day, the notification is not needed.

- The low-battery warning pop-up on the GX device is disabled from the inverter/charger menu: select Setup, then Alarms, and set the Low DC voltage alarm to Alarm only.
- The red blinking LED on the inverter/charger, which warns of a low battery, cannot be disabled.
- Email notifications are suppressed in the VRM Portal by setting Automatic alarm monitoring to Only alarms.

Q22 In an Optimized mode with no feed-in, the AC input current fluctuates widely and sometimes goes negative. Why?

This is normal. The current shown is the RMS current, which does not represent real power or real energy fed into the grid. Around 0 W of real power the RMS current is high, caused by the X-capacitors in the inverter/charger. The input power readings are a more reliable indication of power and energy, and fluctuate much less.

Q23 Why does the system switch off in overload?

Switching off in overload while connected to the grid is caused by the Loss of Mains (LOM) detection linked to the grid code configured in VEConfigure. It occurs when the AC supplied at the AC-In is weak, meaning the connection to the utility has a higher impedance than usual, for example a generator, or an old or remote property connected by a cable that is too long or too thin. For the solution and configuration options, see VEConfigure: grid codes and loss of mains detection.

Q24 Why are the loads powered by the grid instead of the battery or solar?

Work through the following checks when loads are supplied from the grid but are expected to be supplied from the battery:

- Check that the system is not preventing discharge because the battery SOC is below a limit. See Controlling depth of discharge [26] .
- For a managed lithium battery with a CAN-bus connection, check that the battery has not disabled discharging. In the Device List, open the battery entry, then the Parameters submenu, and check the Discharge Current Limit (DCL). A value of zero means the battery is instructing the system not to discharge further. This also shows as reason code #4.
- The ESS relay test may still be pending. The inverter/charger must perform a relay test before it can use battery power, which requires it to run briefly in inverter mode with enough spare battery capacity. If the battery voltage is too low when connecting to the grid, the system starts in pass-through or charging mode and will not feed in, supply the loads from the battery, or export DC-coupled solar power until the battery is recharged sufficiently. The relay test is performed once the battery voltage rises above 14V, 28V or 56V, or the SOC rises above 20%. The ESS relay test entry in the Advanced submenu of the inverter/charger shows either Pending or Completed, and is visible only on systems with the ESS Assistant installed.
- Feed-in may be disabled by a grid code (such as the German or Australian grid code) that uses the aux1 input to disable feed-in, where aux1 is also used by something else such as an AC sensor or a BMS. Clear the relevant option in the grid-code settings to prevent this. See also Q26.
- Check that the rocker switch on the inverter/charger is set to On rather than Charger-Only. When set to Charger-Only, the unit will not discharge the battery. This must be checked physically, as the switch state is not shown on VRM or the GX device. On a MultiPlus-II the rocker switch is at the bottom of the unit and must be in the I position, not the II position.
- If none of the above resolves the problem, temporarily disable LOM to rule it out as the cause. See VEConfigure: grid codes and loss of mains detection.

Q25 Why does the system refuse to discharge the battery?

The system withholds battery discharge for a small number of defined reasons, all of them protective or configured:

- The battery SOC is at or below the minimum SOC. Discharge resumes once the SOC rises at least 3% above the limit.
- An intelligent battery connected via CAN-bus has set its Discharge Current Limit to zero, instructing the system not to discharge. This shows as reason code #4.
- The inverter/charger's rocker switch is set to Charger-Only rather than On.
- The ESS relay test is still pending, because the battery has not yet been charged enough to perform it.
- BatteryLife or Sustain has disabled discharge to protect the battery from a prolonged low state of charge.

See also the checklist under Q24, and Controlling depth of discharge [26] for how the depth-of-discharge limits work.

Q26 Why is the system not feeding in to the grid, or feeding in less than expected?

Feed-in can be limited or prevented by the grid code and by the condition of the grid itself, independently of the ESS settings. Check the following:

- The aux1 input is in use. Some grid codes use the aux1 input to disable feed-in. If aux1 is also used for something else, such as a separate assistant, a jumper or a temperature sensor, feed-in can be blocked unintentionally. Check the grid code settings in VEConfigure against what is actually connected to aux1, and clear the relevant grid code option if it is not wanted.

- The system has only just connected to the grid. Some grid codes, for example in Spain, prevent feed-in for several minutes after the system connects. This is normal behaviour; wait for the delay to pass before investigating further.
- The grid is unstable. Frequency variation or voltage instability can disable feed-in and some other ESS features. This is more common where the local electrical infrastructure is weak.
- The grid voltage is too high. Feed-in is limited or stopped when the grid voltage rises above the limit set by the grid code. Feed-in resumes once the voltage falls back within the permitted range.