

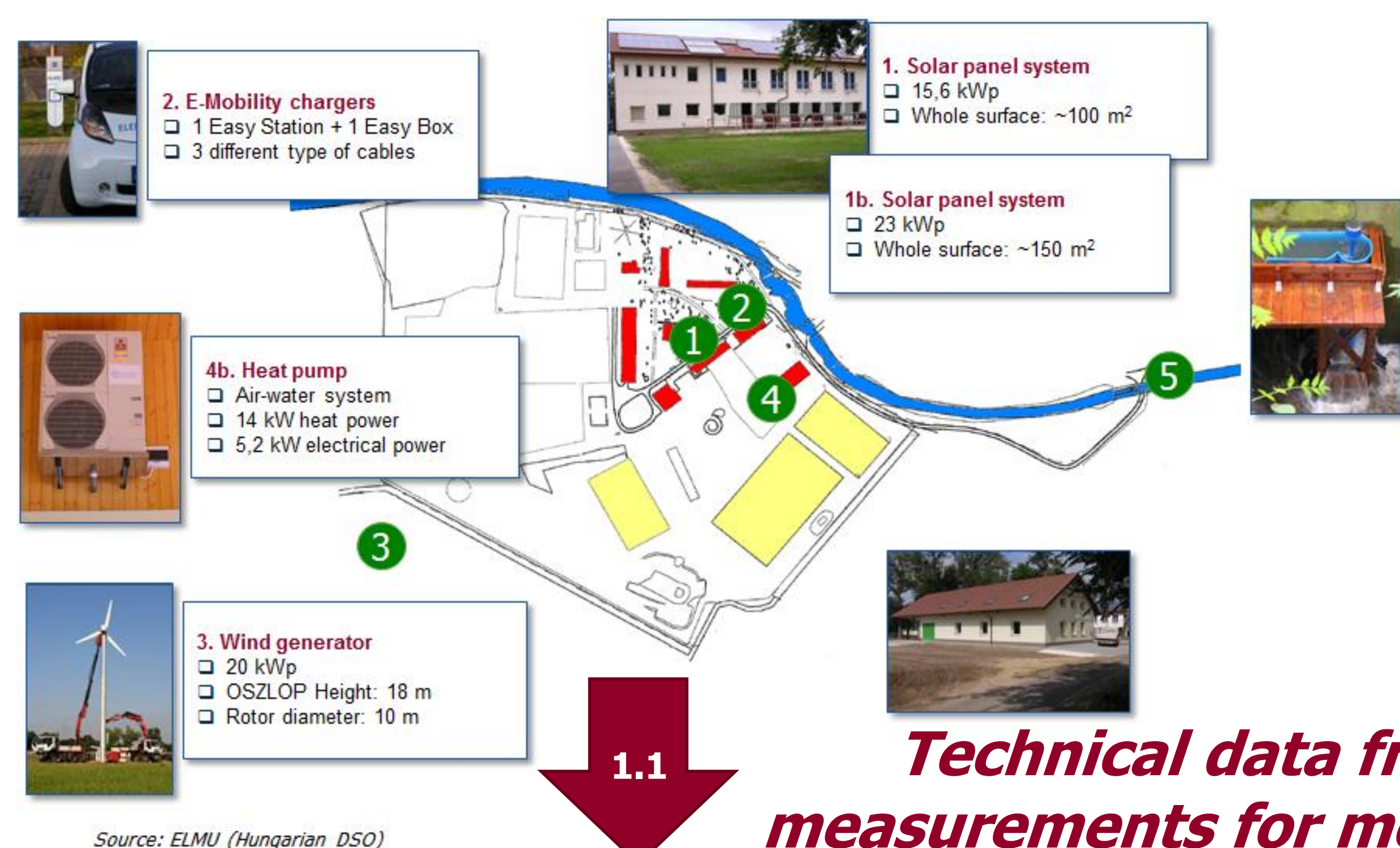
Energy Storage Applications for Distribution Grid Support: Composition of Controlling Strategies and a Standardized Model

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Distribution grids will basically change in the near future: the increasing penetration of renewable energy causes high percentage of intermittent and decentralized generation. This procedure will lead to problems which are unknown for a conventionally planned and operated grid. Bidirectional power flows, power quality issues and voltage sags can occur.

Modelling method for energy storage applications

Demonstrational grid elements

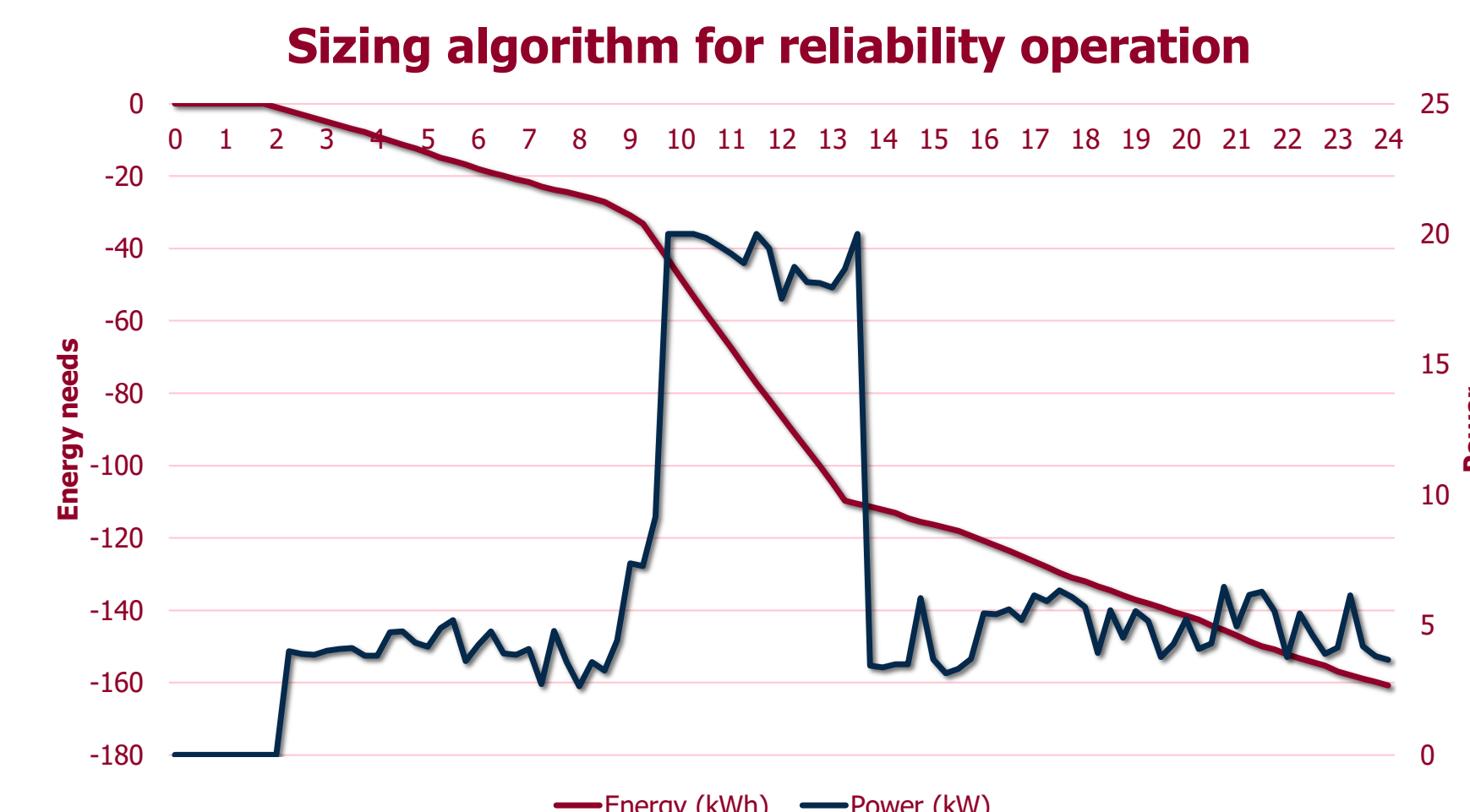
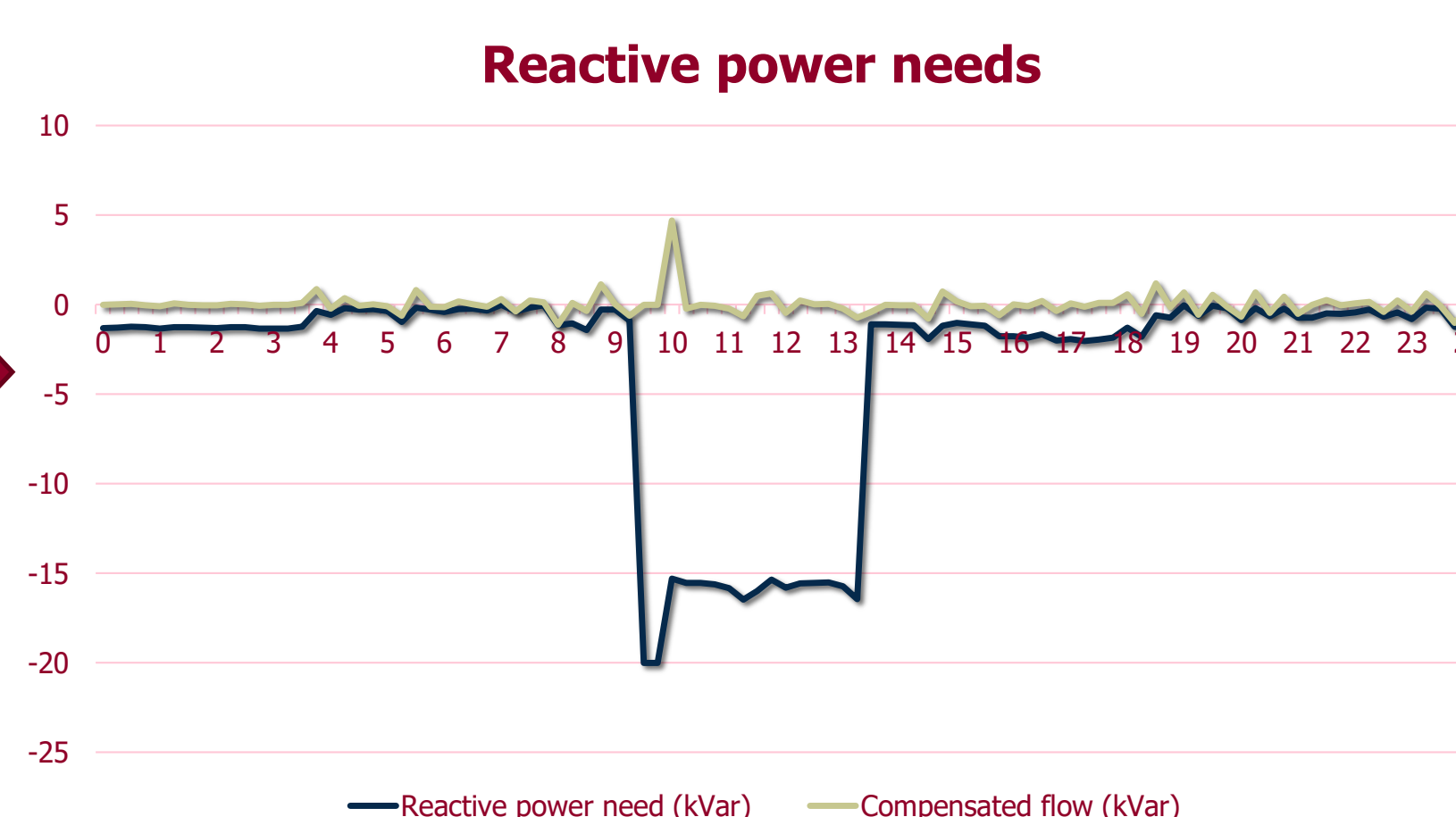
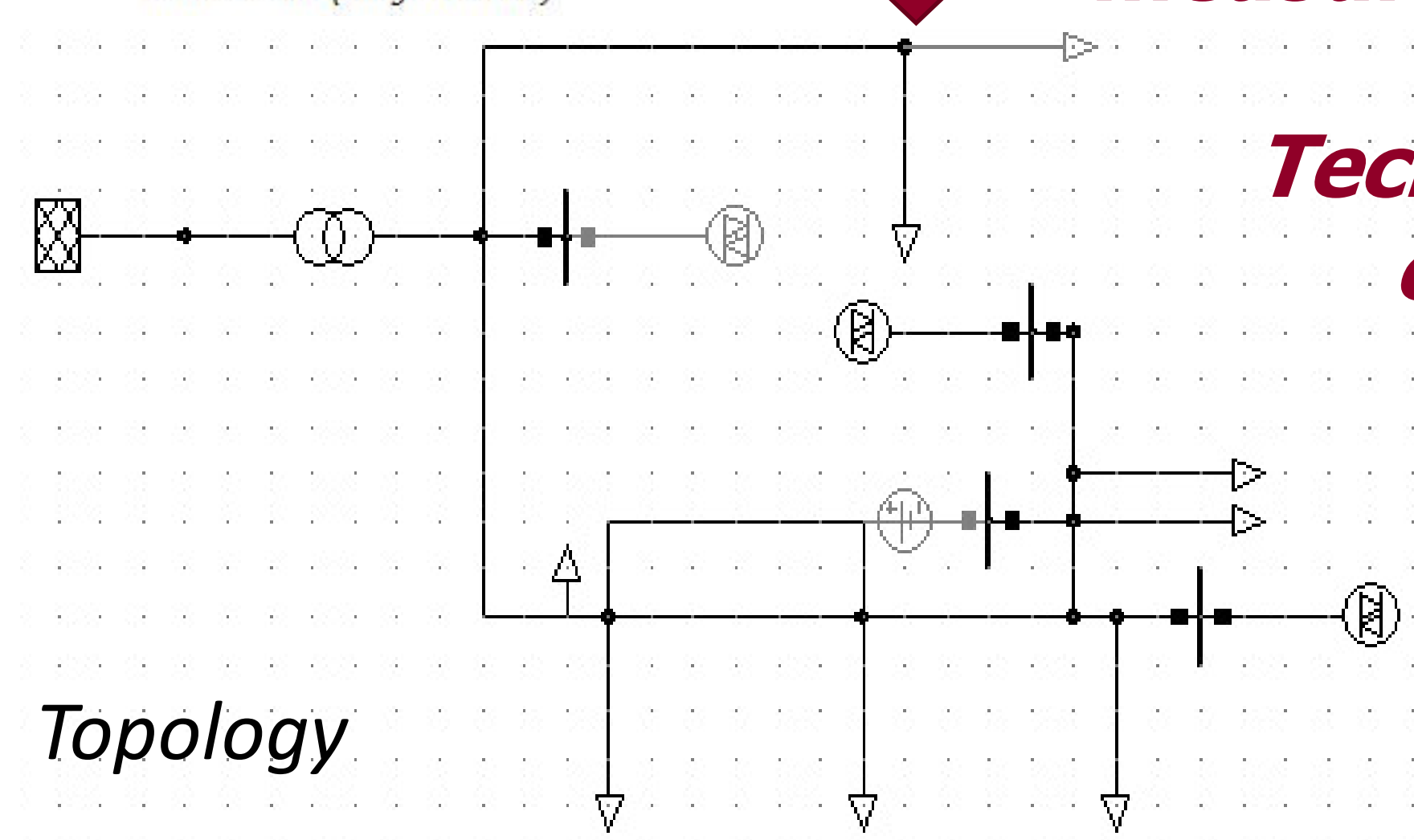


Technical data from measurements for modelling

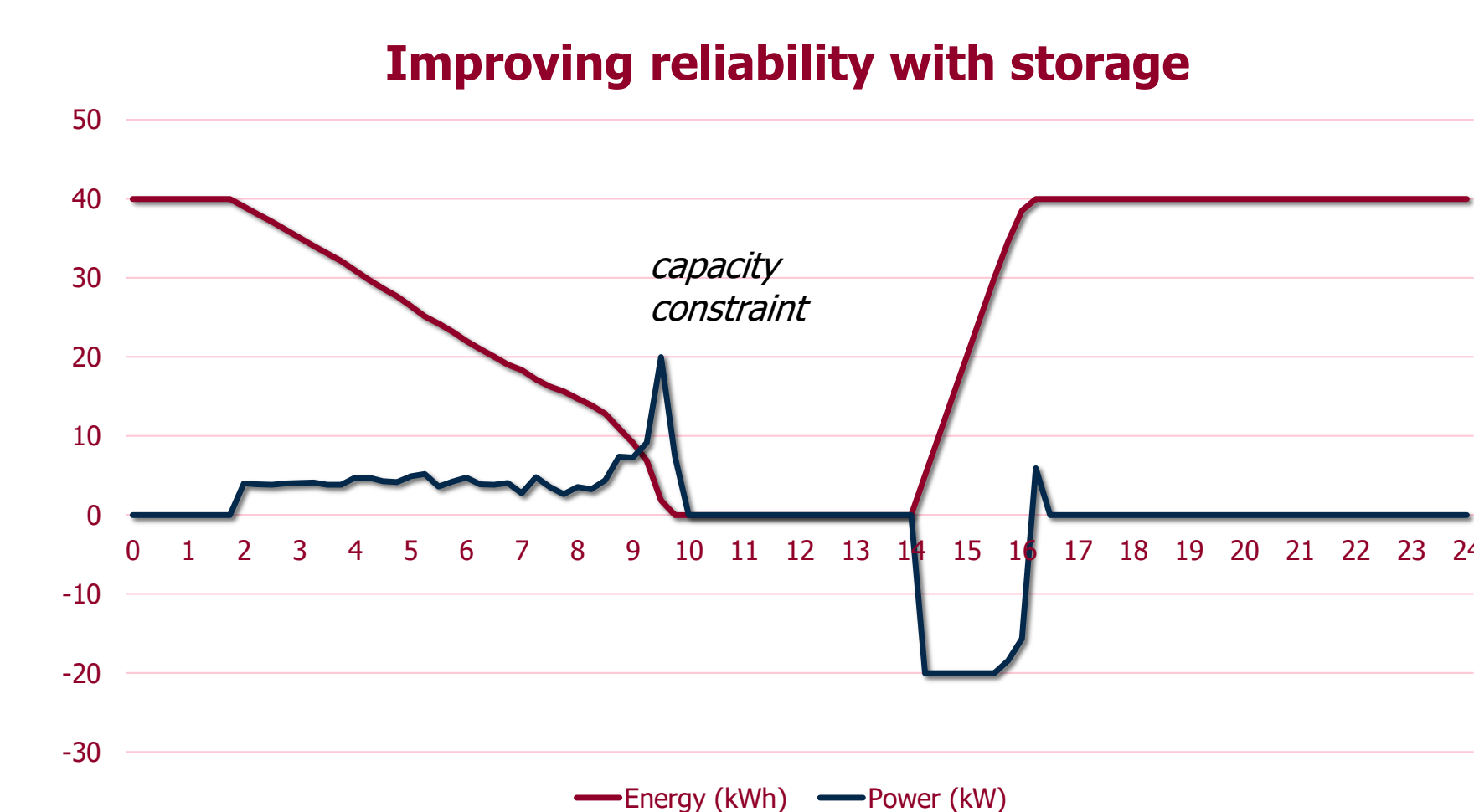
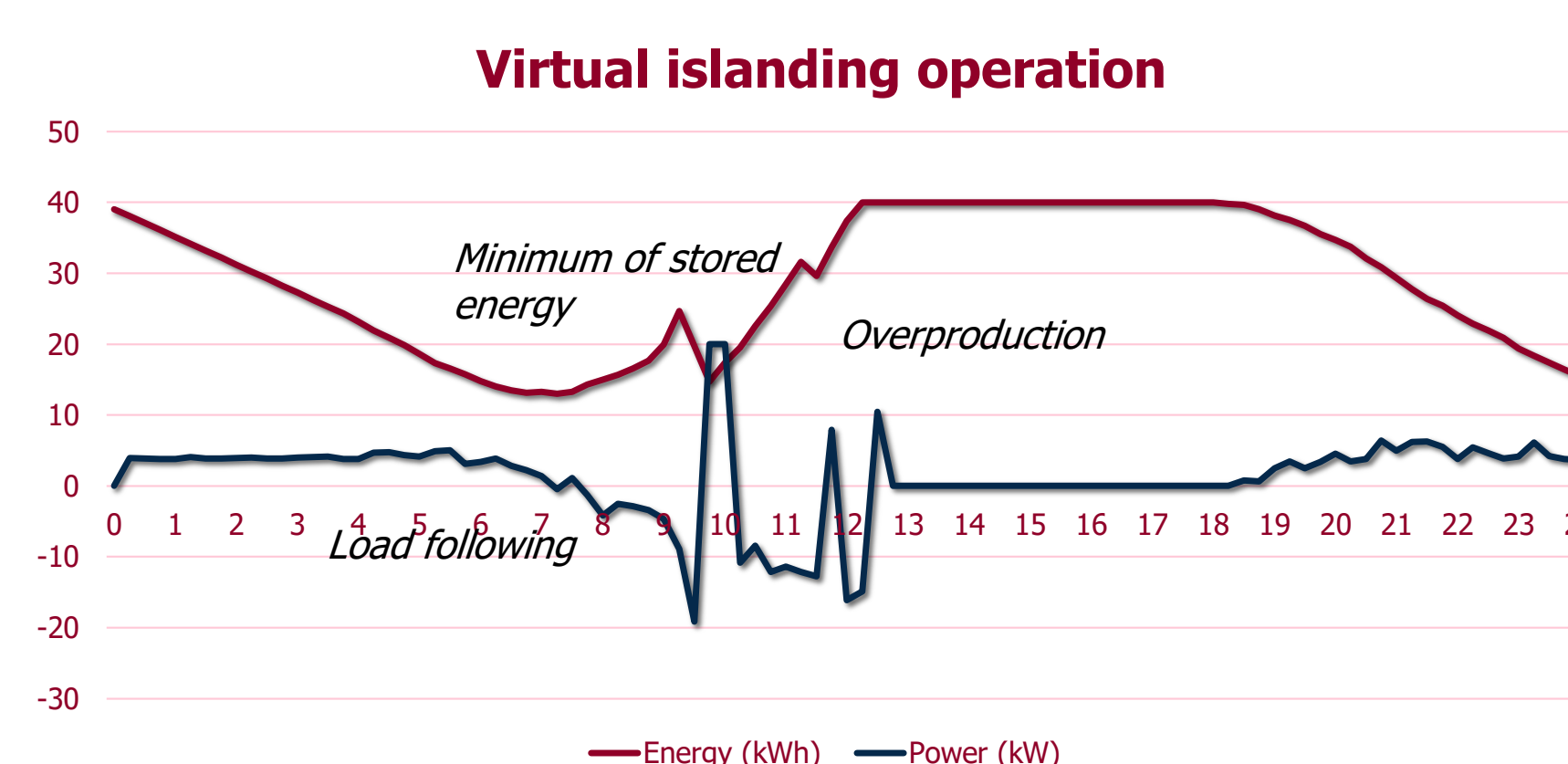
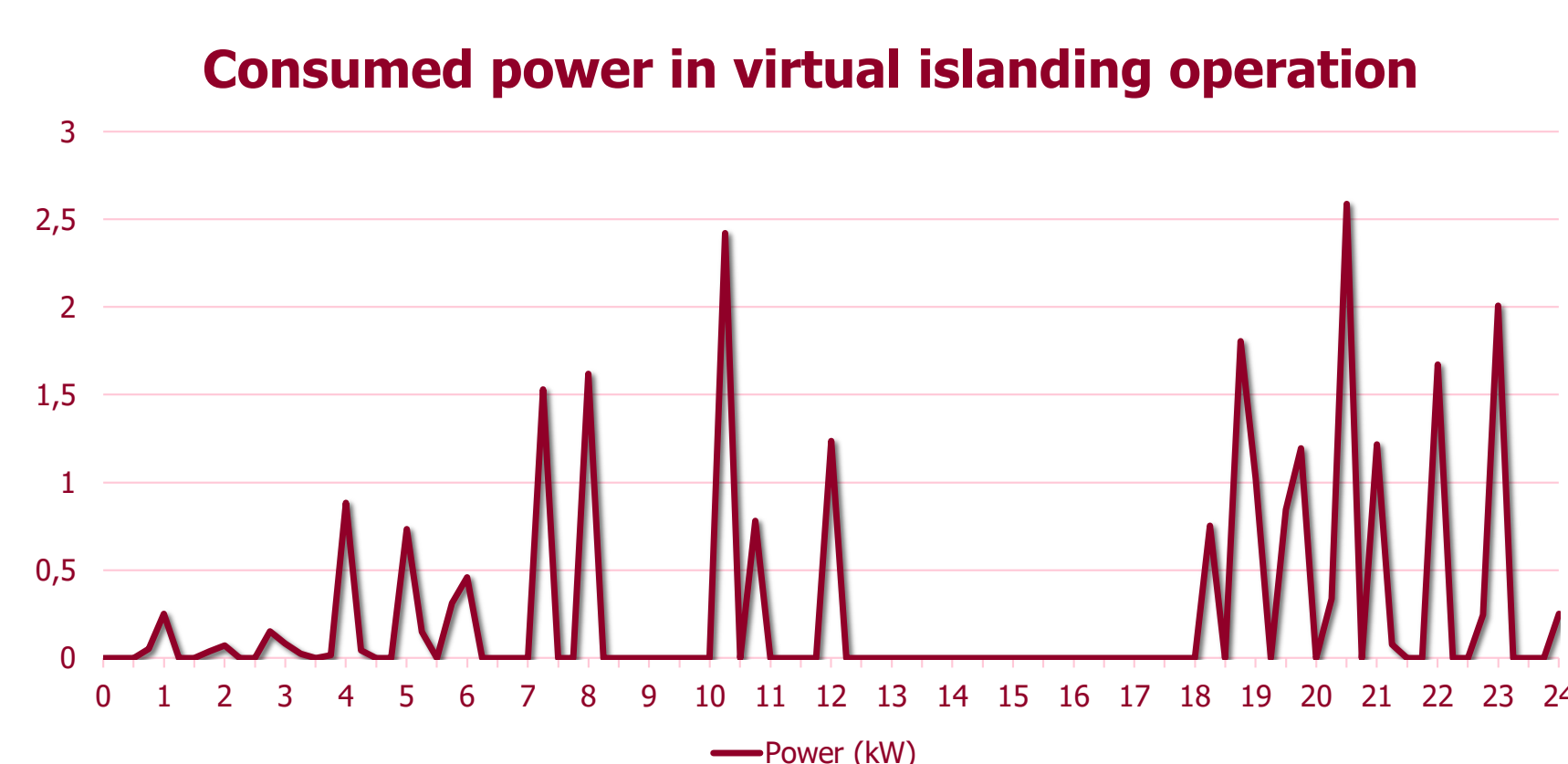
Technology parameters and controlling strategies

Input data and functions

Name	Dimension	Function
Start	hour	Starting time of the simulation
Step	hour	Time step
Stop	hour	Stopping time of the simulation
StorageStrategy	integer	Controlling strategy selection
Efficiency	%	Efficiency of the storage installation
Energy	MWh	Starting charging level
Response	hour	Response time
Sizing	I/H	Sizing strategy set
MidPrice	\$/MWh	Median of the prices
UpLimit	\$/MWh	Selling limit
LowLimit	\$/MWh	Buying limit
MaxCycle	integer	Cycle number
Power	MW	Nominal power
Capacity	MWh	Nominal capacity
SwitchOff	hour	Switches off an element at a definite time
SwitchBack	hour	Switches on an element at a definite time



Simulation results of different operations



Evaluation and conclusions

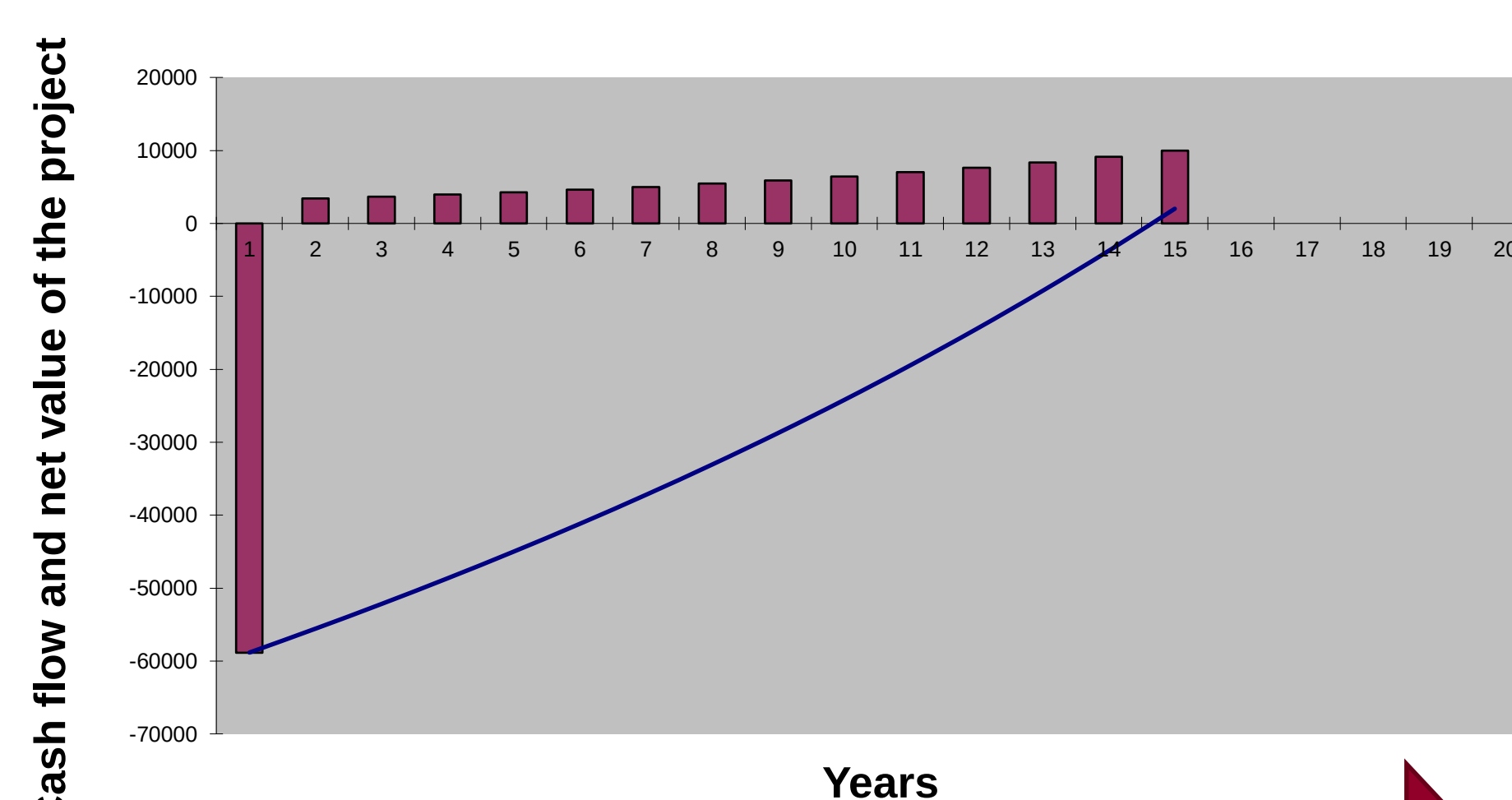
This study shows a possible way for proper evaluation. Further spreading of storage systems depends on the economic success.

Storage systems could be technically useful and also cost-competitive if the controlling strategies and the input parameters are coherent, so proactive planning is crucial

The possibility of aggregated operations is a key advantage. With locally optimized controlling (adaptive and predictive elements) storage could be a holy grail for the upcoming challenges

Valid data for economic analysis

Return on Investment Calculations



Result: decision making support

Benefits realized:

- Reliability
- Capability of islanding operation
- Reactive power compensation
- Optimized trading on the liberalized electricity market
- Voltage support

Expenses
Risks
Reward
Calculate ROI = \$\$\$

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