ENGLISH



Dynamic ESS

rev 01 - 11/2026

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1. Introduction

Dynamic ESS is a control algorithm that runs on the VRM portal and the GX device. It optimises the charging and discharging of the battery using real-time and day-ahead electricity prices, solar generation forecasts, and the system's consumption pattern. Rather than following a fixed strategy, it builds a schedule that determines when to charge the battery, when to discharge it, when to draw from the grid, and when to feed back into it.

The goal of Dynamic ESS is to optimise energy use from a financial perspective. This is what distinguishes it from standard ESS, which aims to minimise grid use regardless of price. Standard ESS stores surplus solar energy for later self-consumption; Dynamic ESS additionally determines when it is most cost-effective to buy energy from the grid or sell energy to it, based on the prevailing prices.

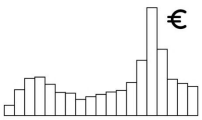
Dynamic ESS is applicable to both residential and commercial installations. It is intended for systems on a dynamic energy contract, where prices change throughout the day, and for systems on a fixed contract with prices that differ by time of day or between weekdays and weekends.

Dynamic ESS has two operating modes:

	Green mode	Trade mode
Surplus solar	Sold to the grid only after consumption and battery charging.	Sold to the grid when it is more profitable.
Energy in the battery	Reserved for consumption.	Used to trade.
Battery is charged	When prices are low.	When it is beneficial for trading.
Emphasis	Consistent and predictable results.	Maximum financial use of the energy storage system.



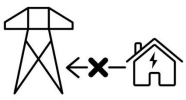
Automated buying/selling energy from/to the grid



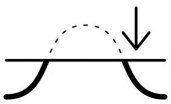
Works with dynamic,variable- and fixed day/night tariffs



Solar irradiance forecast based on location



Disable selling energy to grid option



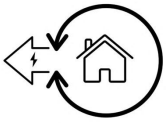
Peakshaving high-power loads



Avoid paying peak-rates for incidental peak usage



Configurable max. import current



Configurable max. export current

1.1. How Dynamic ESS works

Dynamic ESS works by building a schedule. Rather than responding only to the present moment, it plans ahead, so that energy predicted to be needed later in the day is already stored, and stored at the most economical price.

The schedule is divided into intervals, and sets a target for each one. For each interval, Dynamic ESS determines which of the following is most economical:

- charge the battery
- discharge the battery
- import from the grid
- export to the grid
- hold

To build the schedule, Dynamic ESS uses:

- the buy and sell prices for each interval, from either a dynamic contract with changing prices or a fixed contract with defined price bands
- the cost of the energy currently stored in the battery, based on what was paid to charge it
- the battery's capacity, state of charge, maximum charge and discharge rates, and cycle cost
- a solar yield forecast, based on the weather and the system's location
- a consumption forecast, based on the site's own energy use over the previous four weeks

Following the schedule

Each target is a state of charge, the battery level Dynamic ESS aims to reach by the end of that interval. The system charges or discharges at whatever rate is needed to move from the current level towards the target. This is why the charge or discharge rate can appear to change during an interval: the system is continually correcting its rate to arrive at the target, and adjusts as the forecasts and the actual load change.

Local conditions vary from what the schedule anticipated, for example when cloud reduces solar production or an unexpected load appears. Dynamic ESS adjusts to these conditions, following the intent of the schedule rather than the schedule to the letter. Where solar production is not sufficient to reach the target, for instance, it will not import from the grid to make up the difference.

Solar production itself can also be part of the economics. With the optional **Disable solar at low buy prices** setting, solar production is stopped while the buy price is below the configured threshold, and resumes when the price rises above it. The setting is described in System [5].

Battery wear

Dynamic ESS treats the battery as having a cost to cycle. Every charge and discharge cycle contributes to battery wear, and the system assigns a financial value to that wear through the battery cycle cost. Dynamic ESS cycles the battery only when the financial benefit is greater than the cost of the cycle.

Where Dynamic ESS runs

The schedule is prepared on the VRM portal, which has access to the price and forecast data. It is then carried out by the GX device, which controls the inverter/charger and the connected energy sources. This division is why two-way communication between the GX device and VRM is required. The schedule is recalculated regularly, so that new price data, updated forecasts, and actual system behaviour are fed back into the plan.

2. Prerequisites

Before configuring Dynamic ESS, check that the system meets the following conditions.

Grid connection and contracts

Permission from the network operator is always required to connect an ESS installation to the grid.

Selling energy to the grid additionally requires an agreed export limit from the network operator and a contract with the energy supplier that permits it.

System configuration

The system must be configured for ESS. For full ESS configuration, see the ESS Design & Installation Manual.

A supported grid meter is required for Dynamic ESS to function correctly, and its role must be configured as a grid meter. For a list of supported grid meters, see the Energy Meters Selection Guide.

The GX device must run Venus OS 3.50 or later.



Dynamic ESS is being continuously improved, so running the latest Venus OS version is recommended.

VRM communication

Two-way communication with the VRM portal must be enabled, so that VRM can send the schedule to the GX device. Confirm that Realtime updates is switched on in the VRM settings. When it is active, the "Last updated" field on the VRM dashboard shows "Realtime" with an animated wave.

If the system includes solar, set the system location in VRM so that Dynamic ESS receives an accurate solar yield forecast based on the location of the site.

Information to gather

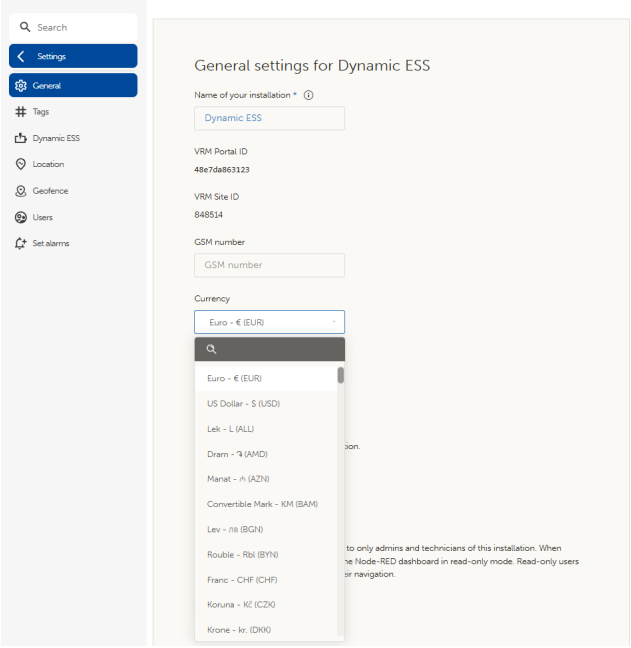
Have the following details in hand before starting configuration:

- The grid connection specifications.
- The battery system specifications.
- The terms of the energy contract with the supplier.

3. Setup and configuration

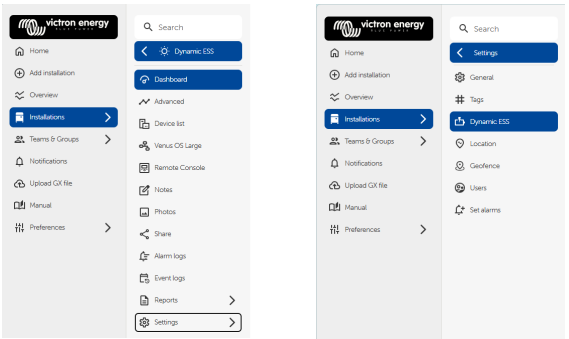
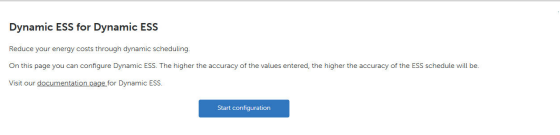
3.1. Currency

Set the currency first, before running the setup wizard. The currency applies to the battery cost, the buy and sell prices, and all cost and earnings figures shown for Dynamic ESS, so it should be in place before those values are entered.

Choose the currency under Settings, then General, in the VRM site settings.	

3.2. Setup wizard

The following steps enable and configure Dynamic ESS through a setup wizard in the VRM portal.

Open the VRM portal and select the site. From the left-hand menu, go to Settings, then Dynamic ESS. At this stage the Dynamic ESS controls can optionally be enabled so that they appear on the VRM dashboard.	
Select "Start configuration" to begin. The wizard then leads through each step in turn: System, Battery, Buy prices, Sell prices, and a final Confirmation. Each step is described in the topics that follow.	

3.3. System

Dynamic ESS needs to know the limits of the grid connection in order to schedule grid usage accurately. The values entered here affect only the Dynamic ESS schedules; system-wide limits are set separately on the GX device.

Can you sell energy back to the grid? Select Yes or No. If No is selected, only the Maximum import power field is shown.

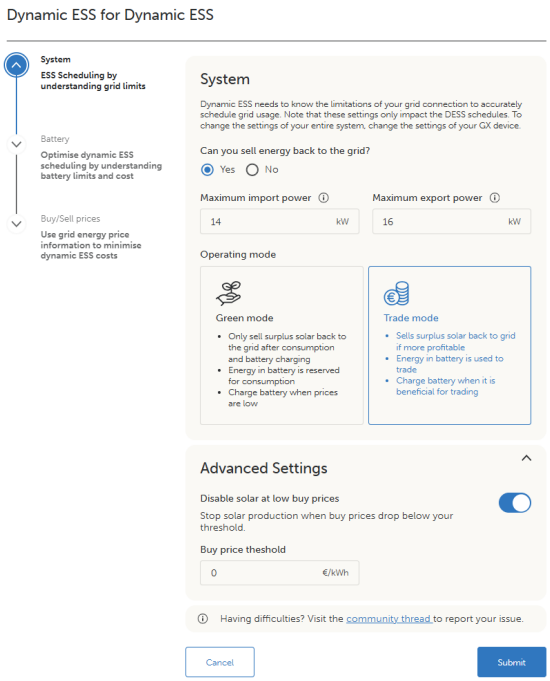
Maximum import power: Enter the maximum power the site can import. On a three-phase system, this is the sum of all phases.

Maximum export power: Enter the maximum agreed export limit or the system's maximum export capability, whichever is lower. For example, if the agreed export limit is 17 kW but the system can export at most 10 kW, enter 10 kW.

Operating mode: Select Green mode or Trade mode. The two modes are described in the Introduction [1].

Disable solar at low buy prices: Found under Advanced Settings. When enabled, solar production is stopped while the buy price is below the configured threshold. At very low or negative prices, producing solar energy can be uneconomical: energy from the grid costs less than the system's own solar production, and exporting the surplus may cost money rather than earn it. Solar production resumes automatically once the buy price rises above the threshold.

Buy price threshold: The buy price, in €/kWh, below which solar production is stopped.



The operating mode, and the other values entered here, can be changed at any time from the Dynamic ESS settings page in VRM.

Once all fields are completed, select Next to continue.

3.4. Battery

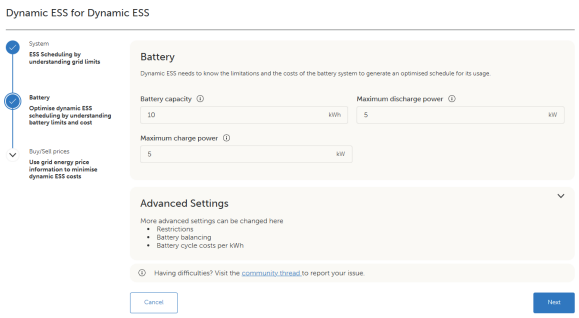
Dynamic ESS needs the limitations and costs of the battery system in order to generate an optimised schedule for its use.

Battery capacity: Enter the capacity of the battery when fully charged, expressed in kWh. To convert from amp-hours, multiply the battery bank capacity in Ah by the nominal battery voltage and divide by 1000.

Where the usable capacity is lower than the nominal capacity, enter the usable figure. For example, a 48V 100Ah battery with a 95% depth of discharge limit gives (48 × 100 × 0,95) / 1000 = 4,56 kWh.

Maximum discharge power: Enter the maximum power the battery bank may discharge at. This prevents discharging the battery at too high a rate, which matters particularly for smaller battery banks.

Maximum charge power: Enter the maximum power the battery may be charged at.



Further options are available under Advanced Settings, which is collapsed by default. Expand it to access the charge or discharge restriction, battery balancing, and battery cycle costs.

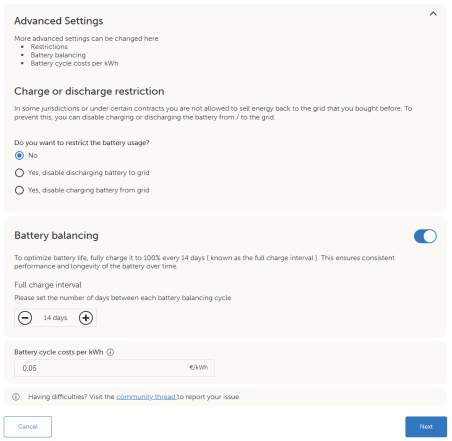
Charge or discharge restriction: In some jurisdictions, or under certain contracts, selling previously bought energy back to the grid is not permitted. To prevent this, charging or discharging the battery to or from the grid can be disabled. Under "Do you want to restrict the battery usage?", select No, "Yes, disable discharging battery to grid", or "Yes, disable charging battery from grid".

Battery balancing: Periodically charging the battery to 100% supports battery life and consistent performance over time. Enable balancing with the toggle, then set the full charge interval, the number of days between each balancing cycle, using the plus and minus buttons.

Battery cycle costs per kWh: Enter the cost of battery wear for each kWh cycled through the battery. This value is used to weigh the financial benefit of using the battery against the cost of wearing it. Calculate it using the formula below.

battery price in system's currency / (battery cycle life x battery capacity in kWh)

Even where the battery has already been paid for, a small amount should still be entered here rather than zero. Values between 0,02 and 0,08 €/kWh are typical.



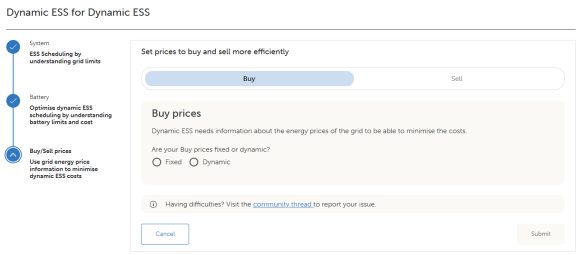
Once all fields are completed, select Next to continue.

3.5. Buy prices

Dynamic ESS works with either fixed or dynamic energy prices.

Fixed prices change at set times of the day, or differ between weekdays and weekends. The price levels are agreed with the energy supplier.

Dynamic prices change frequently throughout the day and are published by the energy supplier the day before.

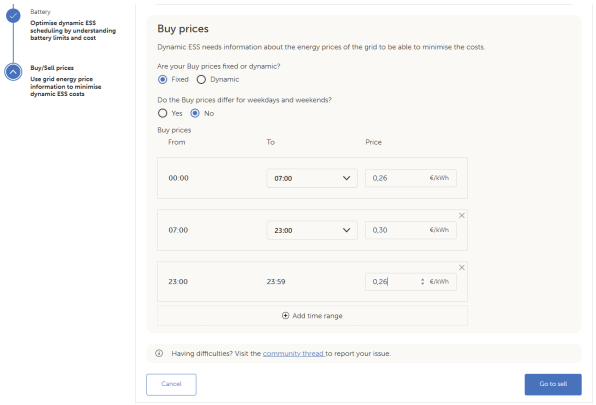
Buy prices are: Choose Fixed or Dynamic. The information requested in the following step depends on this choice.	

3.5.1. Fixed prices

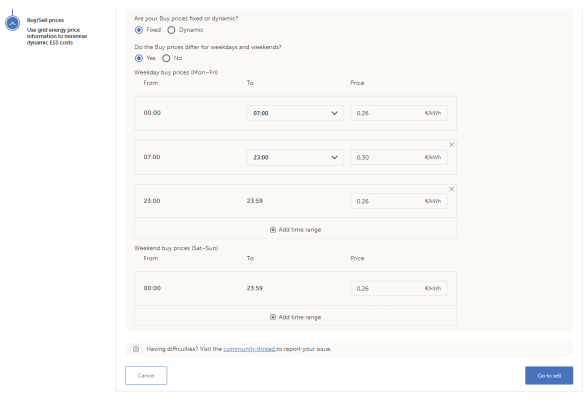
If fixed pricing is selected, buy prices are entered as one or more time ranges across a 24-hour day.

Under "Do the Buy prices differ for weekdays and weekends?", select No if a single daily schedule applies, or Yes to define separate weekday and weekend schedules.

If No is selected, a single schedule is shown. The schedule starts at midnight. Select "Add time range" to add a row, then set the "To" time of each row to build the day; each new row begins where the previous one ended. Enter the price for each time range in the "Price" field.

A single daily schedule, with prices the same on every day of the week.	

If Yes is selected, two schedules are shown, Weekday buy prices (Mon–Fri) and Weekend buy prices (Sat–Sun). Build each schedule in the same way.

Separate weekday and weekend schedules, for prices that differ between Monday to Friday and the weekend.	

When the schedule is complete, select "Go to sell" to continue to the sell prices.

3.5.2. Dynamic prices

How dynamic prices reach Dynamic ESS depends on the country and the provider. Most European countries publish day-ahead prices through ENTSO-E, typically before 15:00 CET, and VRM picks those prices up, with NordPool as a monitored backup source. Some countries and providers publish prices separately, and VRM supports these through a direct connection to the provider's API.

Under "Select your country and provider", choose the country and then the provider. The fields shown next depend on the provider selected. In every case, set "My energy price changes every:" to match how often the supplier's price changes, 15 or 60 minutes.

Where a price formula is supplied for the selected provider, it may not be up to date. Check it against the terms of the energy contract and adjust it where the two differ.

Provider connected by API key

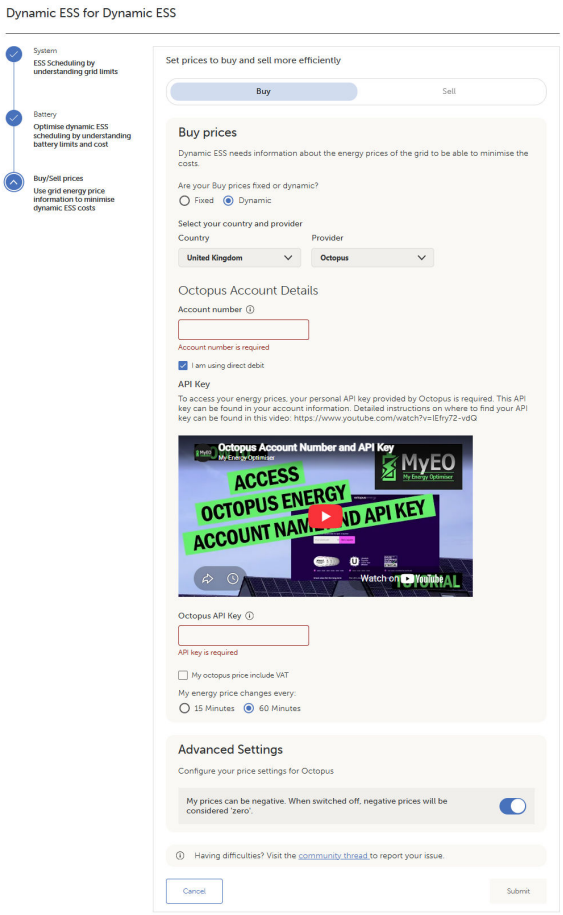
When the selected provider connects by API key (Octopus is shown here as an example), enter the account details and the API key.

Account number: Enter the account number held with the provider. Tick "I am using direct debit" if that applies.

API Key: Enter the personal API key issued by the provider. On-screen instructions show where to obtain it from the provider's account.

VAT: If VAT is already included in the price, enable the price-includes-VAT option. This usually applies to residential customers.

My prices can be negative: Under Advanced Settings, enable this option to take advantage of negative prices. When switched off, negative prices are treated as zero.

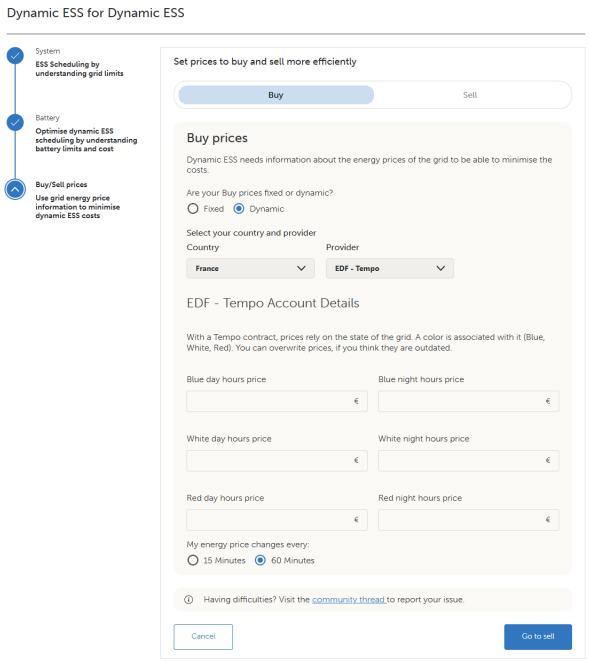


Provider with price categories

Some providers set prices using a fixed set of price categories. EDF Tempo is shown here as an example.

An EDF Tempo contract sets prices according to the state of the grid. Each day is assigned a colour, Blue, White or Red, and each colour has a separate price for its day hours and its night hours, giving six prices in total.

Account details: Enter the price for each category as supplied by the energy supplier: Blue day hours and Blue night hours, White day hours and White night hours, and Red day hours and Red night hours. Prices can be overwritten if they become outdated.



Provider not listed

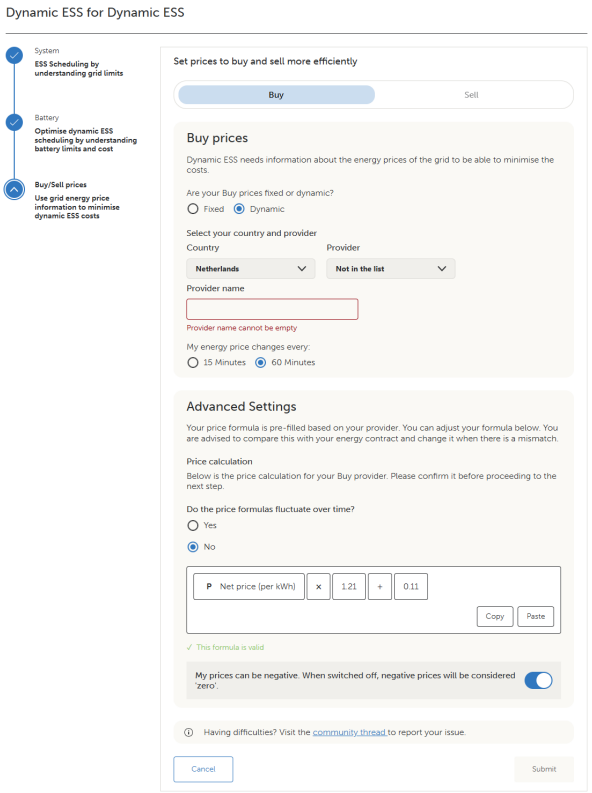
If the provider is not listed, select "Not in the list" and enter the pricing formula obtained from the supplier.

Provider name: Enter the name of the provider.

Price calculation: Enter the buy price formula. For example, where P is the price for 1 kWh, VAT is 21% and there is a flat fee of 11 cents per kWh, the formula is P × 1,21 + 0,11. A formula copied to the clipboard can be added using Paste. The formula is validated below the box.

Under "Do the price formulas fluctuate over time?", select No to use one formula throughout the day, or Yes to set a different formula for different time ranges. When Yes is selected, a further question, "Do the price formulas differ for weekdays and weekends?", appears; select Yes to define a separate weekend formula.

My prices can be negative: As above, negative prices are treated as zero when this option is switched off.

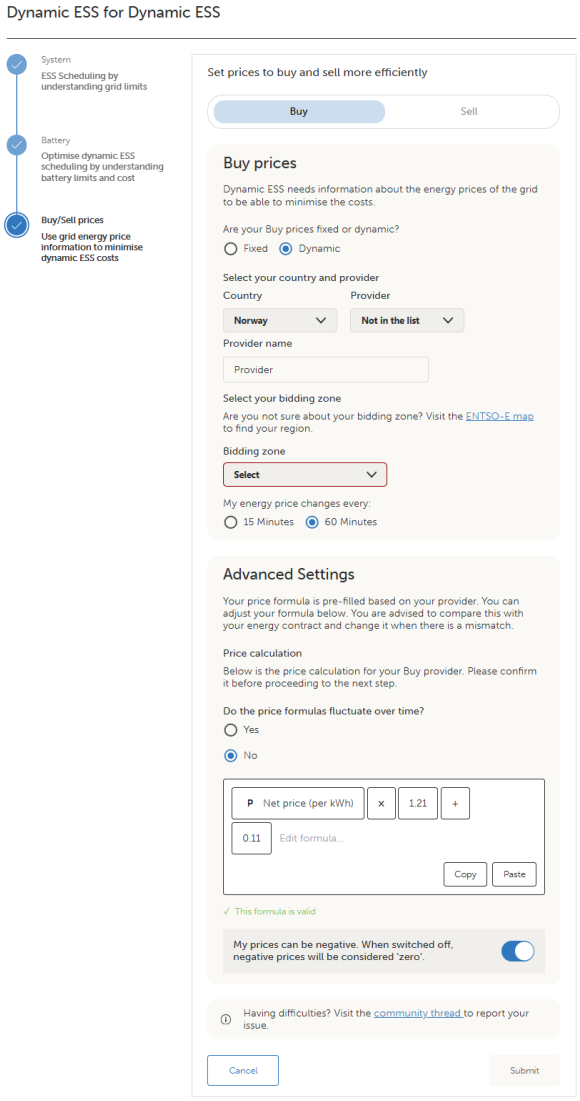


Bidding zone

Some countries are divided into several bidding zones, each with its own energy prices.

Bidding zone: Where the selected country has more than one bidding zone, a Bidding zone field appears. Select the zone in which the site is located, so that the prices used are those of that zone. Norway is shown here as an example.

If the zone is not known, the on-screen link to the ENTSO-E map shows which zone covers a given region.



Once the provider details are complete, continue to the sell prices.

Provider names shown in this section, such as Octopus and EDF, are used only as configuration examples. They do not imply any affiliation with or endorsement by Victron Energy, and remain the property of their respective owners. The list of providers available in Dynamic ESS may differ and change over time.

3.6. Sell prices

Sell prices are entered in the same way as buy prices. Select the Sell tab, then follow the same steps described in Buy prices: choose Fixed or Dynamic, and enter the schedule or provider details accordingly.

The options presented match the choice made for buy prices.

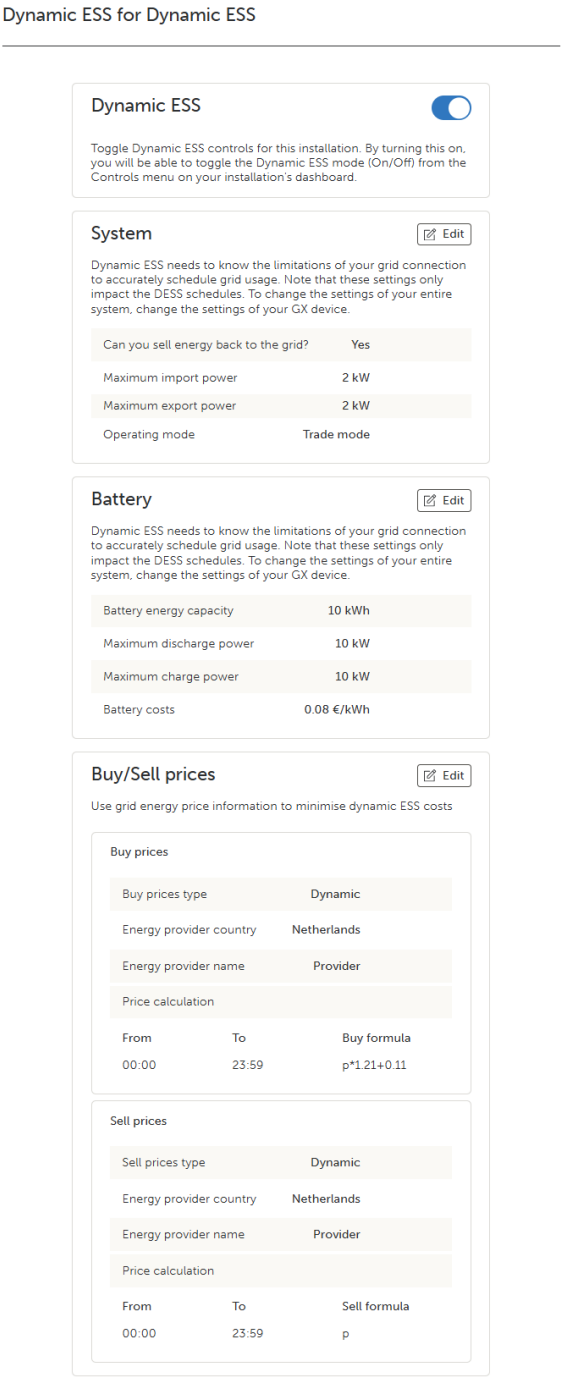
3.7. Confirmation

The confirmation page presents all the entered settings for review, grouped by System, Battery, and Buy/Sell prices.

At the top of the page, the Dynamic ESS toggle enables the controls for this installation. When turned on, the Dynamic ESS mode can be switched on or off from the Controls menu on the installation's dashboard.

Review each section against the intended configuration. To correct a section, select Edit beside its heading to return to that step.

After setup, this page remains available at **Settings → Dynamic ESS**, where the saved configuration can be reviewed and any section edited.

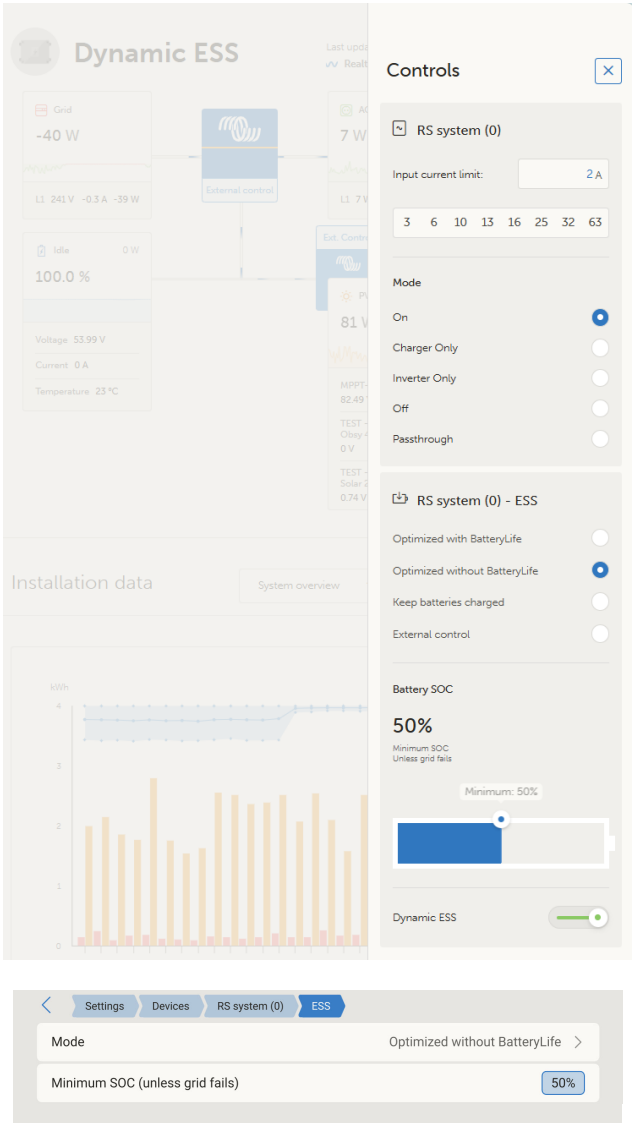


3.8. Minimum SOC and BatteryLife

The minimum SOC is the floor that Dynamic ESS plans against. Dynamic ESS is not designed to operate while the state of charge is below the minimum SOC, and if the battery does fall below it, the system hands control back to standard ESS operation.

The minimum SOC and the Mode setting can both be set from VRM or from the GX device.

- In VRM, from the Controls panel.
- On the GX device, in the ESS menu:
  - VE.Bus inverter/chargers: **Settings → System Setup → ESS**
  - VE.Can inverter/chargers: **Settings → Devices → RS system → ESS**



Lowering the minimum SOC has no adverse effect on Dynamic ESS. Raising it above the current state of charge may mean the battery has to be charged manually, because Dynamic ESS will not run below the minimum.

BatteryLife

BatteryLife works against Dynamic ESS and should be switched off.

BatteryLife raises the Active SOC limit by 5% each day for as long as the battery fails to reach 100% state of charge, which under Dynamic ESS it typically does not. Whenever the Active SOC limit sits above the minimum SOC, Dynamic ESS treats the Active SOC limit as the floor instead, so the usable window shrinks day after day. The battery discharges less and less, and stays progressively fuller. Dynamic ESS has no means of compensating for this.

To switch BatteryLife off, set Mode in the ESS menu to **Optimized without BatteryLife**.

Where the battery requires a periodic full charge, use the **Battery balancing** setting in the Battery step of the setup wizard.

3.9. Power limits

The maximum import power and maximum export power entered during setup, on the System step, are planning values. Dynamic ESS uses them as the assumed ceiling of the grid connection when it builds the schedule. They do not themselves enforce a limit.

Actual enforcement is handled by the ESS current limits, which cap import and export in real time regardless of the schedule. These are part of standard ESS and apply whether or not Dynamic ESS is running. Set them so that they are consistent with the values entered during Dynamic ESS setup.

Maximum system import current and maximum system export current: Set per phase. These cap the current drawn from and fed to the grid in real time.

Maximum feed-in: Caps the total power fed into the grid.

For how to set these limits and how they behave:

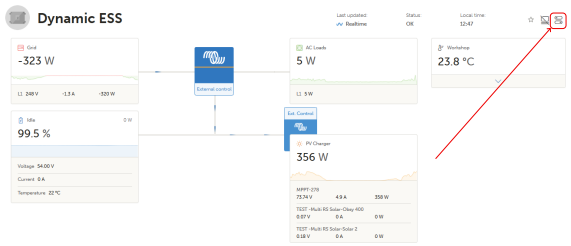
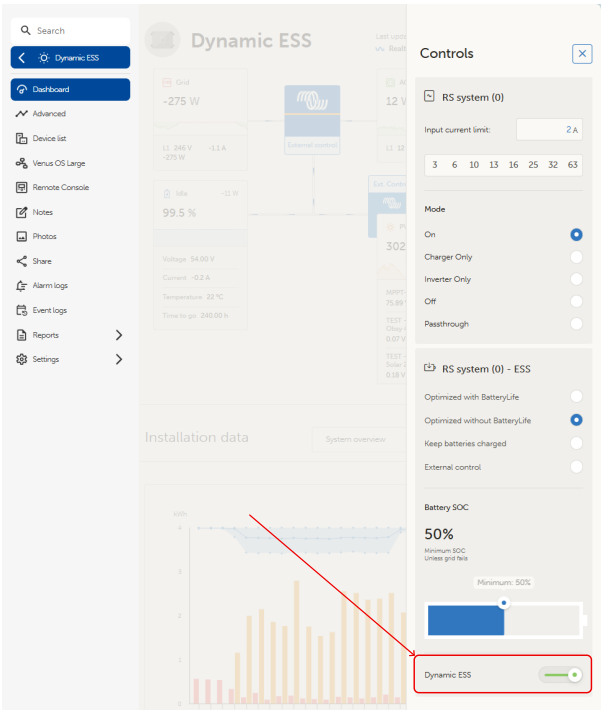
- **VE.Bus inverter/chargers:** see the ESS Design & Installation Manual.
- **VE.Can inverter/chargers:** these settings are made in VictronConnect. See the product manual for the model in use.

4. Monitoring and control

4.1. VRM dashboard

4.1.1. Controls

Once Dynamic ESS has been set up, and its controls have been enabled on the Confirmation page, a Dynamic ESS control appears in the Controls menu on the VRM dashboard, where it can be switched on and off.

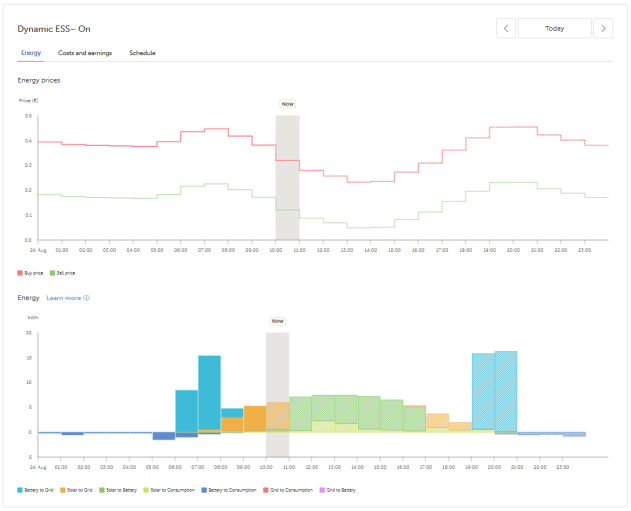
Select the Controls button at the top right of the VRM dashboard.	
In the Controls panel, switch Dynamic ESS on or off using the toggle at the bottom. Depending on the site and the browser window size, it may be necessary to scroll to the bottom of the panel to see it.	

4.1.2. Dashboard graphs

When Dynamic ESS is enabled, additional graphs appear on the VRM dashboard. The graphs page has three tabs, Energy, Costs and earnings, and Schedule, selected from the upper left. A date control at the upper right moves between days, and a shaded "Now" band marks the current time. Values to the right of the "Now" band are forecasts.

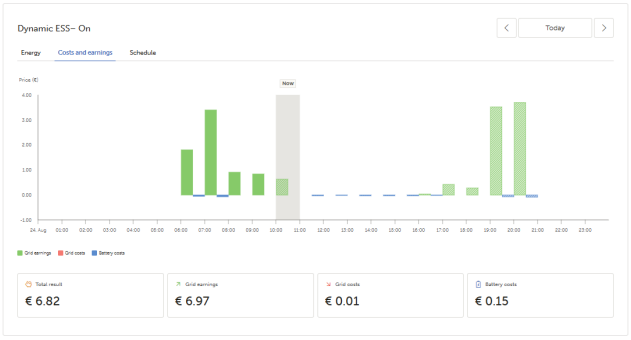
Energy

The Energy tab shows two graphs. The upper graph plots the buy and sell energy prices across the day. The lower graph shows the energy flows between solar, battery, grid and consumption, for example solar to consumption, grid to battery, or battery to grid, as identified in the legend.



Costs and earnings

The Costs and earnings tab shows the costs incurred and the earnings made over the day. Energy bought from the grid and battery wear are shown as costs; energy exported to the grid is shown as earnings. A summary beneath the graph gives the grid earnings, battery costs and grid costs, together with the net total result.



Schedule

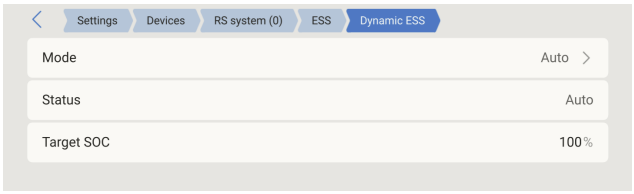
The Schedule tab repeats the energy price graph at the top so it can be compared with the planned usage below. In the usage graph, bars below the axis represent energy drawn from a source, and bars above the axis represent battery charging or export to the grid.



4.2. GX device menu

Dynamic ESS is set up in VRM. The GX device offers no setup options for Dynamic ESS, but it does provide a local read-out of what Dynamic ESS is doing, and allows Dynamic ESS to be switched on or off.

The location of the Dynamic ESS menu depends on the type of inverter/charger used.

Inverter/charger	GX device menu
VE.Bus inverter/chargers such as MultiPlus **Settings → System Setup → ESS → Dynamic ESS**	 
VE.Can inverter/chargers such as Multi RS **Settings → Devices → RS system → ESS → Dynamic ESS**	 

The menu contains the following items.

Item	Description
Mode	The Dynamic ESS operating mode. Set Mode to Off to stop Dynamic ESS. Auto means the schedule supplied by VRM is being followed. Local means the schedule is supplied locally, by Node-RED [17], rather than by VRM.
Status	Read-only. Shows what Dynamic ESS is doing at that moment. Status reads Inactive while Mode is set to Off.
Target SOC	Read-only. The state of charge that Dynamic ESS aims to reach by the end of the current schedule interval. The value is updated with each new schedule interval. Only shown while Dynamic ESS is active.

5. Node-RED

Dynamic ESS is designed to run without intervention: VRM builds the schedule, the GX device carries it out, and the only inputs are the values entered during setup. Node-RED makes it possible to go further, where an installation has conditions Dynamic ESS cannot know about on its own.

Node-RED is a flow-based programming tool included in Venus OS Large, a separate image type for the GX device. Not all GX devices can run it. For installation and requirements, see the Venus OS Large manual.

Node-RED runs on the GX device and can read and write the same values Dynamic ESS uses. It is widely used in Victron systems, and the Victron Community is a good place to find worked examples and ask questions. There are three broad ways it is applied.

Automating settings

Dynamic ESS settings can be changed automatically in response to local conditions. For example, a Node-RED flow can detect that the utility grid has failed and lower the minimum SOC so that more of the battery is available during the outage, then restore the original value once the grid returns. The schedule is still built by VRM; only the conditions it runs under change.

Supplying prices

Prices can be written to Dynamic ESS from a source other than those VRM supports. This also allows scheduling to be steered around known events: where the times of planned grid outages are published, the prices for those intervals can be set high, and Dynamic ESS then treats them as expensive and plans around them. Ready-to-use flows are available for some of these cases.

Supplying the schedule

Dynamic ESS can also run from a schedule prepared locally instead of by VRM. In this arrangement VRM no longer supplies schedules, and the targets must be written to the GX device by another process. A schedule can be retrieved from the Dynamic ESS API, adjusted, and then written back. While this is in use, Mode on the GX device reads Local.

Further information

- Node-RED discussions in the Dynamic ESS category on the Victron Community
- Venus OS Large manual
- Dynamic ESS node for Node-RED
- VRM API node for Node-RED
- Dynamic ESS API documentation

6. Troubleshooting

Alarm: "Dynamic ESS error code: No matching schedule available"

This alarm has two triggers: the system does not have a valid schedule for the current time frame, or the system clock is incorrect.

A missing schedule is usually caused by clock drift. The GX device normally synchronises its clock with an NTP server, but network settings can prevent this. Check that the time is correct, or set it manually. On a Raspberry Pi, which has no real-time clock, occasional errors of this kind are expected, and the system may need time to synchronise after starting.

The alarm can also occur when the system switches from Dynamic ESS to standard ESS because the battery state of charge has fallen below the configured minimum.

Alarm: "Dynamic ESS error code: ESS functionality not available"

This alarm indicates that Dynamic ESS was activated previously and is no longer in use. To disable it fully, set the /Settings/DynamicEss/Mode path in com.victronenergy.settings to 0. This can be done in several ways; the most straightforward is the output-control node in Node-RED.

Error: "Dynamic ESS error code: Battery capacity unset"

This error can occur when Dynamic ESS starts before the battery capacity has been communicated from VRM to the GX device. It clears once Dynamic ESS or the GX device is restarted.

The energy graph shows incorrect data

The Energy graph uses simplified assumptions about energy flow and can show inaccurate results. For precise figures, refer to the installation data graphs for grid, solar and consumption instead.

The Controls button is missing from the dashboard

Check that Realtime updates is switched on, under Settings, General, Realtime updates. When it is active, the dashboard shows "Last updated: Realtime".

6.1. FAQ

Q1. What happens if the VRM connection is lost or the system runs out of its schedule?

After 12 hours without a connection, the system reverts to standard ESS operation. When the connection is restored, new schedules are received and Dynamic ESS resumes. Because Dynamic ESS depends in part on third-party services such as day-ahead price data, a failure of those services can also halt scheduling until the data is available again.

Q2. Is there an API?

Yes. Dynamic ESS provides an API. Access requires an access token. See Node-RED [17] for how the API is used from a flow.

Q3. Are variable daily provider fees accounted for?

The price formula uses the energy price as its only variable input. Fixed multipliers and fees can be included in the formula, but fees that vary from day to day are not modelled separately.

Q4. Does Dynamic ESS work outside the EU, for example in the UK?

Yes, in many cases. Where a provider offers fixed tariffs that are steady but vary by time of day, a fixed contract can be used. Where a provider uses hourly-changing tariffs that are not covered by the ENTSO-E price source, these are not currently supported. Support can be added where a public price API is available, and can be requested on the Victron Community.

Q5. What if the contract does not permit discharging the battery into the grid?

Some contracts, for example in Germany, do not permit exporting previously imported energy back to the grid. Dynamic ESS provides a restriction option to prevent this, set during setup under the charge / discharge restrictions. See Battery [6].

Q6. Why does the charge or discharge rate change towards the end of an interval?

Dynamic ESS continually adjusts the rate to reach the target state of charge for the interval, adapting to variations in load. If the battery capacity is overestimated, the rate slows towards the end of the interval; if underestimated, it speeds up. Because manufacturers' stated capacities are not always exact, some calibration of the entered capacity may be needed.

Q7. Can scheduled charging be used together with Dynamic ESS?

No. Scheduled charging is not compatible with Dynamic ESS because it interferes with the scheduling calculation. Use standard ESS, or Node-RED [17] for tailored charging routines.

Q8. Can custom prices be uploaded manually?

Uploading custom prices through VRM is not currently supported.

Q9. Why does the plan seem to change in the first few minutes of an interval?

Scheduling for each interval begins at the start of the interval, so the plan for the current interval can take a few minutes to take effect. The effect on overall performance is negligible.

Q10. Are battery efficiency losses taken into account?

Yes. Dynamic ESS accounts for battery losses through the system efficiency setting (the SystemEfficiency path in com.victronenergy.settings).

Q11. What happens if the minimum SOC is changed?

See Minimum SOC and BatteryLife [12] for more information.