

Energy Storage for Low-Voltage Distribution Grids

The energy storage is designed for installation in a low-voltage distribution grid, particularly in a grid with a large number of distributed renewable energy sources. Its primary function is to improve voltage quality and stabilise the mains, reducing outages for prosumers and enabling more efficient utilisation of renewable energy sources.

The storage is a complete device with an energy storage unit consisting of a lithium iron phosphate (LFP) battery, an energy management system (EMS) along with grid protections (overcurrent, overvoltage, undervoltage, and frequency), a remote communication system, and a fire protection system. The design of the storage unit, along with the use of a two-stage, bidirectional AC/DC/DC power converter in a four-leg topology ensure galvanic isolation between the battery and the grid, as well as independent control of active and reactive power for each phase of the supply voltage.



Storage operation modes

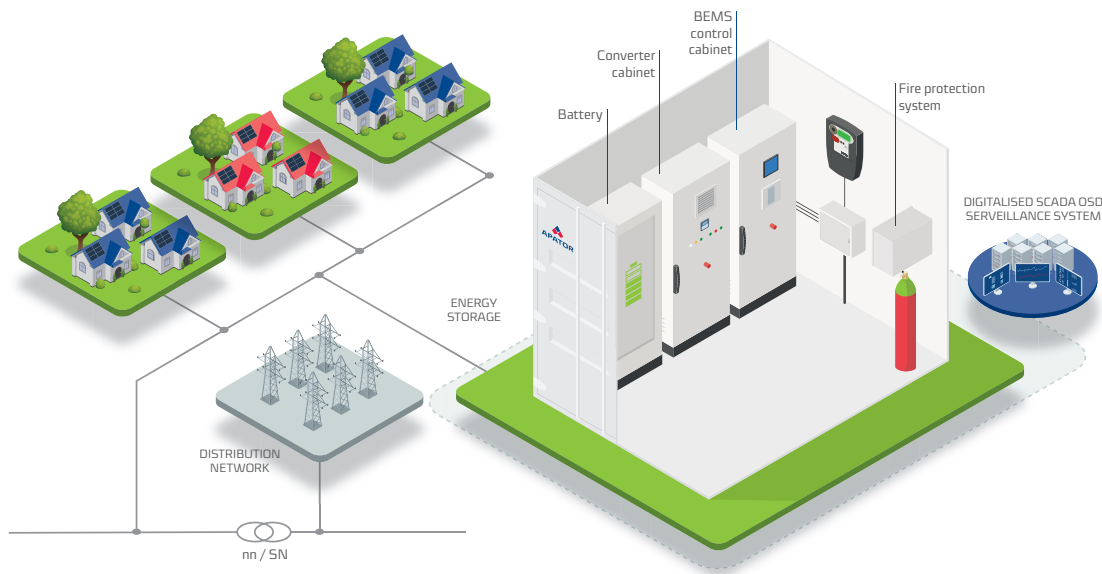
The energy storage, managed by a master EMS (Energy Management System) controller, can execute one of the following operating scenarios, depending on current conditions:

- Balancing of phase voltages at the point of connection to the electricity grid (PCP) by transferring active power between the different phases of the supply voltage.
- Stabilisation of voltages at the PCP by regulating the active power of battery charging/discharging, independently for each phase of the mains.
- Stabilisation of voltages by regulating reactive power with asymmetry limitation when the battery reaches an acceptable charge or discharge limit
- Maintaining the state of charge of the energy storage unit – when the mains phase voltages are normal, the state of charge of the energy storage unit is maintained within limits ensuring the possibility of stabilising the voltage with active power, potentially depending on the time of day (hour). When the phase voltages of the grid are normal – maintaining the state of charge of the energy storage unit within the limits ensuring the possibility of stabilising the voltage by active power, potentially depending on the time of day (hour).
- Compensation of higher harmonics of current and reactive power, taking into account an additional current measurement path.

Energy storage parameters

1	Capacity and power rating range	50 kWh to 250 kWh / 50 kVA to 250 kVA
2	Supply voltage	3 x 400 V
3	Design	free-standing, suitable for outdoor conditions, high aesthetics (container, industrial cabinets, pole-mounted)
4	Battery technology	LiFePO ₄ , NMC, LTO
5	Galvanic isolation between the network and the battery	HF DC transformer
6	Functionality	<ul style="list-style-type: none"> ▪ improvement of power quality in the distribution grid: <ul style="list-style-type: none"> ▪ voltage balancing ▪ voltage stabilisation - P and Q regulation independently for each phase ▪ maintenance of a state of charge that enables the preservation of regulatory properties ▪ battery conservation ▪ reactive power compensation ▪ higher harmonics compensation ▪ island operation (off-grid) – optional

Energy storage in a low-voltage distribution grid – schematic diagram



Optional:

Visualisation and monitoring of energy storage operation

The digital supervision system displays the basic operating parameters of the energy storage: the amount of energy generated by the energy sources, energy taken from the network, from RES and the energy storage. Information on the basic parameters of the network, storage battery and inverter, as well as its state of charge.

