

Comprehensive RES

Challenges in the selection and design stage of commercial energy storage systems

energia.bruk-bet.pl

WHO We are?



1

Construction of industrial and commercial photovoltaic installations

2

Construction of photovoltaic carports with EV charging stations

3

Professional consulting at every stage of the investment (Ready-To-Build)

4

Analysis and improvement of corporate energy efficiency

5

System services and capacity market

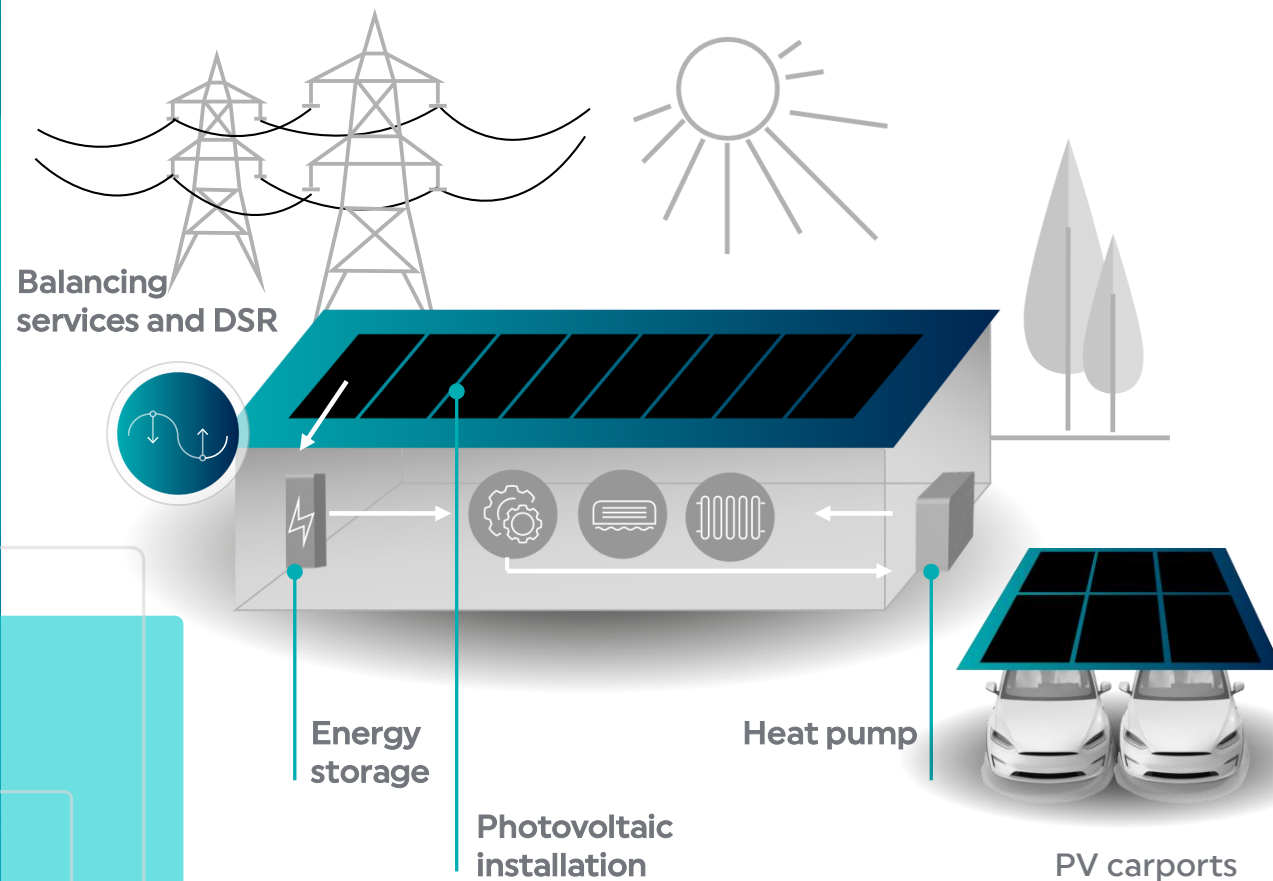
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Operation and Maintenance (O&M)

Comprehensive offer for improving energy efficiency

Our mission is to increase the energy security and financial stability of business entities through the implementation of eco-friendly energy-saving technologies along with accompanying Energy Management Systems (EMS).

Mission and vision



Data analysis as key method for corporate cost optimization



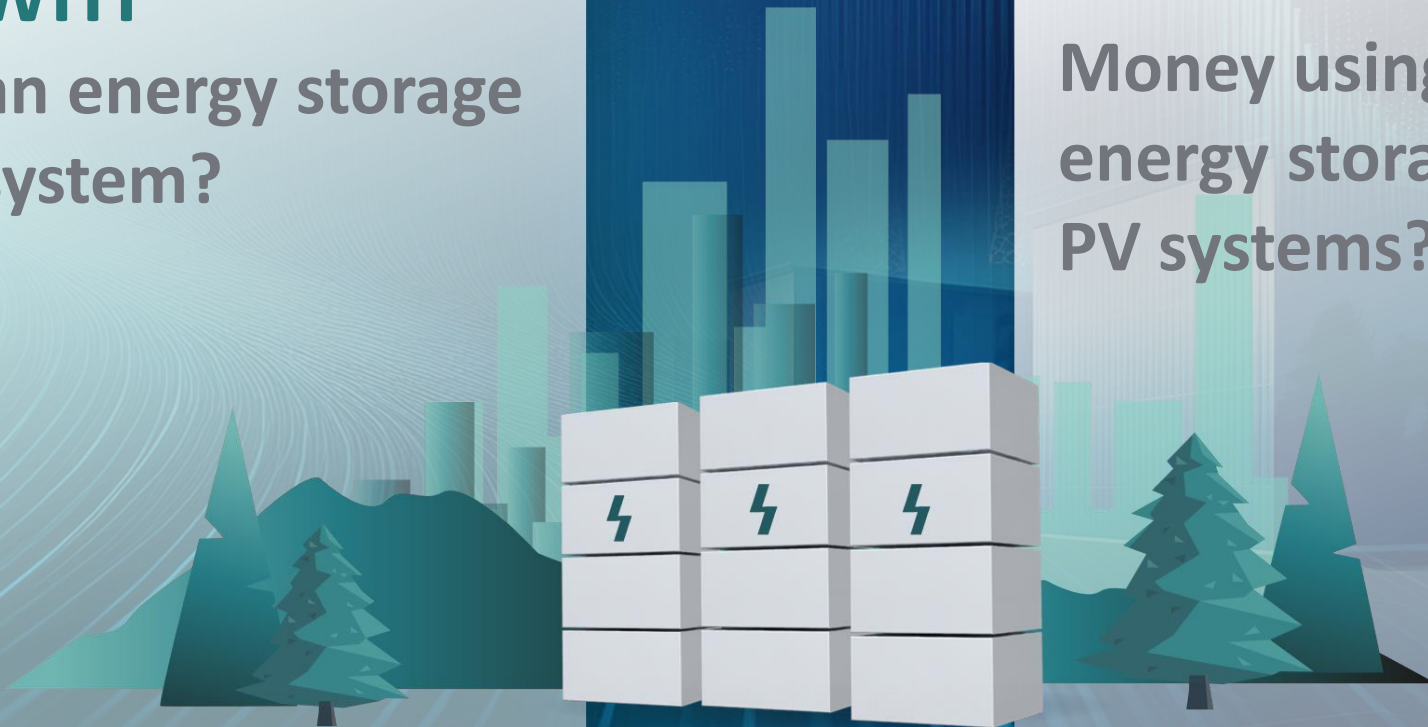
WHY

an energy storage system?



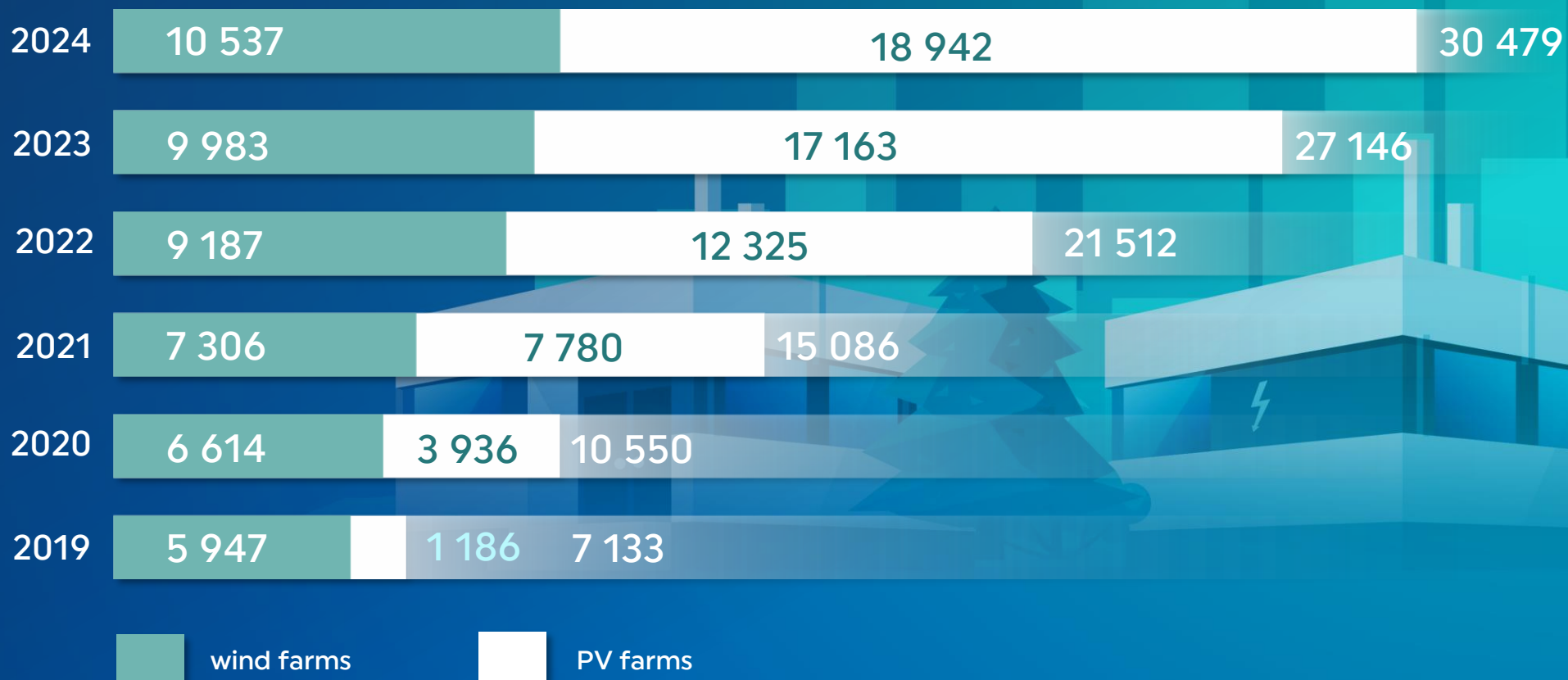
HOW TO EARN

Money using an energy storage and PV systems?



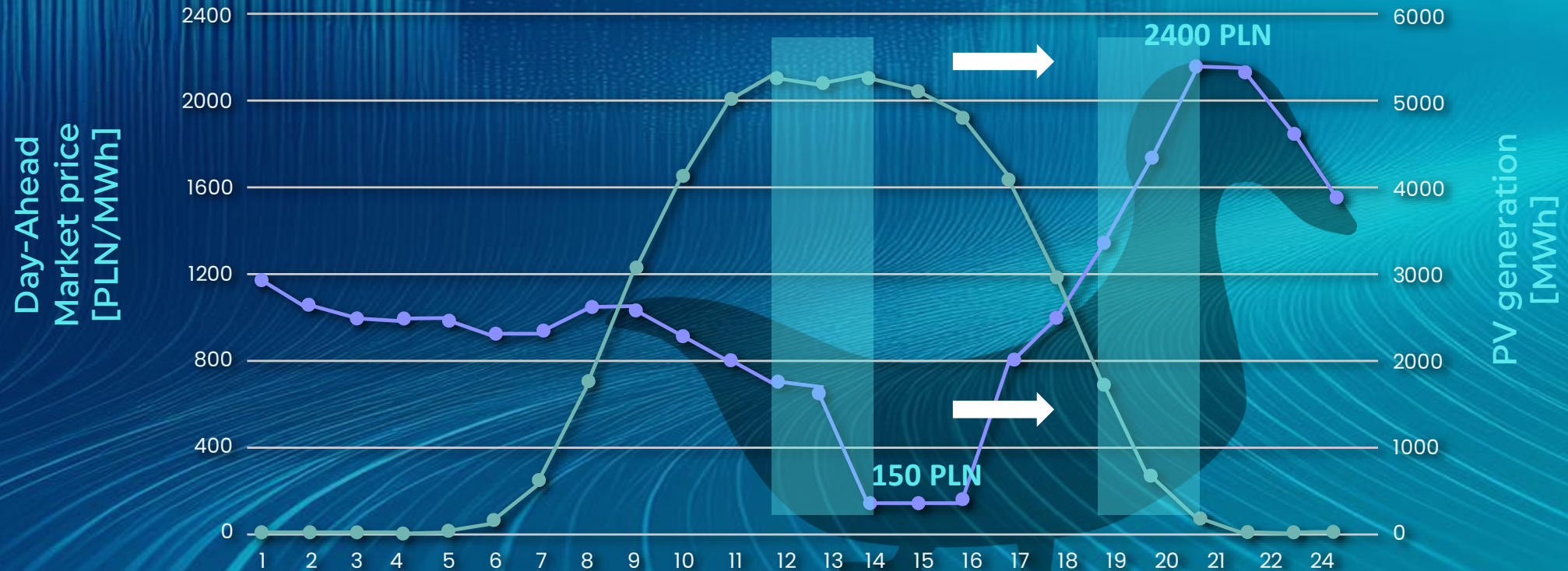
RES structure in Poland

Power of PV installations and wind farms 2006-2024



RES structure in Poland

Electricity prices and PV production on July 18, 2024



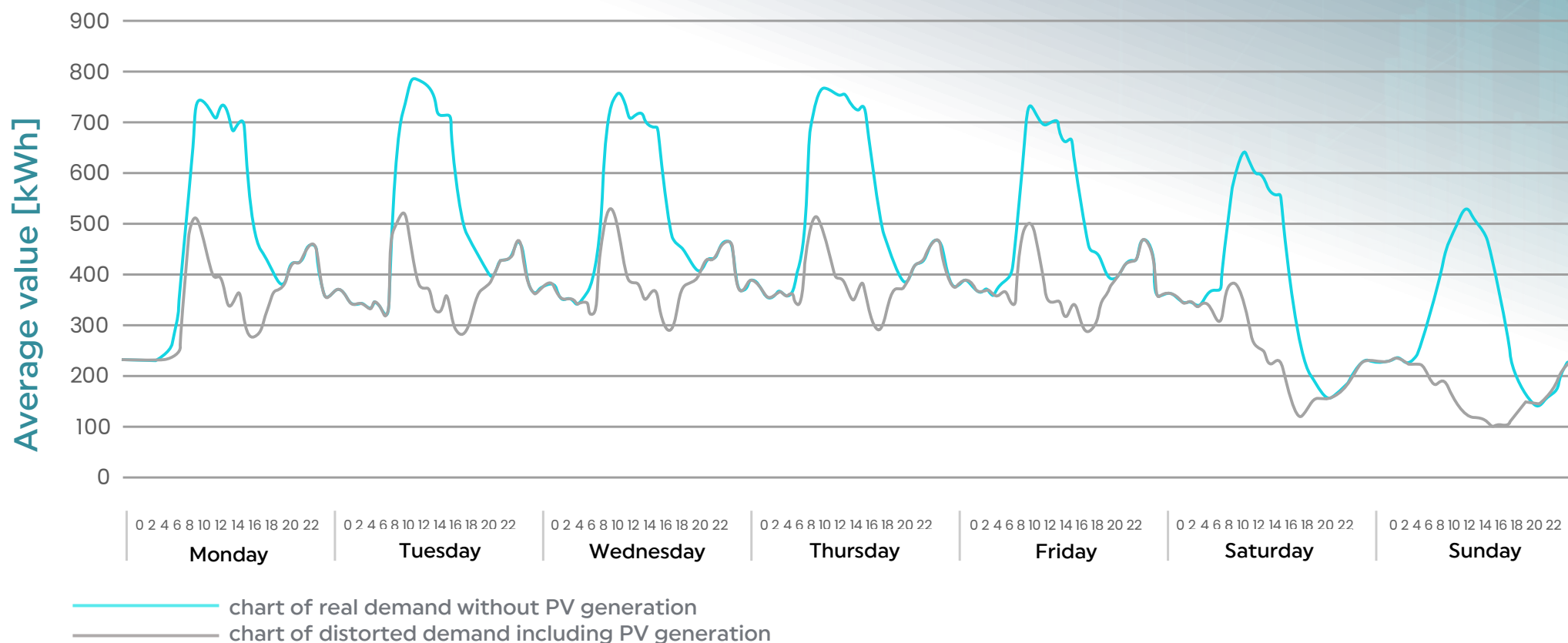
How to earn/save money from an PV & energy storage system?

Energy cost optimization

Demand analysis

Defining needs and capabilities

Average daily energy flow profile broken down by days of the week [kWh]



Optimization of costs resulting from the DSO (Distribution System Operator) agreement.

Entrepreneur's perspective.

DSO invoices



COSTS

1. Contracted capacity
2. Contracted capacity excesses
3. Active Energy
4. Reactive Energy
5. Capacity fee

Energy storage



SAVINGS

1. Reduction of contracted capacity*
2. Energy buffer
3. Price spread +PV - self-consumption
4. Reactive power compensation
5. Up to 83% savings on capacity fee.

Avoided costs.

SYSTEM SERVICES – Grid perspective.

Capacity Market Services

DSR– Demand Side Response

The service involves the voluntary reduction of electricity consumption by companies or the shifting of consumption time at the request of the system operator.

Qualification for DSR:

Minimum connection capacity: 100 kW

Real demand reduction capability

\$ 1 MW = 200,000 PLN

Balancing Services

Grid Frequency Stabilization

If deviations are greater than 0.2 Hz, it may lead to the shutdown of installations or the grid, and even lead to a blackout. Causes of grid frequency fluctuations:

Greater share of weather-dependent sources in the power system

Unplanned electricity consumption and supply

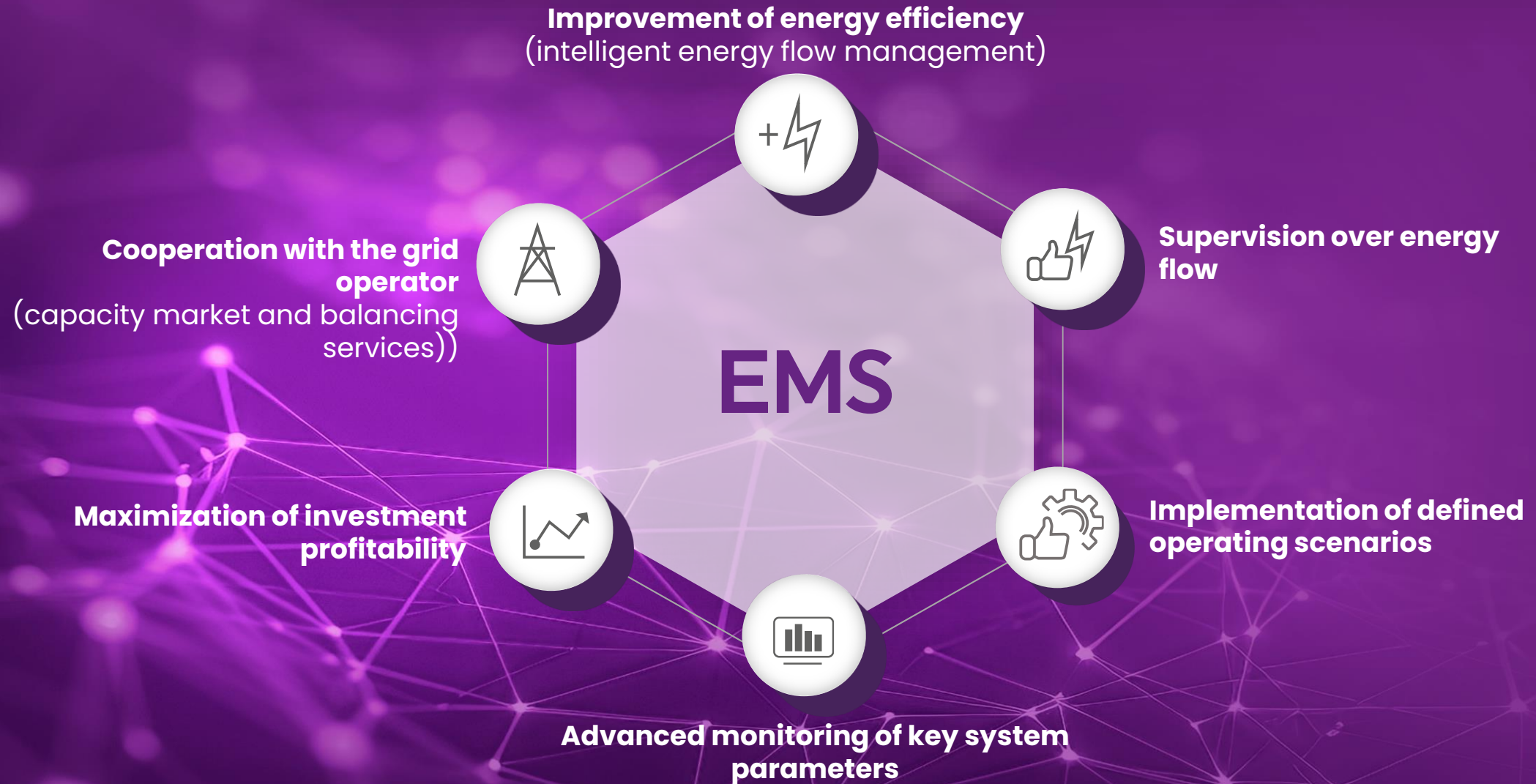
\$ 1 MW = approx. 700,000 PLN

EMS- Energy Management System

The EMS plays a key role in the intelligent management of an energy storage system by monitoring energy flows within an enterprise, as well as performing a supervisory function using dispatchable power to stabilize distribution network parameters through the use of the capacity market and balancing services.



EMS- Energy Management System





CASE STUDY

Technical-economic
analysis

Technical-Economic Analysis

What it includes and what benefits it brings to the investor:



Presents the optimal configuration of ES power and capacity as well as PV power



Visualizes energy flow simulation



Checks the energy storage utilization rate – optimal selection of ES operating cycles



Presents savings potential within the capacity market and balancing services



Illustrates the improvement in the self-consumption rate of existing PV



Indicates the level of investment expenditures, savings in the enterprise, and the payback period

Enterprise Parameters

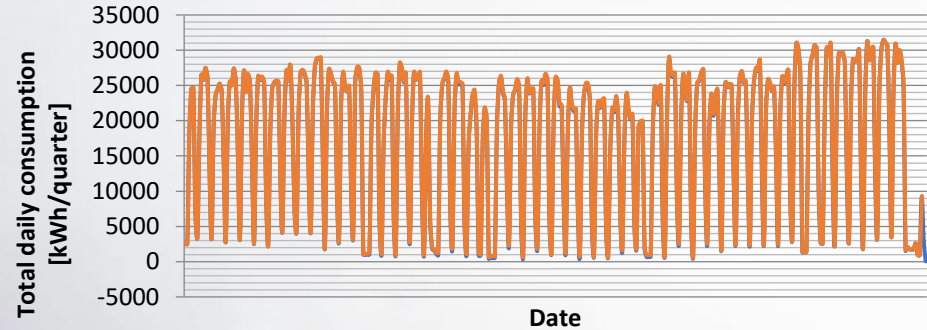
Contracted capacity:	1600kW
Energy settlement:	Market-based purchase
PV – current capacity	50kW
PV planned expansion:	900kW
Capacity reserve:	300kW/2h

Expected Results

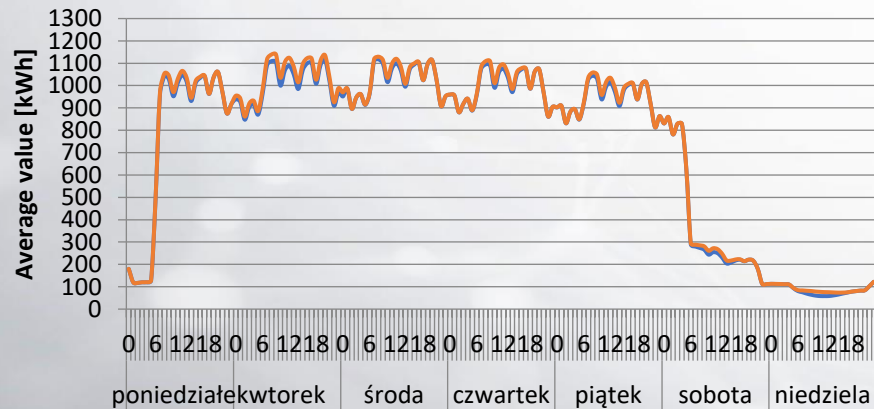
- [x] Increase in self-consumption
- [x] Capacity fee reduction
- [x] Reactive power reduction
- [x] DSR
- [x] Balancing services

Demand Analysis

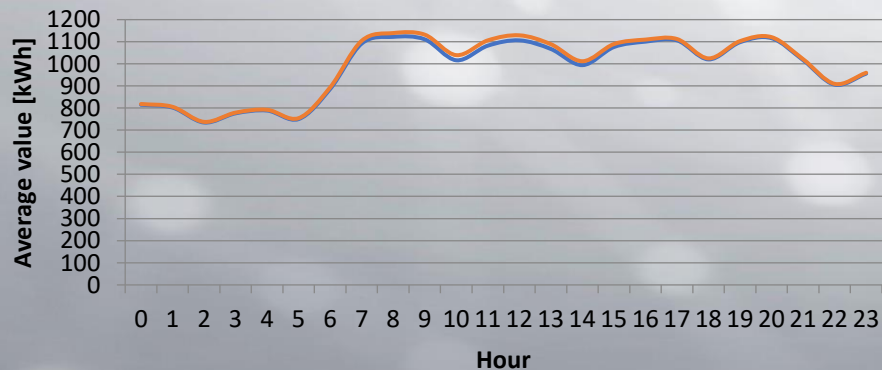
Determining the nature of the enterprise's operations



Annual energy flow profile



Daily energy flow profile by day of the week



Daily flow profile by hour Monday - Friday

Cat litter factory

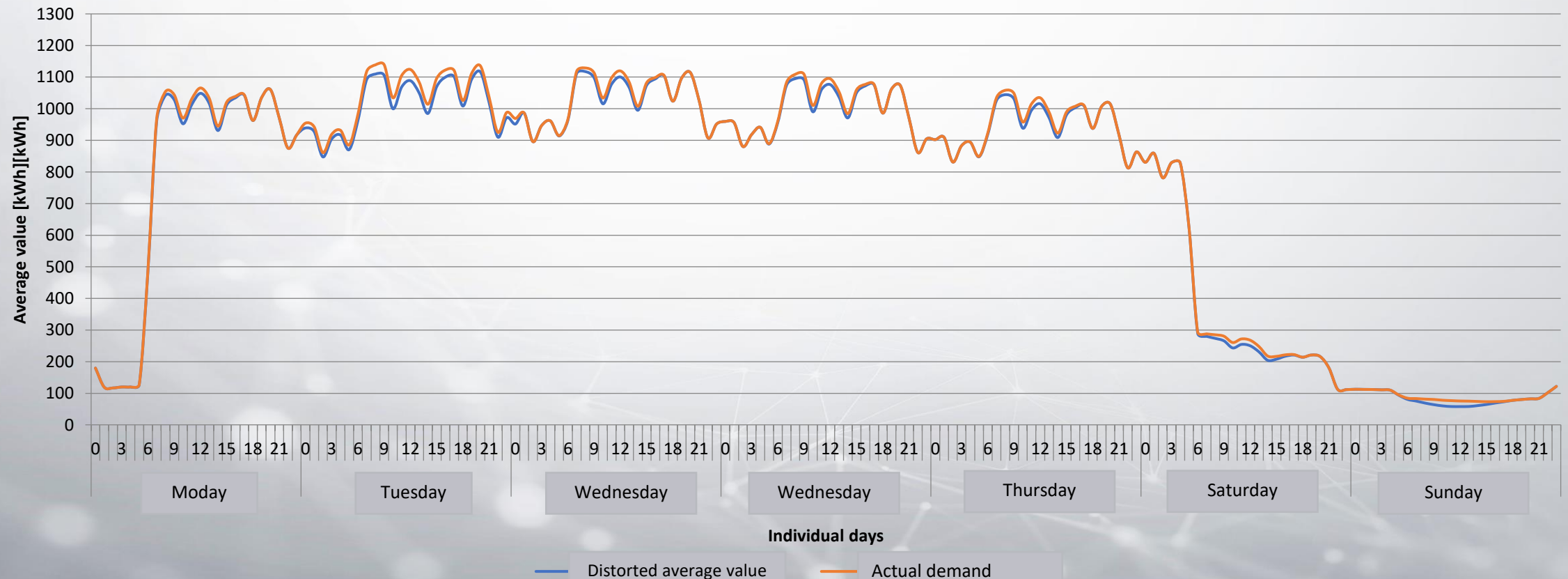
Contracted capacity:	1600kW
Energy settlement:	Market-based purchase
PV – current capacity:	50kW
PV planned expansion:	900kW
Azimuth and angle – southern	15
Power reserve:	300kW/2h

Demand Analysis

Determining the nature of the enterprise's operations

Average daily profile by day of the week [kWh]

The facility's contracted capacity is 1600kW

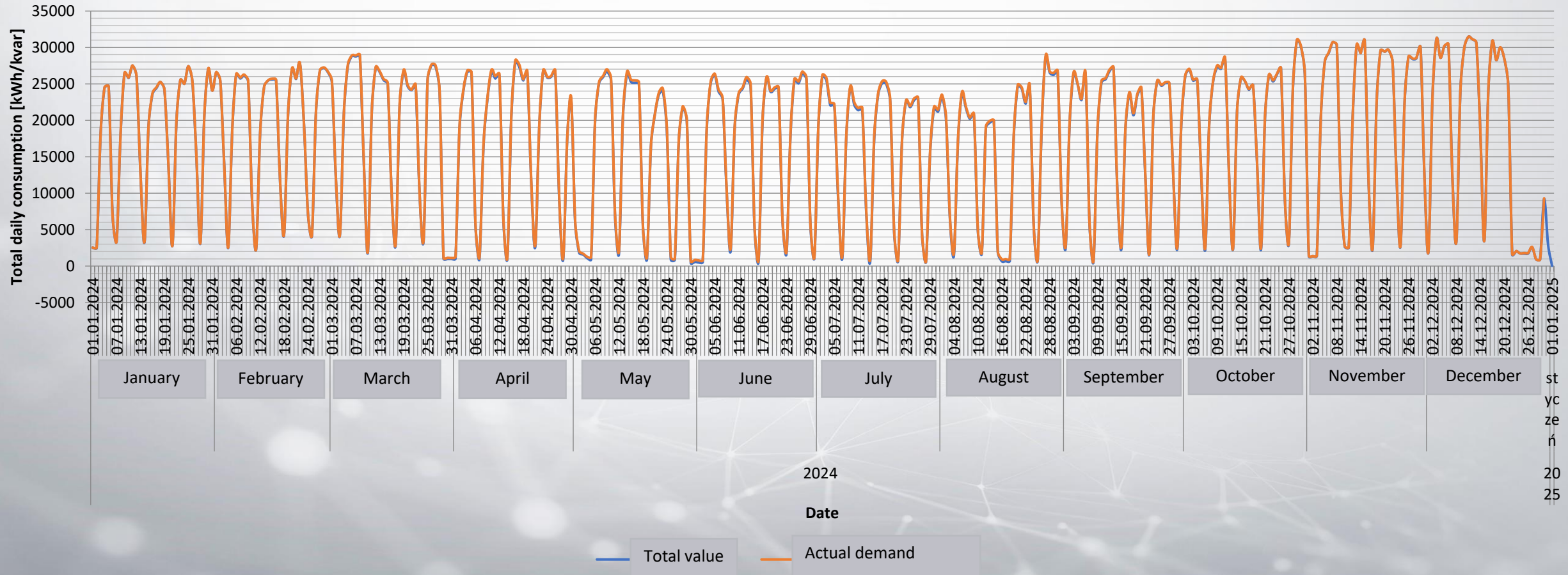


Daily energy flow profile by day of the week

Demand Analysis

Determining the nature of the enterprise's operations

Total consumption on individual days [kWh/quarter]



Annual energy flow profile

Assumptions for ATE (Technical-Economic Analysis)

Parameters for ES (Energy Storage)

Average min. demand.	900kW
Average max. demand	1100kW
ES selection for DSR	min 1000kW
ES selection for balancing services	1500kW

Enterprise Parameters

Contracted capacity:	1600kW
Energy settlement:	Market-based purchase
PV – current capacity:	50kW
PV planned expansion	900kW
Power reserve:	300kW/2h

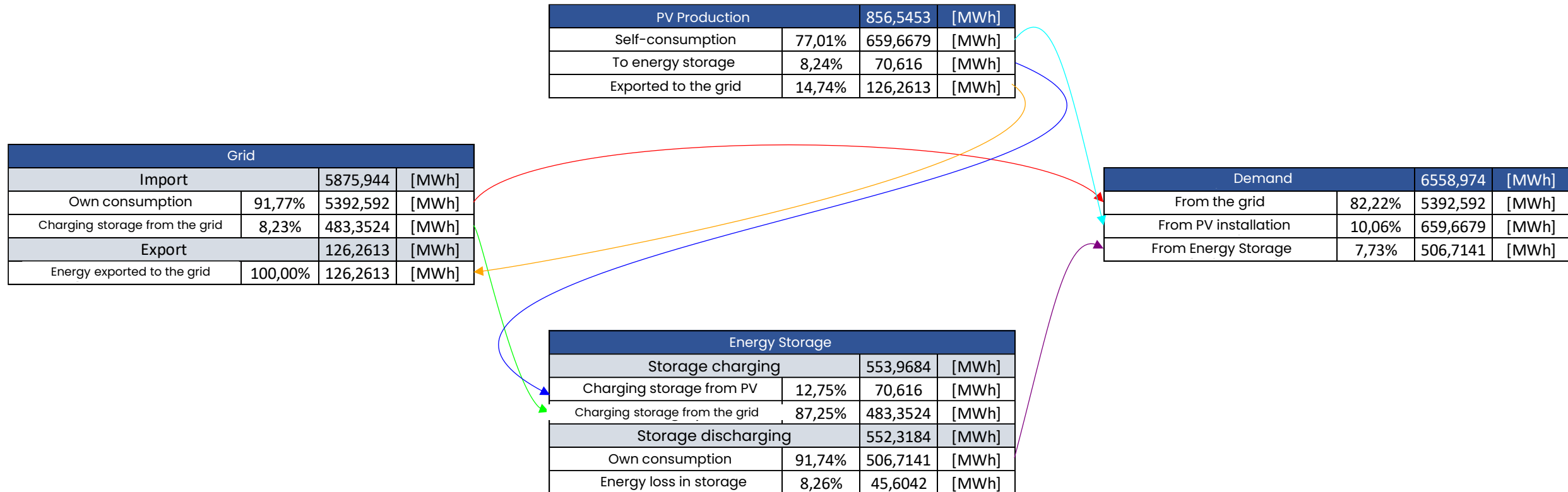
ES parameters adopted for energy flow simulation

1,5MW/3MWh

Adopted RDN (Day-Ahead Market) spread arbitrage: 4h
Winter/2h Summer

System operation simulation

Energy flow diagram



self-consumption rate > 77%

Energy storage arbitrage operation > 87%

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⋮

Miesiąc

Czerwiec 2025

Ceny RDN – tabela dzienna (dni × godziny)

Zielone = 4 najtańsze godziny w dniu, czerwone = 4 najdroższe godziny w dniu.

day	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22
2025-06-01	445.47	427.13	409.46	408.62	427.51	441.61	417.47	392.77	140.30	33.34	-1.23	-21.23	-30.64	-6.25	-0.02	12.10	308.90	507.68	514.25	504.94	525.02	523.89	438.15
2025-06-02	387.80	364.39	351.50	374.74	389.01	408.09	506.13	544.33	476.81	388.06	219.41	168.94	97.29	83.03	147.20	348.71	418.26	479.99	726.45	1193.58	1864.27	1158.45	600.61
2025-06-03	477.28	464.36	436.51	432.66	433.46	478.39	558.43	525.92	446.91	425.66	373.52	264.96	243.01	220.93	217.12	320.87	327.09	370.80	497.99	837.05	1473.37	880.89	560.40
2025-06-04	493.58	466.09	438.11	432.24	424.36	418.39	510.18	483.83	423.77	284.93	10.92	-31.00	-2.39	22.02	86.18	199.38	339.82	439.59	504.32	652.28	859.74	645.34	438.15
2025-06-05	462.13	437.24	441.68	441.59	434.91	446.57	489.11	528.81	489.81	444.35	354.77	244.43	217.34	213.83	285.61	383.46	438.86	448.56	507.90	659.38	912.18	686.68	438.15
2025-06-06	454.50	450.64	447.31	449.35	447.95	443.54	443.14	409.82	412.30	260.36	14.44	0.75	4.44	-5.83	-0.75	0.24	39.12	346.40	582.47	578.78	798.83	604.81	438.15
2025-06-07	505.57	499.64	495.92	475.71	445.11	433.10	442.11	439.95	405.62	311.72	173.16	65.43	78.69	178.48	339.15	415.02	439.94	510.13	450.70	510.90	600.61	560.40	438.15
2025-06-08	414.96	381.63	369.03	354.97	333.67	325.23	292.24	275.51	93.56	-0.71	-2.84	-7.55	-27.96	-28.53	-17.08	-28.47	-8.30	215.49	365.93	418.76	468.34	438.15	438.15
2025-06-09	79.35	78.03	31.18	37.78	41.68	93.85	184.30	210.75	75.41	-0.59	-26.77	-40.04	-66.07	-70.93	-71.34	-32.43	-3.71	148.14	411.08	513.82	790.49	646.67	438.15
2025-06-10	443.18	435.16	400.76	396.47	376.73	395.14	421.95	421.21	444.69	389.81	266.40	262.85	327.71	346.49	398.34	447.53	488.29	533.35	662.15	795.69	961.00	630.23	438.15
2025-06-11	454.31	443.75	410.23	386.97	377.03	400.03	484.20	501.50	467.76	406.42	213.96	132.22	28.72	5.12	5.99	16.77	74.66	316.72	454.80	613.59	863.38	705.15	438.15
2025-06-12	440.80	439.06	435.15	426.74	407.26	422.51	486.43	448.08	372.69	179.72	0.00	0.20	-5.79	-14.93	-0.67	8.68	84.17	319.43	446.93	659.23	972.72	735.65	438.15

Identify best hours window to charge/discharge BESS every day

Selekcja 4 najniższych i 4 najwyższych cen energii (dziennie) + spready ⇄

Spready dzienne

Dzień	Śr. 4 najtańsze [PLN/MWh]	Śr. 4 najdroższe [PLN/MWh]	Spread 4x4 [PLN/MWh]	Min
2024-06-24 00:00:00	375.2325	1175.1125	799.88	
2024-06-25 00:00:00	338.5875	1192.2625	853.675	
2024-06-26 00:00:00	275.265	1181.645	906.38	
2024-06-27 00:00:00	305.7225	1187.3275	881.605	
2024-06-28 00:00:00	452.9175	923.12	470.2025	
2024-06-29 00:00:00	168.2875	643.8875	475.6	
2024-06-30 00:00:00	-86.0275	484.0675	570.095	
2024-07-01 00:00:00	436.095	1222.69	786.595	
2024-07-02 00:00:00	314.4425	862.195	547.7525	
2024-07-03 00:00:00	375.2425	939.885	564.6425	

Uśrednienie do miesiąca

Miesiąc	Średni spread 4x4 [PLN/MWh]	Średni spread min-max [PLN/MWh]	Średnia cena minimalna
Czerwiec 2024	708.2054	923.6457	
Czerwiec 2025	685.1149	885.3696	
Grudzień 2024	384.5056	444.8	
Kwiecień 2025	594.369	726.663	
Lipiec 2024	722.5268	920.6248	
Listopad 2024	494.7443	607.5047	
Luty 2025	328.7128	402.8557	
Maj 2025	534.0627	760.4232	
Marzec 2025	505.8339	596.0297	
Październik 202	479.1494	613.44	

 Pobierz raport RDN (tabela dzienna + spready) – Excel

Real time prices spread calculation between cheapest and most expensive hours every day.

Revenue summary

DSO invoices

1. Contracted capacity
2. Contractual power exceedances
3. Active Energy
4. Reactive Energy
5. Capacity fee

System services

6. DSR
7. Grid frequency balancing

SAVINGS

1. Reduction is not recommended*
2. Reduced 100% -**22k. PLN**
3. Arbitrage + PV self-consumption -**282k PLN**
4. Reduced 100% -**68k PLN**
5. Reduced 83% -**250k PLN**

6. Declared capacity 1,05MW -**265k PLN/year**
7. Registered capacity 1,5MW -**1,068M PLN/year**



Energy storage
1,5MW/3MWh

Savings + revenues = 1,955,000 PLN/year

Cost estimate for works including energy storage delivery

Energy Storage System Components	Price (PLN)
Energy storage system with 3MWh usable capacity and 1.5MW power	3 845 500
Transformer station	720 000
Energy Management System (EMS) / hardware + software	100 000,00
Energy Management System (EMS) / Services (commissioning)	9 000,00
commissioning	pcs
Battery module system with 3 MWh capacity in LFP technology with BMS management system Number of duty cycles (10% – 90% SoC 0.5C) > 7200 Permissible ambient temp. -25°C to +55°C	1
AC/DC Energy Conversion	pcs
Bidirectional power conversion module – 1.5MW	1
Energy Storage Housing – Freestanding	pcs
Container housing	1
Comprehensive Implementation Service	pcs
Configuration and commissioning	1
TOTAL	4 674 500 PLN net



Return on Investment (ROI) calculation

Correction indicators based on the simultaneity factor

		power / quantity	amount	Service coverage level	value
Avoided cost calculation	DSO arbitrage calculations	1	231 377 PLN	90%	208 239 PLN
	PV arbitrage calculations	1	51 739 PLN	90%	46 565 PLN
	Peak Shaving - reduction of contractual power exceedances	1	21 729 PLN	90%	19 556 PLN
	Reduction of reactive power fee	1	67 732 PLN	90%	60 959 PLN
	Reduction of capacity fee	1	500 425 PLN	50%	250 212,50 PLN
System services calculation	DSR services	1	265 255 PLN	100%	265 255 PLN
	DSR +	1	0 PLN	0%	0 PLN
	Revenues from the balancing market	1	1 068 237 PLN	90%	961 413 PLN
	*Revenues from Intervention Power Reserve	1	0 PLN	0%	0 PLN
	Return on investment calculation [years]:	3,38	Total benefits		1 812 200 PLN

Simple return on investment

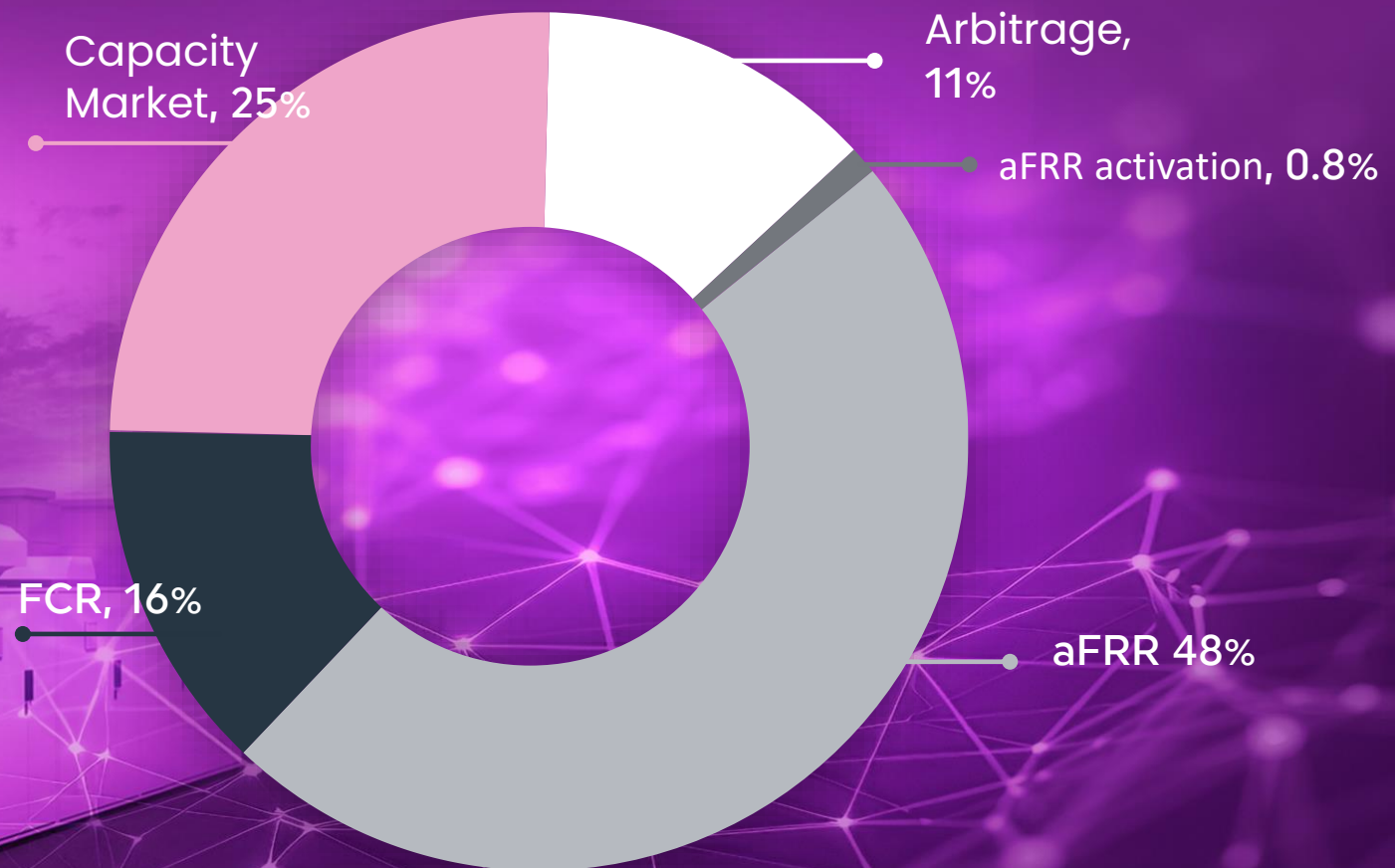
Investment value in BESS

1,5MW/3MWh – 4 674 500 million PLN

Revenues + savings

from invoices = 1,812,200 million PLN/Year

Expected simple payback period in as little as 2.58 years



*Estimates based on Aurora Energy Research data



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