APATOR


# Efficient use of electricity

## Energy storage systems

electricity

# Solutions for Your Business

Looking to manage your energy production and consumption? Seeking to reduce costs? Discover our tailored solutions for your business.

## Key challenges faced by our clients

**High energy costs**

**Reducing emissions**

**Selling surplus energy to the grid at undervalued prices**

**Inability to utilise the full production capacity of renewable energy source (RES) generation systems**

**Stable energy supplies, no threat of a blackout (reduction or lack of electricity supply)**

Diverse generation sources, the installation of a new source system, grid stabilisation, or the need for energy storage – we understand your needs.

**We will tailor a comprehensive Apator offer to your needs.**

# Scope of the offer

Design and turnkey construction of new RES-based generation sources: photovoltaics, wind turbines, cogeneration.

Design and turnkey construction of energy storage systems in various product ranges.

Integration of existing and new generation sources, consumers, storage systems, etc. into a single system, including integration with DSOs and closed DSOs.

Advanced technological solutions related to the automation of RES operation (switching equipment, protections, controllers, power demand controller, bidirectional smart meters).

Support in obtaining grants or financing for energy storage. Option to lease storage systems under long-term contracts.

Storage management from design to disposal. System maintenance.

24/7 service link and monitoring of critical parameters.

Implementation:

- Design and mapping of utility generation and distribution systems.
- Systems for monitoring, grid operation supervision, ongoing grid operation management, maintenance, and operation.
- Implementation of an energy resource management system within the area of operation of a closed DSO (production and distribution of electricity and heat across all technologies).
- Automation of grid operations and billing for community users across all utilities.
- Reporting for the entire system as well as individual utilities, sources, and consumers.
- Making management decisions based on monitoring data and decision-making algorithms programmed into the systems.

# Applications of energy storage

**Energy storage systems are utilised by a wide range of business consumers, from small companies to large enterprises and industrial plants.**

**Example applications:**

Industrial plant

Local government units and public utility buildings

Commercial clients (retail and logistics facilities, offices, rental spaces)

Production and distribution of electricity and heat

RES generation systems in various facilities

Energy clusters and cooperatives

Storage systems are used to optimise energy supply in industrial plants in the following **sectors: fuel and energy, metallurgy, electrical and mechanical engineering, chemical, wood and paper, light industry**, and others.

A separate branch of the economy that can benefit from the opportunities provided by energy storage is **agriculture and agri-food processing**, which often have high electricity demand and simultaneously require security of power supply. Examples of agricultural consumers requiring the above criteria include: **large poultry and dairy cattle farms, cowsheds, pigsties, and large-scale greenhouse cultivation**.

## Local government units

can significantly reduce incurred energy costs through the use of energy storage systems and, with the support of installed renewable energy sources, become increasingly energy independent.

**An energy storage system allows for the accumulation of surplus energy and its utilisation during periods of demand within municipal, city, or metropolitan infrastructure.**

## Water and sewerage plants

for which energy costs represent a large portion of the value of water supply and wastewater treatment services, are seeking ways to reduce energy costs and are investing in RES.

Operational efficiency can be increased through the application of energy storage systems, where unused surpluses can be stored and utilised at a later time. Thanks to such infrastructure, **public utility plants can become self-sufficient and, with well-planned investments, electricity surpluses can be sold to the grid**.

## Hospitals

are public utility facilities burdened with high electricity costs that also require power supply security. To reduce costs associated with energy supplies and increase supply reliability, roof space is utilised, where photovoltaic panels are often installed. Combining them with an energy storage system can provide **tangible economic benefits for the operation of such facilities and increase their energy security**.

Local government units often participate in energy communities, such as energy clusters and energy cooperatives.

# Financial **benefits** of using storage systems

- Reduction of electricity costs through the use of RES and drawing power from the grid when more favourable tariffs are in effect (dynamic tariffs); price arbitrage: charging at low prices, discharging at high prices.
- Reduction in contracted capacity requirements.
- Savings from the minimisation of reactive power.
- Utilising the full production capacities of RES systems.
- Minimisation of the capacity fee.
- Revenue from providing services on the capacity market and balancing market: from providing services in the Demand Side Response programme (demand flexibility); revenue from participation in the balancing market.

# What else will your **business** gain?

- **Energy security and independence**: emergency power function, stabilisation of energy supplies, island mode capability, independent of the grid, reduction of production downtime.
- **Improved power quality,** enhancement of parameters, voltage stabilisation: protection of the company's technical infrastructure.
- **Lower emissions**, the possibility of phasing out combustion generators.
- **The image of an innovative company** committed to optimal energy utilisation.

# Practical examples of energy storage applications

## Industrial plant in the food industry

**Client challenge**
Recurring power outages caused malfunctions in the automation of the high-bay warehouse and resulted in downtime, creating bottlenecks in the transport of products from the production lines.

**Solution**
An energy storage system with a power of 250 kW and a capacity of 500 kWh was installed.

**Benefits**
The use of the energy storage system ensured the uninterrupted completion of the production cycle without the production plant incurring additional financial losses.

## RES electricity producer (photovoltaic power station)

**Client challenge**
Full utilisation of the production capacity of the photovoltaic power station.

**Solution**
Construction of an energy storage system with a power of no less than 1.3 times the maximum generation power of the PV power station.

**Benefits**
Thanks to the energy storage system, it is possible to decide when energy is sold back to the grid and when it is stored. Simultaneously, in the event of a request to reduce production, the producer can continue to produce and store energy. As a result, the profitability of using the photovoltaic system increased and the return on investment improved.

## Forest nursery, Dobrzejewice Forest District

**Client challenge**

Utilising the production capacity of the photovoltaic system at the forest nursery in the Dobrzejewice Forest District. The nursery produces up to 7 million seedlings, requiring a stable electricity supply.

**Solution**

As part of the Forest of Energy project, an energy storage system with 50 kW of power and a capacity of 160 kWh was installed.

**Benefits**

The delivered energy storage system stored solar-generated energy and ensured a stable power supply for the forest nursery. Energy costs decreased significantly from approximately 15,000 PLN to less than 3,000 PLN per month, while utilising the production capacities of the photovoltaic system.

# Energy storage guide

**An energy storage system performs various tasks for consumers:**

- **Accumulates energy surpluses from electricity production.**
- **Stores energy drawn from the grid during low-price periods or from RES production.**
- **Releases energy when needed based on established algorithms.**

All these tasks can be performed using the automation systems described later in the brochure.

**Choose the best storage model tailored to your needs.**

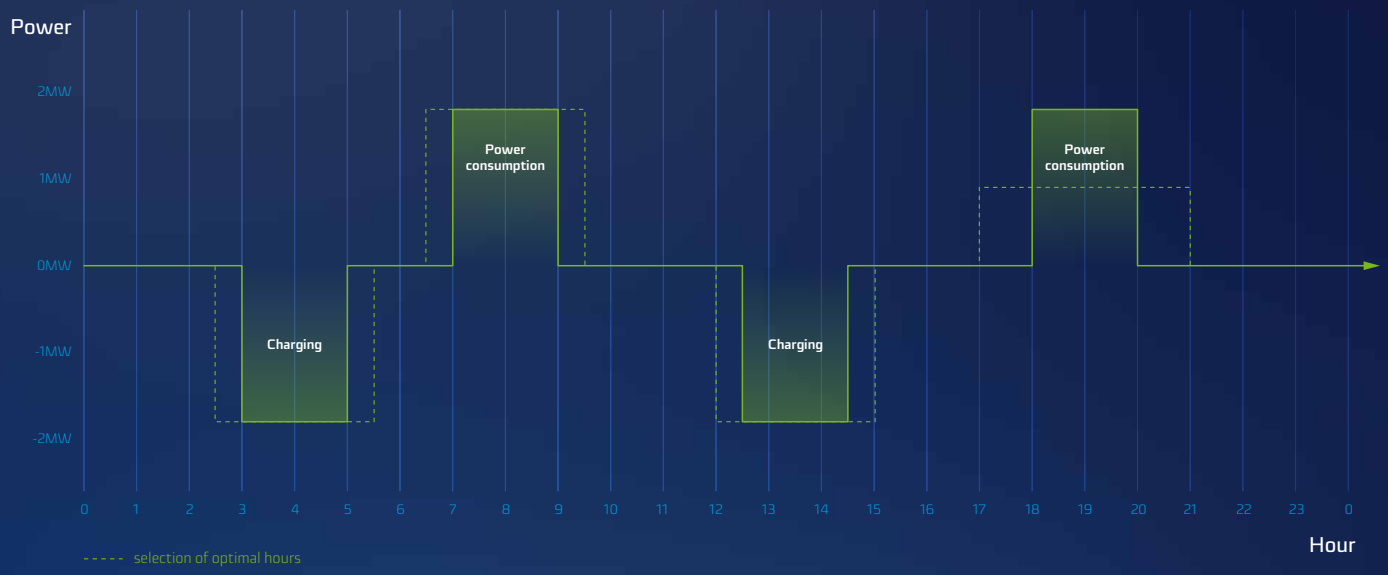
Energy storage systems are built in various configurations for clients with diverse needs:

- Stand-alone energy storage system.
- Energy storage system operating with a commercial photovoltaic or wind RES system (electricity production and resale – producer).
- Energy storage system optimising the use of RES production capacity within own energy resources (industry, energy communities).

# Stand-alone storage system

**Revenue sources:**

- ✓ Morning profit from the energy storage system: from arbitrage
- ✓ Periodic additional income from the energy storage system: from participation in the balancing market, from participation in the capacity market
- ✓ Evening profit from the energy storage system: from arbitrage




**Explanations for the chart:**

**CHARGING**: charging the storage system when the energy price is lowest.
**DISCHARGE**: drawing power from the storage system when the energy price is highest.

A stand-alone storage system utilises price arbitrage based on the price difference between peak energy demand and times of day with high supply (early afternoon period: PV generation peaks) or low demand (night period after midnight).

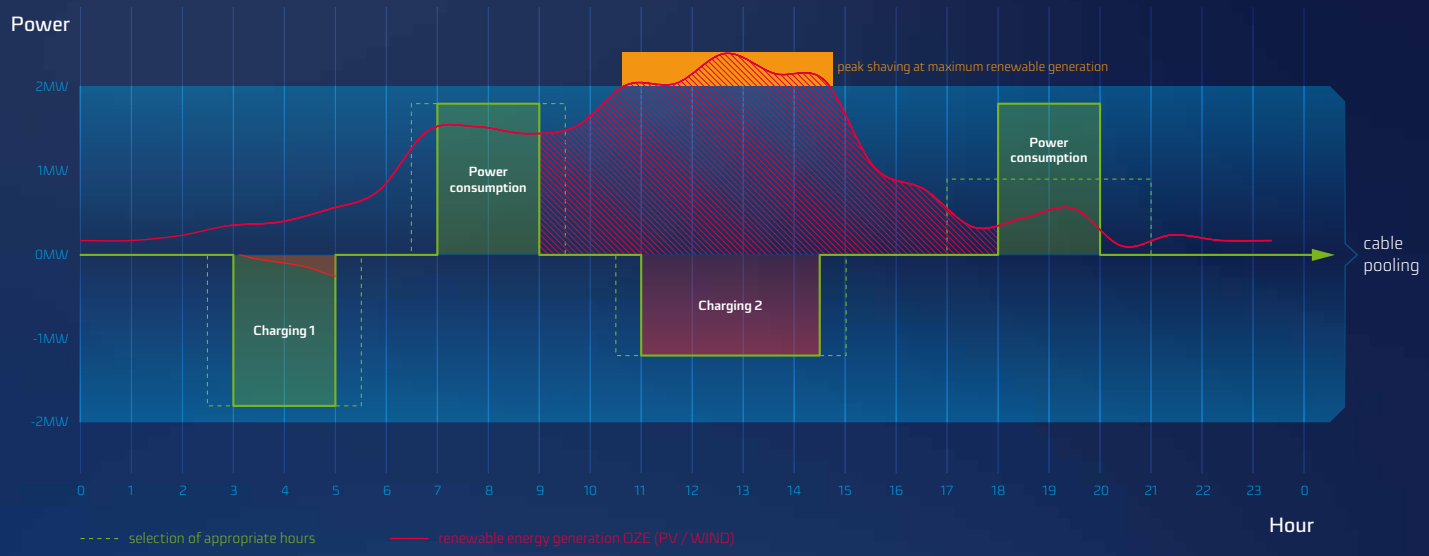
The regulatory capabilities of the inverter controlled by an EMS management system (e.g. the EKTIN system) allow for an adaptive mode of storage operation, where charging and discharging periods are determined according to current hours of price minima and maxima, which vary across different seasons.

**In addition to arbitrage, such an energy storage system can be used in capacity market programmes as well as on the balancing market, where settlement rules introduced since July 2024 create new and valuable income prospects.**

# Energy storage system operating with a photovoltaic or wind RES generation system (energy producer)

**Revenue sources:**

- ✓ Morning profit from the energy storage system: from arbitrage, from time-shifting (moving energy in time), from load peak-shaving
- ✓ Periodic additional income from the energy storage system: from the minimisation of the capacity fee, from participation in the balancing market, from participation in the capacity market
- ✓ Evening profit from the energy storage system: from arbitrage, from time-shifting (moving energy in time), from load peak-shaving




**Explanations for the chart:**

**CHARGING 1**: charging the storage system when the energy price is lowest.
**DISCHARGE**: drawing power from the storage system when the energy price is highest.
**CHARGING 2** - charging the storage system from RES generation when contracted power is exceeded and when the energy price is highest.

An energy storage system operating within the same grid as an RES generation system significantly **improves the financial results of the photovoltaic power station or wind system itself**.

**Shifting energy sales (time-shifting)** from hours with lower prices to price peak hours is the primary application of the storage system in this configuration. **Energy produced from RES and sold at the price peak delivers particularly significant benefits**.

At the same time, the storage capacity can be used for the peak-shaving function during RES generation peaks to efficiently utilise its volume. Full utilisation of the cable infrastructure (cable pooling) is possible thanks to the combination of RES generation and energy storage.

Flattening the amplitude characteristic of this system through the use of energy storage results in a reduction of the capacity fee to as low as 17% of the nominal value, while maintaining the variability of this characteristic below 5%.

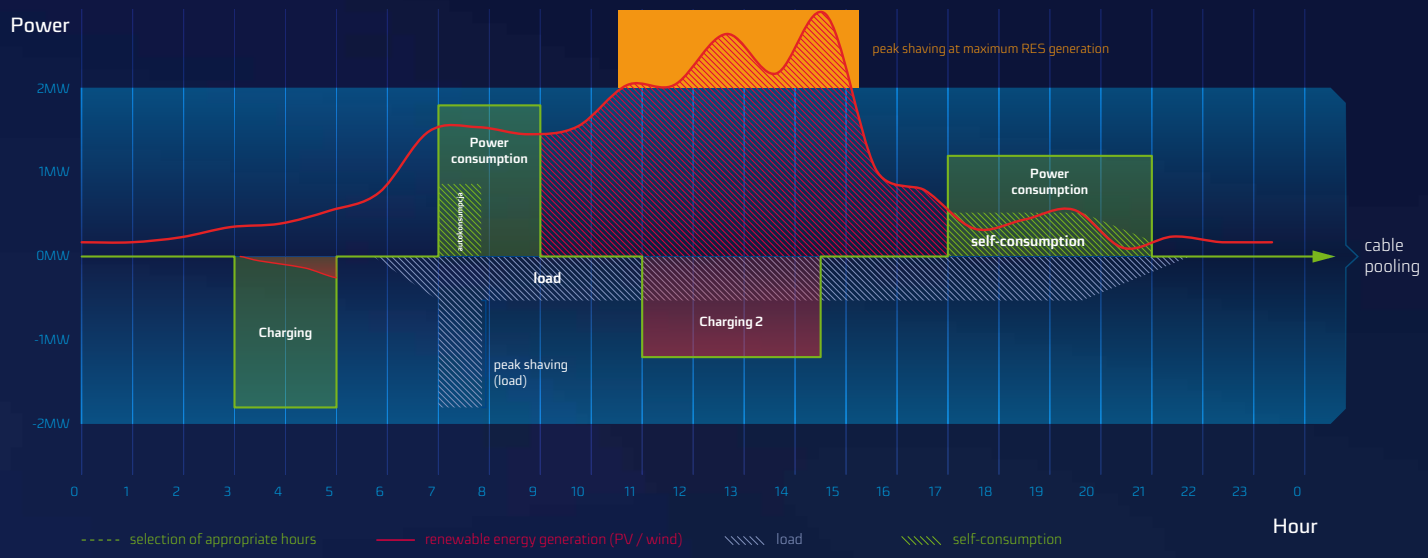
The use of generation prediction by an EMS-type storage control system (e.g. the EKTIN system) allows for the **optimisation of storage battery charging as a function of the expected generation value of the discharge period, which helps avoid financial losses**.

Maintaining an effective, constant resulting power level of the source, consisting of the RES generation and energy storage system, is an excellent solution for application in the capacity and balancing markets.

# Energy storage system operating with RES generation for self-consumption

**Revenue sources:**

- ✓ Morning profit from the energy storage system: from arbitrage, from time-shifting (moving energy in time), from load peak-shaving
- ✓ Periodic additional income from the energy storage system: from the reduction of connection capacity, from the minimisation of the capacity fee, from participation in the balancing market, from participation in the capacity market
- ✓ Evening profit from the energy storage system: from arbitrage, from time-shifting (moving energy in time), from load peak-shaving




**Explanations for the chart:**

**CHARGING 1**: charging the storage system when the energy price is lowest.
**DISCHARGE**: drawing power from the storage system when the energy price is highest.
**CHARGING 2** - charging the storage system from RES generation when contracted power is exceeded and when the energy price is highest.
**peak-shaving (load)** - peak-shaving of load peaks (self-consumption from storage as a supplement to generation); reduction of connection capacity to the level of maximum storage charging power

Installing an energy storage system and an RES generation system in a single system for self-consumption brings many benefits. It is possible to **utilise own production in full**, achieving the **maximum possible profits from the operation of such a system**.

Profits also include the effective sale of energy surpluses during peaks (time-shifting). Other benefits may be related to the **reduction of contracted capacity**. In the event of exceptionally high peak consumption, the use of storage allows for the reduction of contracted capacity and lower fixed costs.

On the other hand, in case of high demand at price peaks, energy from storage allows for the **reduction of peak demand from the grid (peak shaving)**.

The described applications do not exclude **the use of storage in capacity and balancing market services**, as the fixed revenue values from these services often exceed the costs of energy purchased on the market during the provision of the service by the energy storage system.

To effectively control the operation of the system, it is necessary to **use special software supporting the operation of the storage system – Energy Management System (EMS)**. Thanks to algorithms created individually for the client, it is possible to fully utilise production as well as consumption, fully controlled by the EMS system.

# Construction of an energy storage system


## Battery

The primary component of an energy storage system is the energy storage unit – in the case of battery storage systems, it is stored in **electrochemical batteries**.

Electrochemical batteries are characterised by basic parameters:

- rated voltage,
- capacity and power,
- current-carrying capacity,
- service life expressed in charging cycles.

Among the available battery technologies, **lithium-ion batteries** are distinguished by features most useful in stationary energy storage systems, i.e. **the possibility of long-term cyclic operation, the ability to accumulate large amounts of energy, and the absence of the memory effect**.

Ion batteries are divided into several basic groups depending on the materials used, among which lithium iron phosphate batteries (LiFePO4, LFP) are most commonly used in stationary energy storage systems due to their relatively low price and high level of operational safety.

**Long service life, a high level of operational safety, high energy density, and low price are the characteristics that distinguish LFP batteries from other battery technologies**, which is why they are most frequently used in the energy storage solutions offered by Apator SA.

The main parameters describing a battery are: capacity as well as **charging and discharging current**.
Capacity expressed in Ah or kWh describes the battery's ability to store energy, while the charging and discharging current together with the rated cell voltage allows for the estimation of the power at which the battery can operate.

Therefore, from the user's point of view, the most important battery parameters are:

- rated capacity,
- usable capacity,
- charging and discharging current,
- number of cycles,
- battery technology.

Battery operational safety is ensured by the **BMS** (Battery Management System), responsible for monitoring the operating status and balancing cells within battery packs.

Depending on the battery's condition and operating conditions, the BMS **primarily limits the maximum permissible battery charging/discharging current** (protecting it from overheating) and collects historical data regarding battery operation and undesirable states.

# Converter

The main execution device in the energy storage system is a specialised **4-leg power electronic AC/DC converter, serving as the interface between the power grid and the battery**. The converter enables bidirectional energy flow between the grid (alternating voltage and current, AC) and the battery (direct voltage and current, DC). The converter's design and the applied control algorithm determine:

- power quality on the grid side (accuracy of parameter regulation on the grid side),
- battery charging/discharging current,
- the functionalities provided by the storage system.

**The converter's power rating determines the power at which the storage system can supply energy to the grid or draw it**. The converter also enables additional functionalities related to improving power quality at the grid connection point, such as: reactive power compensation, **higher harmonic compensation, or voltage stabilisation and balancing**.

An energy storage system is a complex device; therefore, converter control and the management of stored energy is a process carried out within a multi-level control structure.

The converter control algorithm is responsible for control in the following areas:

- shaping currents and voltages on the grid side,
- voltage matching between the grid and the battery,
- controlling the battery charging/discharging current.

**Supervisory storage functions are performed by automation systems and the energy management system (EMS).**

## AUTOMATION AND CONTROL

A properly designed and implemented **EMS** ensures the efficient and full utilisation of the energy storage system's capacity and power in daily cycles, which in turn leads to **an extended service life of the storage system and a shorter return on investment**.

The EMS ensures the efficient and most cost-effective management of energy stored in and discharged from the storage system for the user.

Control of the storage system's operation can be based on the current and future energy balance or schedules correlated with changes in electricity prices and changes in demand for its use in specific types of systems.

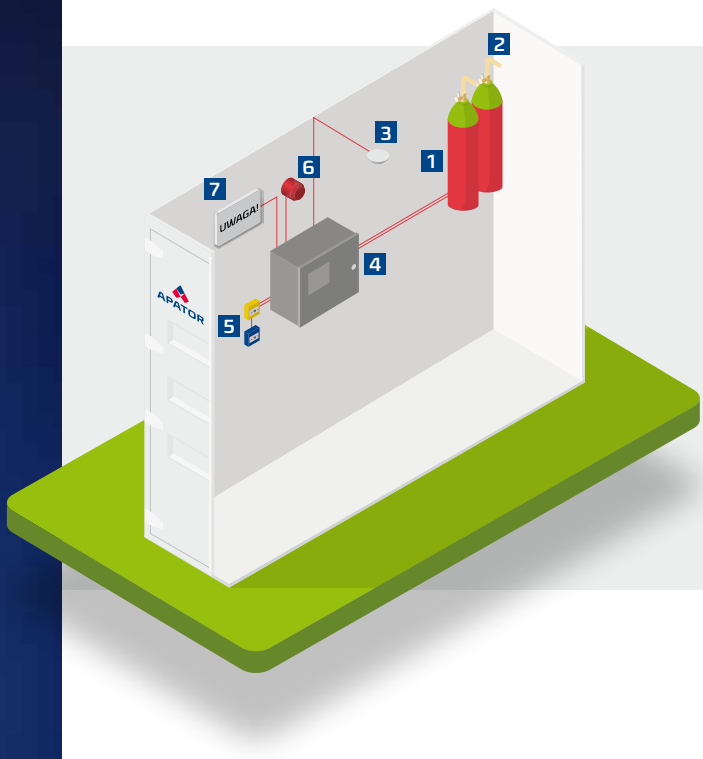

The main execution device in the energy storage system is a specialised 4-leg power electronic AC/DC converter, serving as the interface between the power grid and the battery. **The converter enables bidirectional energy flow between the grid (alternating voltage and current, AC) and the battery (direct voltage and current, DC)**.

The converter's design and the applied control algorithm determine the grid-side power quality (the accuracy of grid-side parameter regulation), the battery charging/discharging current, and the functionalities provided by the storage system.

The converter's power rating determines the power at which the storage system can supply energy to the grid or draw it. The converter also enables additional functionalities related to improving power quality at the grid connection point, such as: reactive power compensation, higher harmonic compensation, or voltage stabilisation and balancing.

# Fire Protection System

In containerised energy storage systems based on LFP batteries, a key role is played by the Fixed Extinguishing System, whose task is to quickly suppress the fire and maintain safe operating conditions. As an energy storage provider, we install extinguishing systems in our solutions that are adapted to high energy density environments. In the case of LFP batteries, rapid detection of temperature increases and a fast response are particularly important before a fire outbreak occurs. The offered Fixed Extinguishing System systems are integrated with advanced temperature, smoke, and gas sensors to reliably identify fire hazards in the early stages of fire development.




**Legend**

| | | | | | |
|---|---|---|---|---|---|
| 1 | Extinguishing agent tank | 2 | Extinguishing nozzles | 3 | Smoke detector |
| 4 | Automatic fire extinguishing control panel | 5 | START EXTINGUISHING and STOP EXTINGUISHING buttons | | |
| 6 | Acoustic sounder | 7 | Visual alarm indicator | | |

The first technology offered is **gas extinguishing**, using inert gases such as argon or gas mixtures. Gas solutions ensure a rapid reduction in oxygen concentration, limiting the possibility of sustaining a fire in its initial phase. Gas extinguishing systems are ideal for airtight container enclosures. The advantage of using inert gases is the lack of impact on electrical equipment, allowing for a quick return of the system to operation after the Fixed Extinguishing System has been activated.

The second technology offered is **condensed aerosol extinguishing**, which is distinguished by its ability to rapidly distribute the agent throughout the entire volume of the container. The aerosol works by inhibiting free radical reactions, which significantly reduces the fire energy. Aerosol systems do not lower oxygen levels and do not require pressure relief vents. This technology is characterised by its ability to penetrate crevices and tightly packed electronics, where traditional inert gases may have limited effectiveness.

Both technologies can be combined with a ventilation system, allowing people to be present inside the battery container. The Fixed Extinguishing System equipment we use complies with current standards and industry guidelines, ensuring the highest level of energy storage operational safety.

Regardless of the extinguishing technology, the system is equipped with:

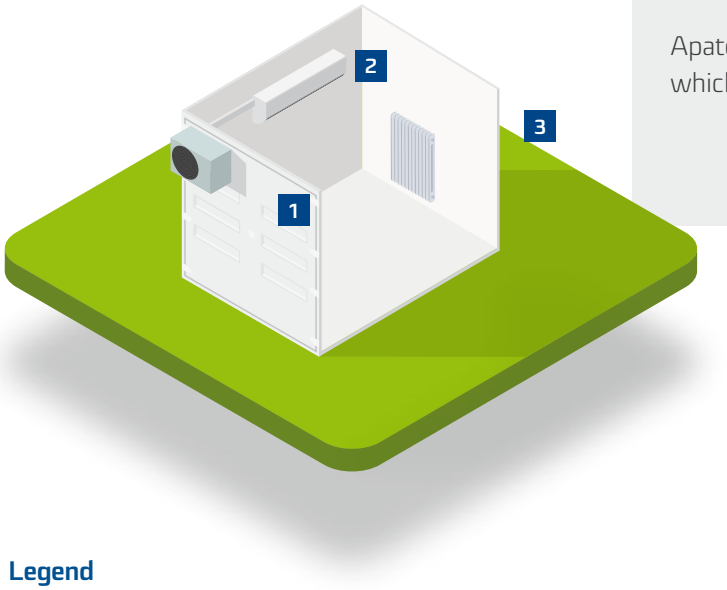
- control panel,
- visual and optical indicators,
- gas, temperature, and smoke sensors,
- additional START/STOP extinguishing buttons.

Thanks to a flexible design approach, we apply extinguishing technology tailored to the container architecture, LFP pack configuration, and end-user requirements. The proposed systems are covered by a design and consultations with a fire safety specialist. The Fixed Extinguishing System (FES) is coupled with EMS/SCADA systems for the exchange of diagnostic data and alarm signals. At the request of the FES, EMS systems carry out the procedure to prepare the battery container for extinguishing.

# Ventilation, Heating, and Air Conditioning (HVAC) Systems

Depending on the container's purpose, whether as a facility for inverter and/or transformer systems or for battery systems, dedicated HVAC solutions are applied to ensure optimal operating conditions.

The battery container is equipped with air conditioning units, and both container types feature electric heaters. In battery containers, ventilation is automatically shut off by the integrated Fixed Extinguishing System. These solutions are managed by an integrated control system.




Apator SA energy storage systems are CE certified, which is recognised as the European Safety Certificate.

**Legend**

1 Outdoor air conditioning unit

2 Indoor air conditioning unit

3 Electric heater

# Enclosure

Energy storage systems can be housed in various types of enclosures tailored to the installation site, weather, or environmental conditions as required by the investor or the company designing the system in which the storage is to operate.


**Enclosure types:**

- shipping containers in standard sizes (10', 20', 40'),
- custom-designed enclosures with external access,
- cabinet enclosures for indoor installation,
- specialised enclosures for power pole mounting.

# Energy storage system range

**1. Industrial enclosure – indoor or outdoor**

| Power [kW] | 50 | 100 | 150 | 200 |
|---|---|---|---|---|
| Capacity [kWh] | 100 | 200 | 300 | 400 |
| Cabinet | enclosure | | | |

**2. Containerised enclosure – outdoor**

| Power [kW] | 250 | 500 | 1 000 | 2 000 | 4 000 | 5000 |
|---|---|---|---|---|---|---|
| Capacity [kWh] | 500 | 1,000 | 2,000 | 4,000 | 8,000 | 10000 |
| Enclosure | 10ft container | 20ft container | 2x 20ft container | 2x 20ft container | 4x 20ft container | 4x 20ft container |
| EMS | ✓ 2 levels | ✓ 2 levels | ✓ 2 levels | ✓ 2 levels | ✓ 2 levels | ✓ 2 levels |
| Grid voltage | LV / LVPV, MV | LV / LVPV, MV | LV / LVPV, MV | LV / LVPV, MV | MV | MV |
| Transformer | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| DSO integration | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Telemechanics / Power demand controller | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Off-grid capability | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Grid voltage quality improvement | ✓ | ✓ | ✓ | option | option | option |
| Standard warranty | 5 years | 5 years | 5 years | 5 years | 5 years | 5 years |
| Battery technology | LFP / NMC | LFP | LFP | LFP | LFP | LFP |

We implement projects tailored to individual requirements.

**3. Large-scale energy storage systems – containerised – outdoor**

| Custom-configured power ratings and capacities |
|---|

# Project implementation

Apator offers energy storage system construction in both basic and extended scopes. Each offer is individually tailored to the client's needs and specific situation. Apator SA provides comprehensive energy production and storage solutions for various segments.

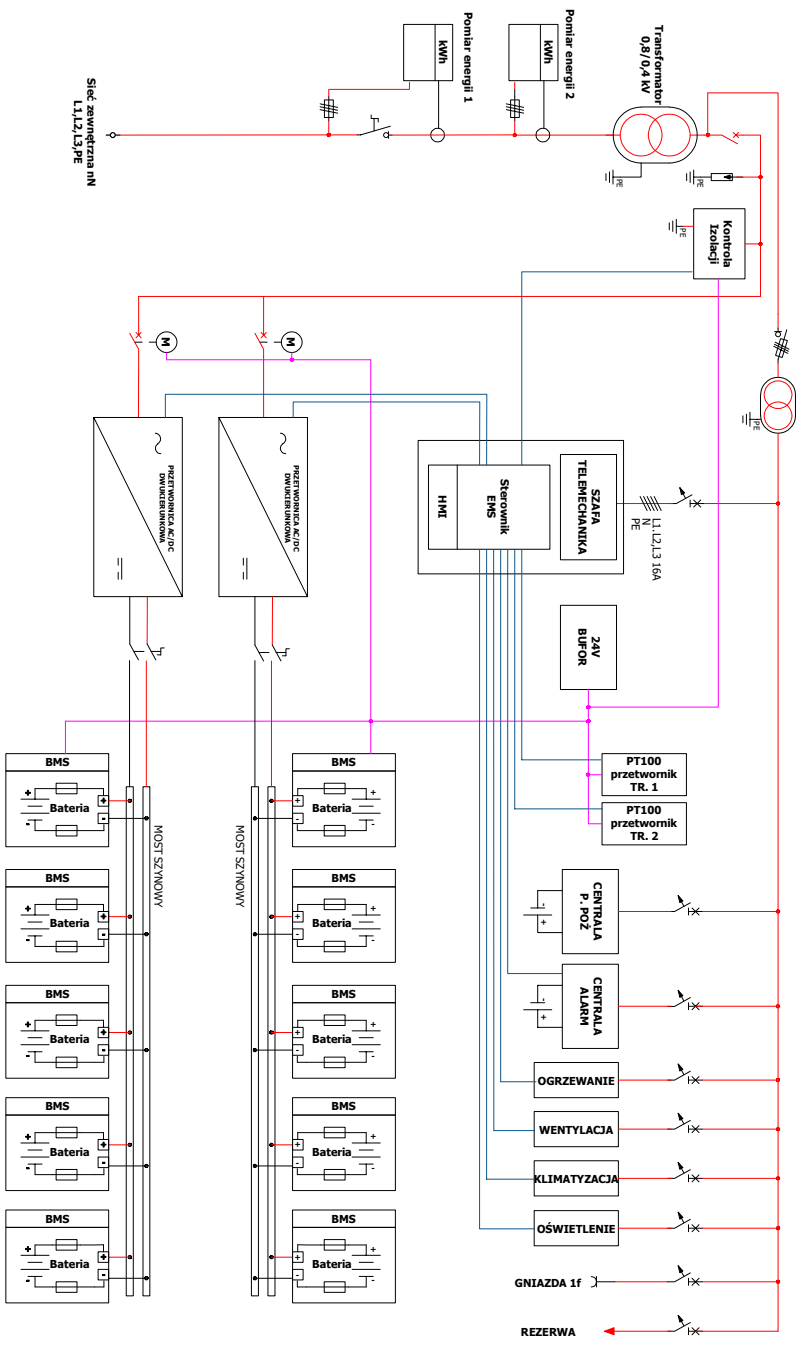
**Taking the client's needs into account, it is possible to create a customised offer.**

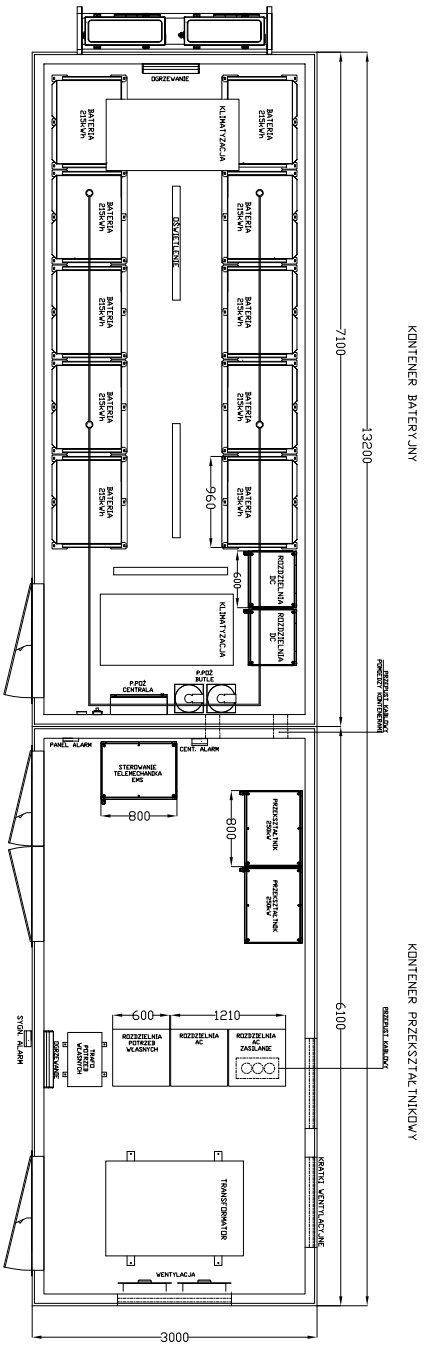
The table below presents the responsibilities for tasks related to the investment process implementation.

| Process stage | Role of Apator SA in the investment process for energy storage system supplies | | |
|---|---|---|---|
| | Basic scope | Extended scope | Support |
| Selection of basic energy storage system parameters (power and capacity) depending on the application and potential functionalities | | ✓ | |
| Simple payback period estimation for the energy storage system investment (based on numerical data from the Client) | | ✓ | |
| Completion of the grid connection application to the DSO / closed DSO | | | ✓ (application submitted by the client) |
| Pricing for a complete energy storage system with a basic management system (EMS) | ✓ | | |
| Designing external circuits (primary and secondary) | | ✓ | ✓ |
| Energy storage system delivery | ✓ | | |
| Connection to the MV and LV grid | | ✓ | ✓ |
| Commissioning | ✓ | | |
| Warranty service | ✓ | | |
| Advanced EMS (for microgrids, balancing areas), integration with external management and forecasting systems, cooperation with the Polish Power Exchange (TGE) | | ✓ | |
| Post-warranty service and system operation optimisation | | ✓ | |
| Securing investment funding | | | ✓ (via partners) |
| Cell servicing and recycling | | ✓ | |

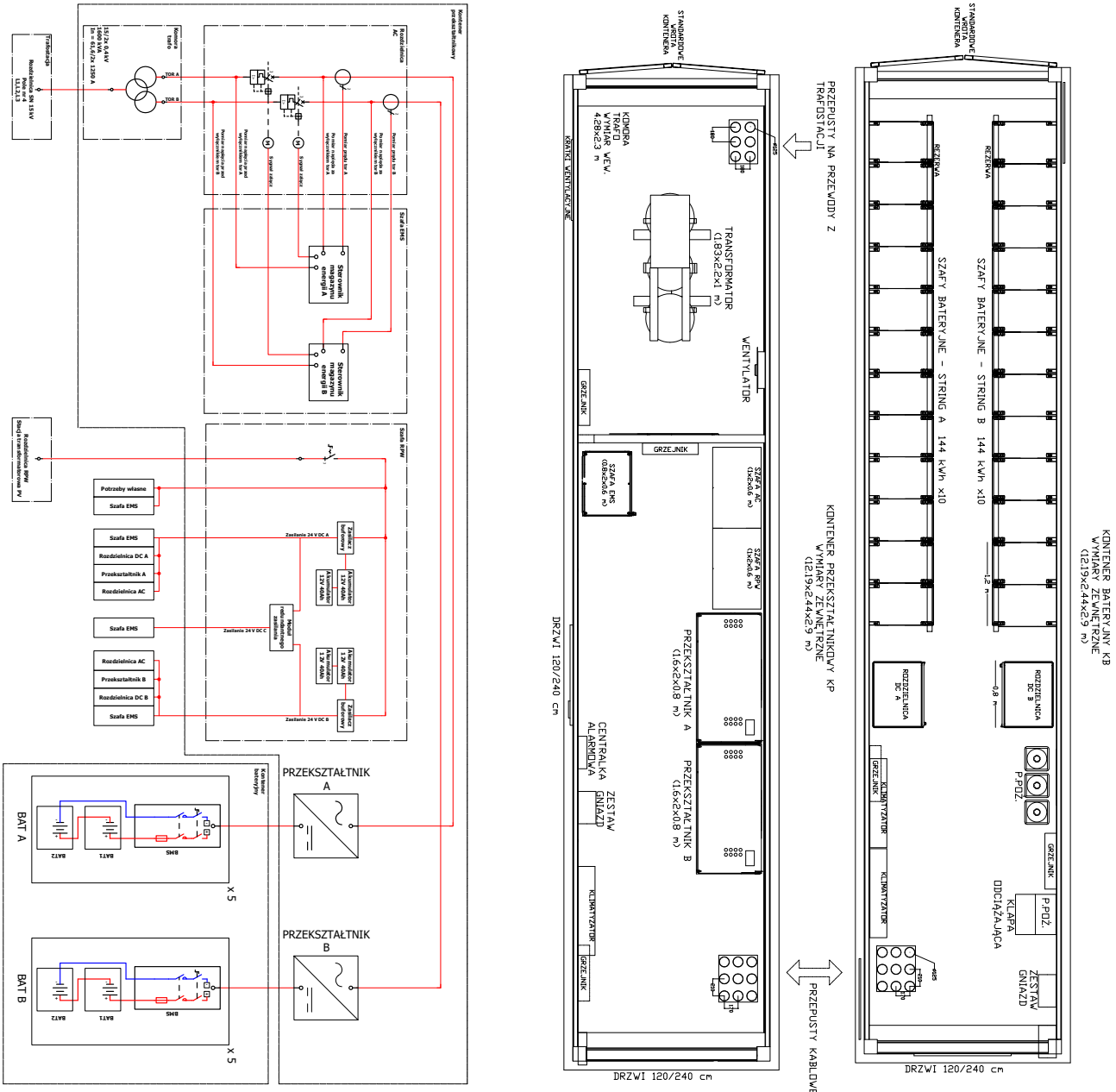
# Example energy storage system projects

500 kW / 2150 kWh Energy Storage System – Low Voltage (LV) grid connection

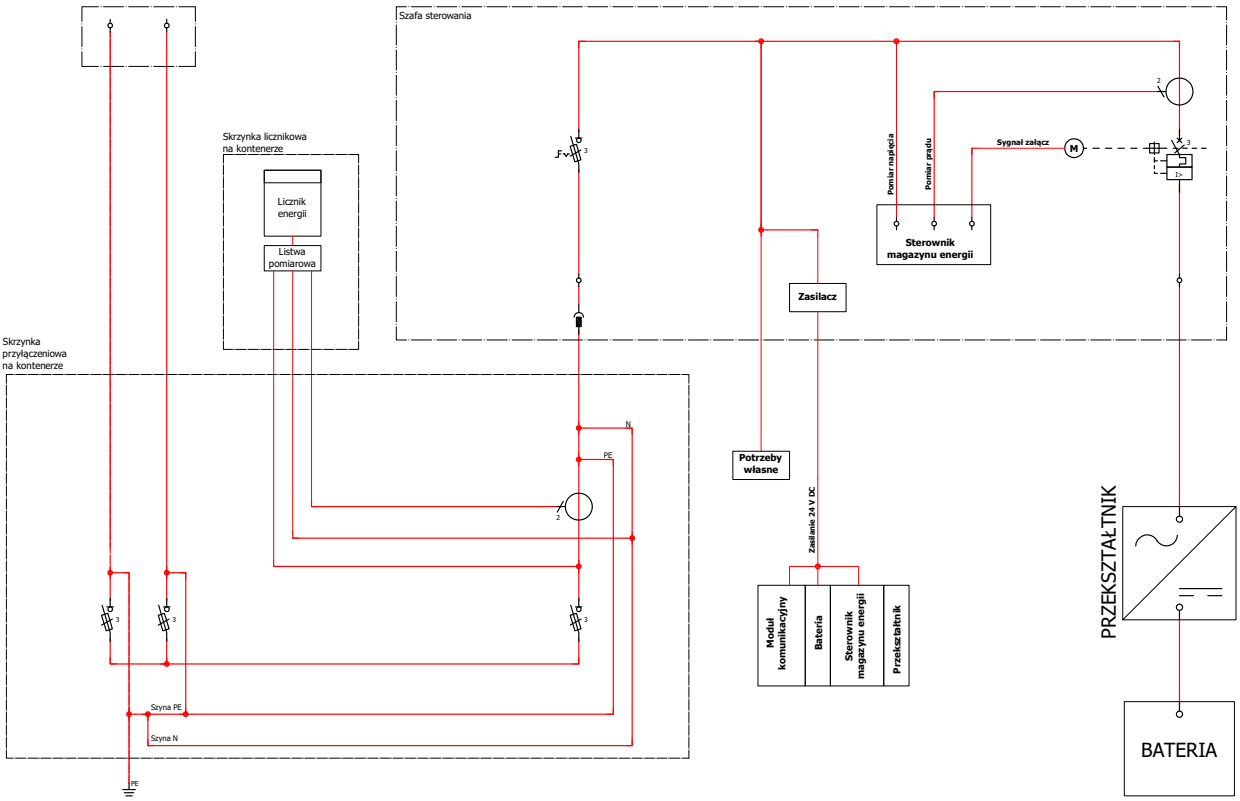


# 1000 kW / 2500 kWh Energy Storage System – Medium Voltage (MV) grid connection



# 50 kW / 140 kWh Energy Storage System – Low Voltage (LV) grid connection

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WYMIARY ZEWNĘTRZNE
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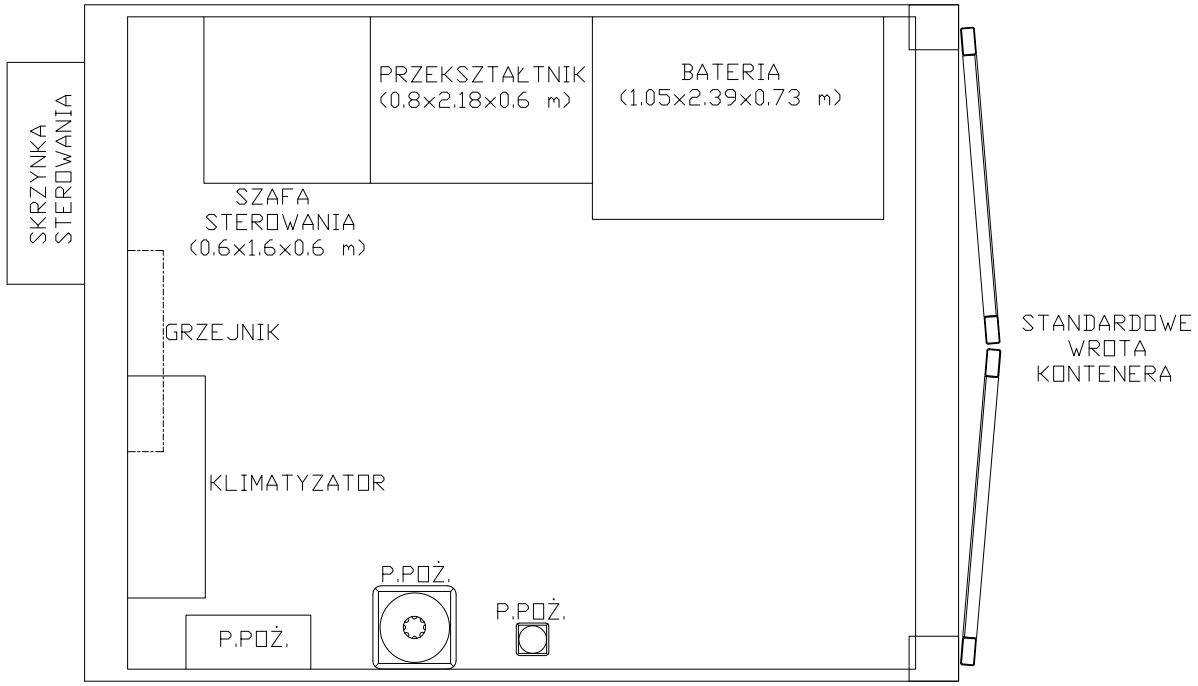

# Financing

Through cooperation with financial institutions, Apator SA offers streamlined financing processes for energy storage systems, including loans and leasing options.

Alternatively, the client may sign a lease agreement directly with Apator SA, under which Apator SA assumes all responsibilities related to the project implementation, maintenance, and the eventual decommissioning of the system.

Together with our partners, we also support the acquisition of funding from grant programmes for the deployment of energy storage systems.

# About us

We manufacture metering devices and systems that enable effective utility management, covering electricity, water, heat, and gas. We provide solutions that facilitate utility consumption monitoring, enhance grid efficiency, and minimise costs.

We support distribution system operators, industry, retail and service chains, housing cooperatives, and private investors in the successful deployment of renewable energy sources and corporate energy management.

# The Apator Group takes a flexible approach to each client's needs, drawing on:

Years of experience in metering and telecontrol systems installed for a diverse range of customers.

Proprietary IT solutions; as the owners of the source code, we can adapt and implement system modifications tailored to specific client requirements.

An in-house team of experienced engineers and developers.

A network of partner companies that supports project implementation.

# Benefits of choosing Apator SA:

Decades of experience in metering and utility management: electricity, water, heat, and gas.

Patented proprietary solutions and technologies, with production based in nine manufacturing plants, over 2,000 employees, and extensive know-how and experience.

Proprietary software that supports the real-time management of networks and devices, as well as managerial decision-making, always tailored to specific client requirements.

Technologies meeting the highest safety standards and cybersecurity requirements for the operation of critical network infrastructure.

A strong Polish capital group operating in both domestic and international markets.

# The EKTIN system with an EMS module.

## Effective energy management


As the share of renewable energy sources grows, so does the need for intelligent energy management. The EKTIN system with an EMS module integrates generation sources, storage systems, and loads, providing real-time monitoring and optimisation of energy flows. The system enables the techno-economic optimisation of energy storage operations and supports the stable, secure functioning of energy infrastructure.

- Reducing energy costs
- Management of multiple energy generation sources and storage systems within a single system
- Stable and secure grid operation
- Optimising generation and storage
- Optimising energy storage system utilisation

We invite you to contact us to learn more about the comprehensive offering of the Apator Group – **a leader in energy, water, and heat solutions.**

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