

**Technical specifications
for
PURCHASE AND SUPPLY OF THE ENERGY STORAGE SYSTEM
100 kW / 200 kWh**

1. Purpose of Energy Storage System (hereinafter - ESS) installation:
 - 1.1. The first operating model: to connect ESS to the distribution network. The ESS will be loaded from the grid during the hours of the lowest electricity prices and unloaded to the grid during the hours of the highest prices during the same day.
 - 1.2. The second operating model to connect ESS to the internal network of a consumer with a high electricity demand. In this case the ESS will be loaded from the grid during the hours of the lowest electricity prices and unloaded to the internal consumer's network during the hours of the highest prices.
2. The Energy Storage System must be made in a hermetic container or other standalone cases suitable for installation in the outside environmental conditions, that meet all electrical and fire protection standards and regulations which are in force in the European Union (hereinafter - EU).
3. ESS must be a fully equipped, standalone "plug & play" device, which means that it does not require any additional devices or installations for proper operation.
4. The ESS must fully comply with the European Union "COMMISSION REGULATION (EU) 2016/631 of 14 April 2016 establishing a network code on requirements for grid connection of generators" (hereinafter- Directive). ESS must fully comply with the requirements for the Type B power-generating modules described in the Directive.
5. All elements of the ESS must have CE certification. CE marking indicates that a product has been assessed by the manufacturer and deemed to meet EU safety, health and environmental protection requirements. It is required for products manufactured anywhere in the world that are then marketed in the EU.
6. The ESS must fully comply with relevant EU safety standards.
7. For connecting the ESS to the company's installation or grid operator's connection point, the company will provide an electrical connection and a hardened ground on which the ESS containers will be placed.
8. **Technical parameters of ESS:**

1	Total Rated power	100 kW
2	Total Battery capacity	200 kWh or more
3	Battery management system	three-level BMS with active correction*
4	Input / Output Phases AC	3
5	Input / output voltage	3 x 400 $\pm$ 8% V AC
6	Input output voltage frequency	50 Hz
8	Power compensation	Inductive/capacitive reactive power compensation
9	ESS Efficiency	> 94%
10	Working temperature	-30 o C - +55 o C
11	Relative humidity	<95%, non-condensing
12	Availability annual	360 days
13	The factor of possible discharge power (DOD) from the installed capacity	97%
14	The minimum number of charge-discharge cycles	>6000
15	Battery capacity degradation factor during the lifespan of 6000 cycles	from 100% to not less than 80% from installed capacity
16	Thermal runaway prevention	Obligative
17	Overcharge protection	Obligative
18	Battery technology	Any battery technology, ensuring safe and stable completion of consume / supply requirements.

*A *three-level BMS with active correction refers to a type of BMS architecture. In this system, the BMS is divided into three levels or layers: the cell level, module level, and pack level. Each level has its own set of functions and responsibilities. The active correction feature means that the BMS can actively adjust and correct any imbalances or issues within the battery pack. This can include balancing the charge levels of individual cells, detecting and mitigating faults or abnormalities, and optimizing the overall performance and lifespan of the battery pack.

9. Case:

1	Type	hermetic containers, or another standalone cases suitable for installation in the outside environmental conditions
2	Material	powder coated steel with anti-corrosion protection
3	Cooling	Internal forced cooling and air conditioning system
4	Fire protection	Internal standalone fire protection system
5	Water protection	Rain and snow protection, hermetic roof suitable for installation in the outside environmental conditions
6	Thermal insulation	Must be installed if needed to ensure the operation of ESS in outside environmental conditions from -30 oC to +55 oC

10. Battery module shall include the following elements:

- 10.1. Battery modules
- 10.2. Modules security system
- 10.3. BMS controller

11. Energy management module shall consist of the following elements:

- 11.1. Bidirectional power inverter.
- 11.2. Controller cooperating with the BMS system of battery cabinets.
- 11.3. Inverter protection Securing the feed line from the company's installation.
- 11.4. Universal communication module UMK (RS 485, RS 232, Ethernet interfaces; ModBus RTU, ModBus TCP / IP protocols)
- 11.5. Supercapacitors in an intermediate circuit
- 11.6. Digital input for remote control of the inverter
- 11.7. General alarm displayed on a potential - free NO/NC contact.
- 11.8. Main switch with door interlock
- 11.9. The energy management module has the ability to scale the power and connect inverters in parallel depending on the needs of the installation.

12. Monitoring software shall have

- 12.1. the software that monitors energy flows throughout the system
- 12.2. The application shall provide the user with quick, clear and direct access to the following information:
 - 12.2.1. Graphical presentation of the directions of energy flow in the form of the so-called "Flow rose" facilitating the quick identification of processes taking place in the system,
 - 12.2.2. the amount of energy taken from the grid, from renewable energy sources and from the energy storage on a daily, weekly, monthly, annual basis,
 - 12.2.3. state of charge of the energy storage,
 - 12.2.4. basic parameters of the energy storage battery and its remaining service life,
 - 12.2.5. basic operating parameters of the energy storage inverter and renewable energy inverters,

- 12.2.6. electrical parameters of the grid (voltage, frequency, current, active power, apparent power, reactive power, $\cos\phi$, THDu , THDi),
- 12.2.7. system efficiency during the day (by showing the following parameters: total energy demand, share of energy from storage and amount of energy taken from the grid),
- 12.2.8. the level of CO2 reduction achieved through the operation of the entire system,
- 12.2.9. list of alarms from the entire system,
- 12.2.10. defined reports in the form of charts and numerical data,
- 12.2.11. the monitoring software shall be accessed via a web browser from anywhere in the world, on any device with Internet access; (No need for any additional software or specialized hardware to use it),
- 12.2.12. Only authorized people with an account registered in the application shall have access to the application, so the data is not readable by unauthorized third parties.

13. Requirements from the Grid Operator:

- 13.1. Remote control of the ESS from the DMS system of the Grid Operator's dispatch center must be installed:
 - 13.1.1. Must ensure remote Starting/stopping the electric generation via the ESS controller.
 - 13.1.2. Must ensure remote Switching on/off of the electrical switchgear. After disconnecting the switchgear, the power supply for the ESS's own needs must remain.
 - 13.1.3. Electrical reactive power control $\cos\phi$ function with control from Grid Operator's DMS. The adjustment range of 0.95...+0.95 must be ensured at the connection point, and the equipment capacity of 0.9...+0.9 must be substantiated by the equipment certificates that are provided during the tests. The $\cos\phi$ algorithm is implemented in the Manufacturer's power plant controller (PLC, Programmable Logic Controller).
 - 13.1.4. When installing the type B production facilities, it must be ensured that the voltage level does not exceed + 1.08 relative units and will not be lower -1.08 relative units from the nominal voltage value.
 - 13.1.5. The ESS must have protection against the loss of the network (including the transmission network), prohibiting the operation of the ESS in isolated mode from the transmission network, as well as the automatic connection of the ESS only after restoring the standard network parameters.
 - 13.1.6. Control from the Grid Operator's DMS system must be carried out according to the IEC 60870-5-104 protocol.
 - 13.1.7. A tele information collection and transmission device (TSPI) must be installed with communication equipment for the exchange of tele information signals between the ESS and the Grid Operator's DMS system of the Grid Operator's dispatch center. The list of electrical tele information signals must be coordinated with the Grid Operator during the preparation of the technical project. The manufacturer must ensure the possibility of uninterrupted operation of the connection

between the controller and the Grid Operator's dispatch center DMS during the entire period of operation of the power plant.

- 13.1.8. Minimum set of signals:
 - 13.1.8.1. Actual power in kW
 - 13.1.8.2. Accumulated energy in kWh
 - 13.1.8.3. Voltage in V.
 - 13.1.8.4. Current in A.
 - 13.1.8.5. Frequency in Hz.
 - 13.1.8.6. To be registered:
 - 13.1.8.7. Undervoltage $U <$, time (t), in seconds (Number, up to 3-4 characters);
 - 13.1.8.8. Overvoltage $U >$, time (t), in seconds;
 - 13.1.8.9. Frequency too low 1 $f <$, frequency (f) Hz in seconds (Number, up to 3-4 characters);.
 - 13.1.8.10. Too low frequency 2 $f <$, frequency (f)Hz (Number, up to 3-4 characters).
- 13.1.9. The ESS can only operate in grid-friendly mode.
 - 13.1.9.1. The ESS must be equipped with equipment that automatically limits the power generated by the ESS to the network and consumed from the network, according to the defined by Grid Operator instantaneous load of the Grid Operator's power transformer and the maximum allowed full power of the Grid Operator's power transformer. In the maximum generation mode, the reverse generation of the power transformer cannot exceed limits, defined by Grid Operator. During the ESS consumption mode, the consumption load of the Grid Operator power transformer cannot exceed limits defined by Grid Operator. (Power measurements shall be taken from the 10 kV terminals of the Grid Operator power transformer and provided to ESS by Customer.)
 - 13.1.9.2. The ESS must be equipped with equipment that automatically limits the power generated by the ESS to the network and consumed from the network, to the extent that it does not exceed the amount of permitted generation or consumed power granted to the Customer by Grid Operator.
- 13.1.10. In the event of a short circuit in the power grid, the ESS protective disconnection devices must operate and disconnect the power plant from the power grid with a delay of 250 ms.
- 13.1.11. Frequency range requirements at which ESS can work:
 - 13.1.11.1. Must be able to freely set the two-stage underfrequency protections.
 - 13.1.11.2. Must have protection from the rate of change of frequency.
 - 13.1.11.3. ($\Delta \text{Hz} / \Delta t$).
 - 13.1.11.4. Must have the possibility of the automatic connection to the grid after the frequency returns to the normal limits (to be set) number (up to 3-4 characters).

14. Documentation

- 14.1. English language paper and electronic version
 - 14.1.1. Technical and operational documentation
 - 14.1.2. Maintenance instructions and documentation
 - 14.1.3. Installation instructions
 - 14.1.4. Operation instructions
 - 14.1.5. List of software and remote connection passwords and all passwords (except manufacturer password). Passwords that can have an impact on warranty, shall be provided in sealed and signed by manufacturer representative envelopes.
 - 14.1.6. Quality Certificate
 - 14.1.7. Declaration of Conformity
 - 14.1.8. Certificates or declarations of conformity to CE marking for all components and materials used in ESS;
 - 14.1.9. Certificate of Conformity to the European Union "COMMISSION REGULATION (EU) 2016/631 of 14 April 2016 establishing a network code on requirements for grid connection of generators."
 - 14.1.10. Warranty Card
- 14.2. Documentation shall be handed before ESS departure from the manufacturer facility. Handover or acceptance certificate for ESS by the Company cannot be signed before documentation handover to the Company.