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PROTASIS 20 YEARS
engineering & consulting
with power, we perform

Driving the energy transition with BESS

Solutions for future energy systems

energy@copadata.com | 2023

A brief discussion about technology and practice…

- What is the purpose of large-scale BESS, and where is the industry heading?
- Discussing major concepts and functions of effective O&M software for BESS…
- Case Study: The application of BESS in one of the most modern refineries in Europe

Presenters

COPA-DATA
Partner Community

Stefan Hufnagl
Industry Specialist Energy
COPA-DATA

Lewis Williams
Industry Specialist Energy
COPA-DATA

George Arvanitis
Head of Systems
Integration Division at
PROTASIS SA

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Webinar Housekeeping

- **50 min presentation time**
- **10 min Q&A**

- You will receive a weblink to summary and wrap-up page after soon after the webinar session
  (Session recording, sample project download)

- This session is recorded

- Submit your questions

State of play..

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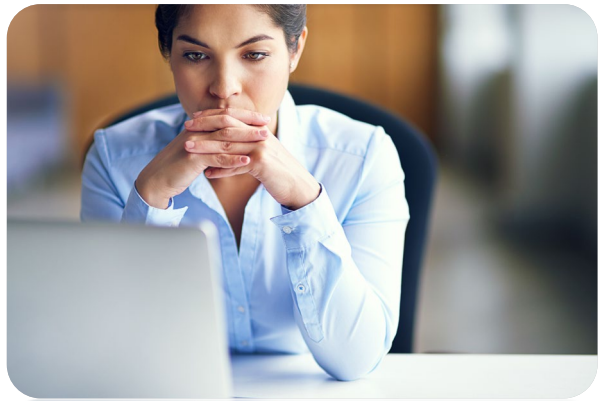
Energy Industry Challenges and Drivers in the 2020s



| Increasing dynamics in the grid

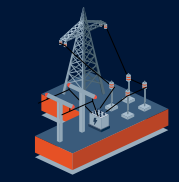
- Movement towards renewables
- Grid expansion and stabilization
- Increased electrification
- Desire for self sufficiency

| Entrepreneurial

- Efficient asset operation
- CAPEX / OPEX
- Dealing with technical and commercial volatility
- Investing in new forms of energy management

| Socio Economic

- Climate Consciousness
- Technical Skillset
- Dealing with complex systems

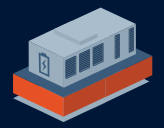


Substation

Solar PV

Wind Power

Hydro Power



Battery ESS

Network Control

HVDC

EV-Charging

The role of large-scale BESS

Use cases across the electrified industry

Electricity Transmission and Distribution Sector

- Grid Stabilization
- Infrastructure Support (Investment Deferral)
- Frequency Regulation
- Spinning Reserve
- Demand/Response Balancing

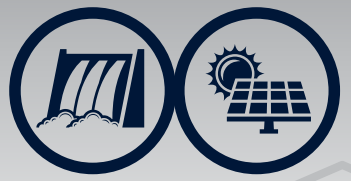
Renewable Generation

- Storage and economic dispatch
- Capacity Firming
- Generation shifting
- Participation in whole-sale electricity markets

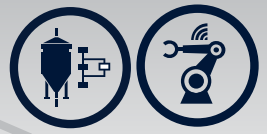
Industrial and Commercial Sector

- Microgrid support
- Self Sufficiency
- Economic Energy Sourcing
- Backup Power
- Electric Vehicle Fleet Operations
- Second-Life battery usage models

Utilities



Independent Power Providers



Process / Raw Materials Manufacturing Industry

Public Sector

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A glance on the BESS market

Large-scale energy storage - on the rise

Motivators

- Cost and Performance Improvements
- Grid Modernization Programs
- Global movement towards renewables
- Participation in wholesale electricity markets
- Financial incentives | National policy
- Desire for self-sufficiency

Impediments

- Perception of high prices
- Lack of standardization
- Outdated regulatory and market design

Online Source: https://www.energy-storage.news/large-scale-battery-storage-plant-chosen-by-california-community-as-alternative-to-gas-goes-online/

Further trend

- From grid ancillary services to intraday market
- Growing capacities from 10 to 100 MWh and larger
- Alternative battery technologies

CAGR till 2030: **~25%**

Insights in BESS operations and software

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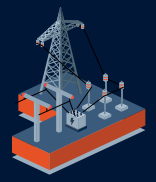
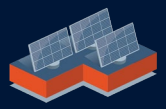


Substation



Solar PV

Wind Power

Hydro Power

Battery ESS

Network Control

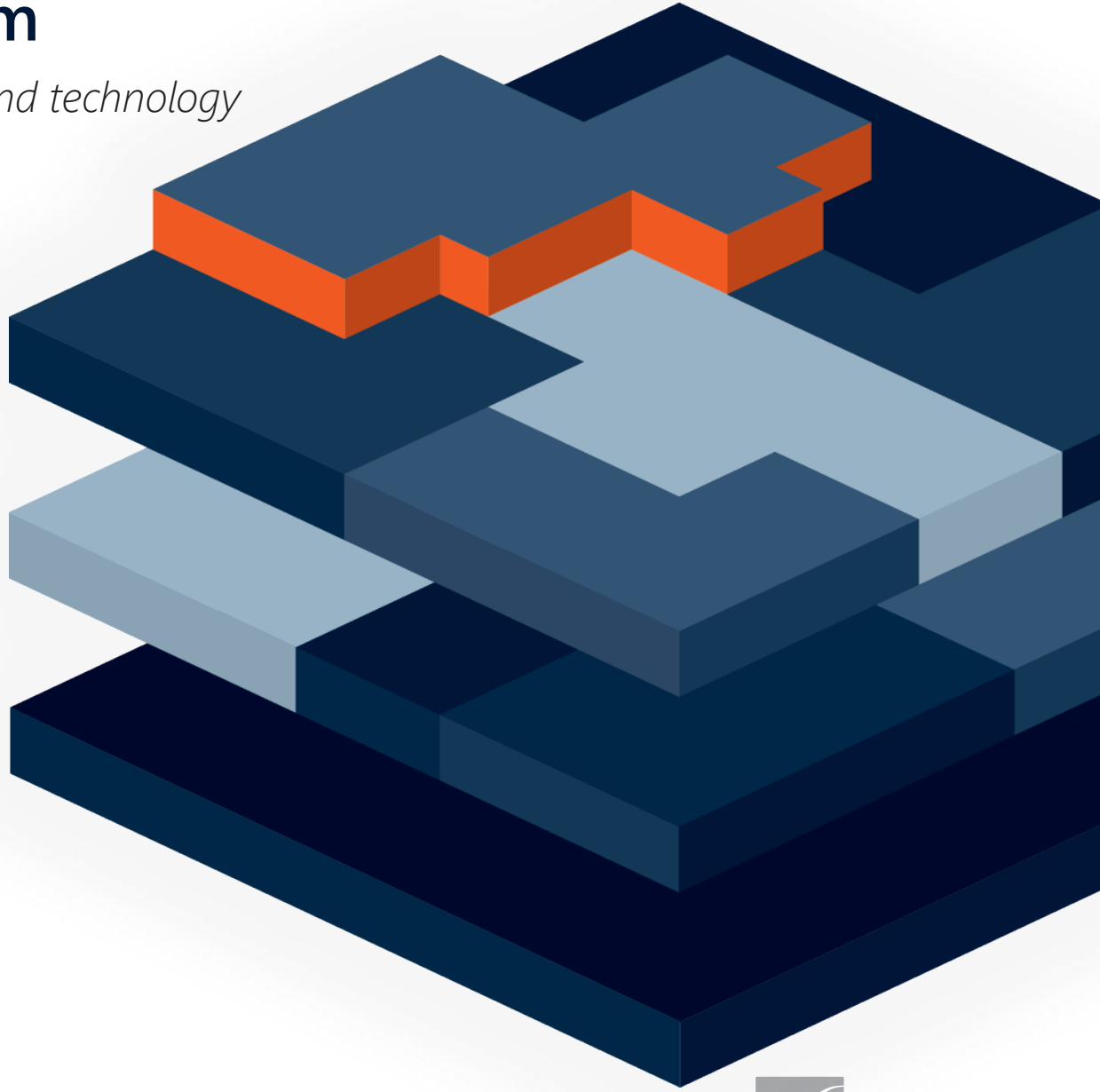
HVDC

EV-Charging

zenon Software Platform

Effective integration of energy systems and technology

- Data Acquisition
- Data Management
- Visualization and Control
- Reporting and Analytics
- Application Engineering and Maintenance



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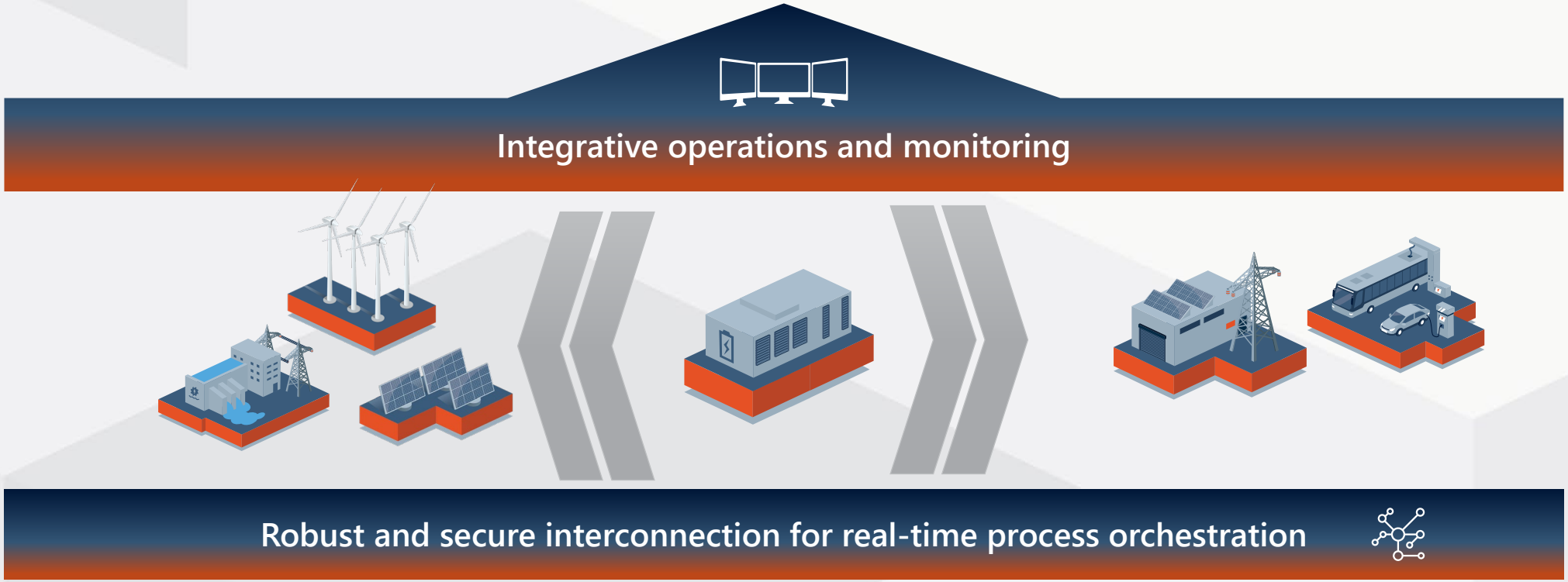
ESS solutions across the electrified industry

ESS – Integrative Operations

- Realtime Monitoring and Operation
- Local/Remote visualization and control
- State of Charge / State of Health Monitoring
- Control Room and Microgrid Operations
- Integration with auxiliary energy systems
- Performance Analysis and Reporting



Live Demo

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zenon Application Set for Battery Energy Storage System SCADA

- Leverage the benefits of battery energy storage all the way from residential to utility scale levels.
- Control, monitor and optimize your battery storage system with professional Energy Storage Management Software.
- Interconnect your battery storage assets with other entities in the smart grid environment.
- Capitalize on a vendor-independent solution

Get FREE BESS SCADA Application Set

Flexible project template

Out-of-the-box connectivity

Ready to use component templates

Visit copadata.com/energy

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Driving the energy transition with BESS

A success story by PROTASIS 20 YEARS engineering & consulting

George Arvanitis | 22/02/2023

About me

George Arvanitis

Head of Systems Integration Division

Electrical & Computer Engineer

MSc on Energy Production and Management

15 years in #teamprotasis

About us

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engineering & consulting
with power, we perform

Est. 2002

Services & solutions

for Transmission and Distribution utilities, Power Generation companies and industrial facilities

Power Systems Engineering and Consulting

100+ customers

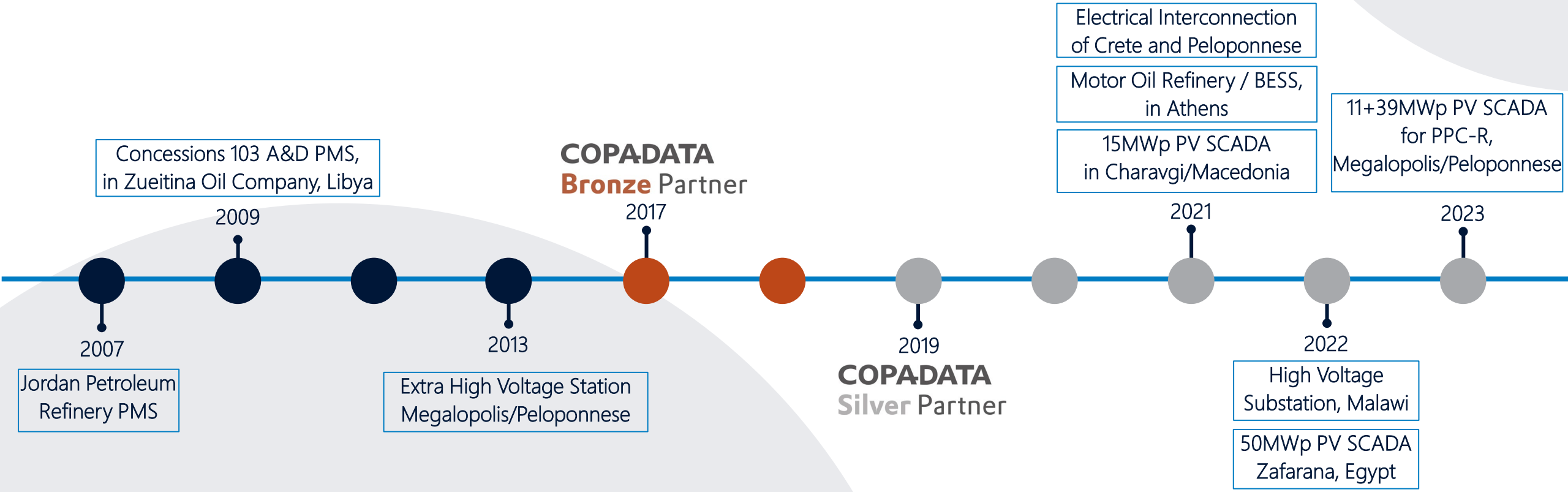
20+ countries

3 continents EMENA

Private & independent

the PROTASIS and COPA-DATA story

More than 50 successful projects have built a bond of mutual trust and respect



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Our Success Story

A BESS management system by PROTASIS
installed in one of the finest refineries in Europe

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About BESS

Why BESS are on trend for the Green Energy Transformation of electrical networks?

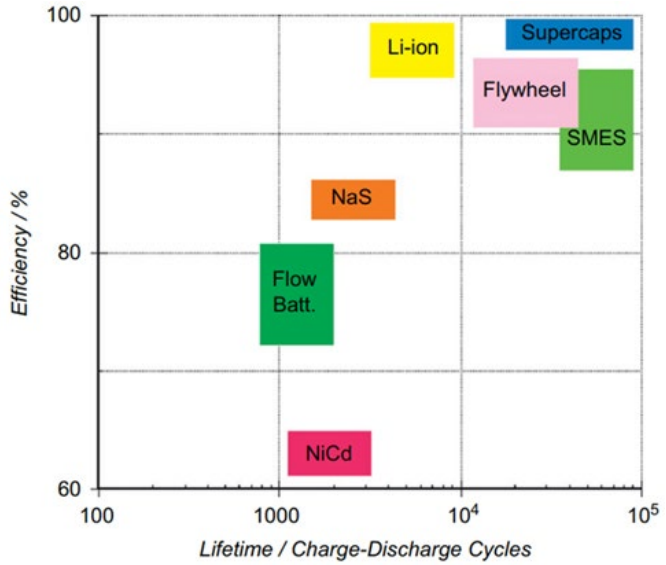
- Increase of renewables (RES) integration
- Installation to counterbalance the stochastic nature of RES units
- Increased flexibility of distributed generation units
- Increased efficiency of existing electrical networks (industrial networks, transmission/distribution systems, etc.)

BESS meets a wide range of applications, such as hybrid systems using RES, microgrids, interconnected and non-interconnected electrical networks, industries, etc.

BESS technologies & characteristics

Main BESS technologies

- Lead-acid
  - ⊕ low cost
  - ⊕ "maturity" of technology
  - ⊕ large operating temperature range
- Nickel-cadmium (Ni-Cd)
  - ⊕ high reliability
  - ⊕ higher power & energy density
  - ⊕ longer lifetime
- Sodium-sulfur (NaS)
  - ⊕ fast charge/discharge capabilities (power quality support & peak shaving services)
- Lithium-ion (Li-ion)
  - ⊕ high energy density
  - ⊕ longer lifetime
- Flow batteries
  - ⊕ fast power response charging to discharging and vice versa



Source: Peter J. Hall, Euan J. Bain, "Energy-storage technologies and electricity generation", Energy Policy, Volume 36, Issue 12, 2008

The choice of the appropriate battery technology depends on the special characteristics and requirements of each application:

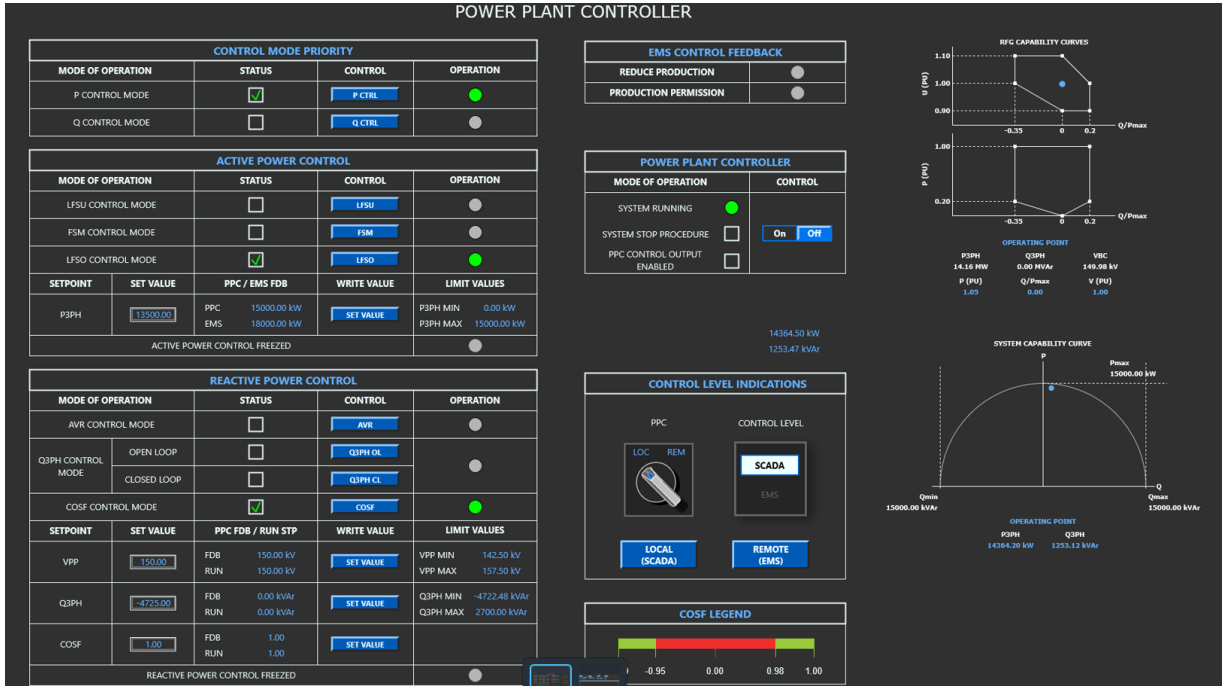
- required energy/power density
- aging factor
- maintenance requirements
- cost etc.

Benefits of BESS operation

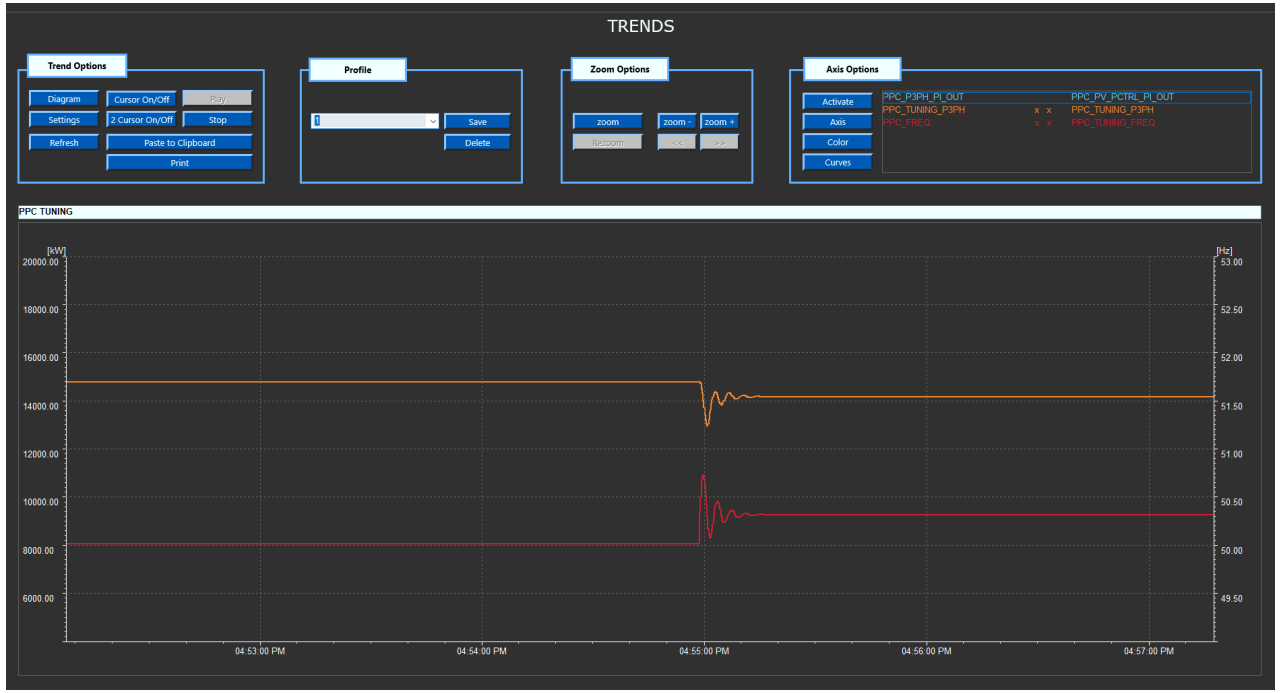
- RES power fluctuation smoothing
- Electrical losses reduction
- Backup supply
- Voltage & frequency support
- Reactive power regulation (power factor correction)
- Black-start functionality
- Transmission and distribution upgrade deferral
- Environmental benefits

Benefits of BESS operation

❑ Management System User Interface



❑ Frequency support functionality



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Success Story of BESS integration / The Motor Oil Refinery Project

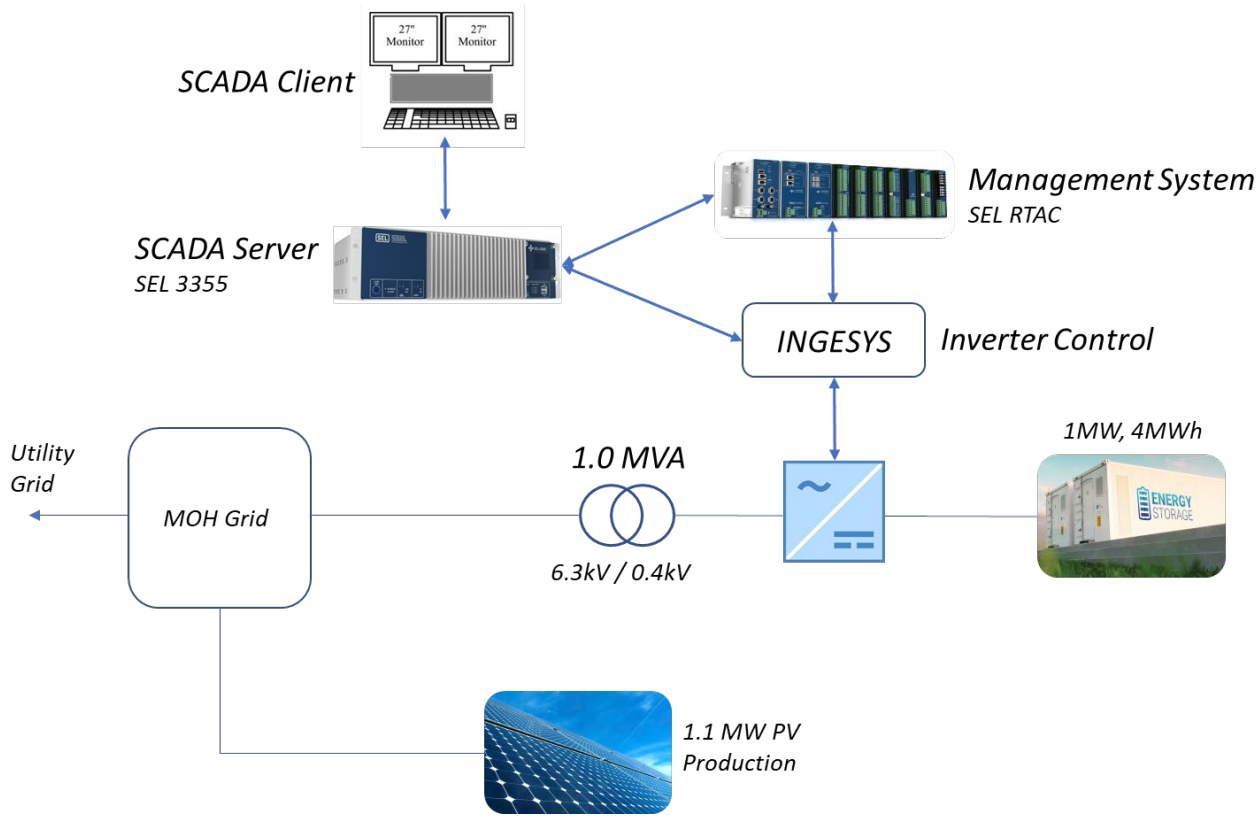
Success Story of BESS integration / The Motor Oil Refinery Project

Installation of 1MW/4MWh/Znyth BESS technology /
Key objectives

- Energy upgrade of the existing industrial system
- Greater flexibility at peak hours
- Optimization of demand profile

PROTASIS Power Management System (PMS) /
Key objectives

- Safe integration with the central monitoring and control system of the refinery electrical network
- Coordination and communication with the battery charging/discharging supervisory controller
- Reduction of active power injection to the utility grid



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Success Story of BESS integration / The Motor Oil Refinery Project

Basic components of the provided PMS

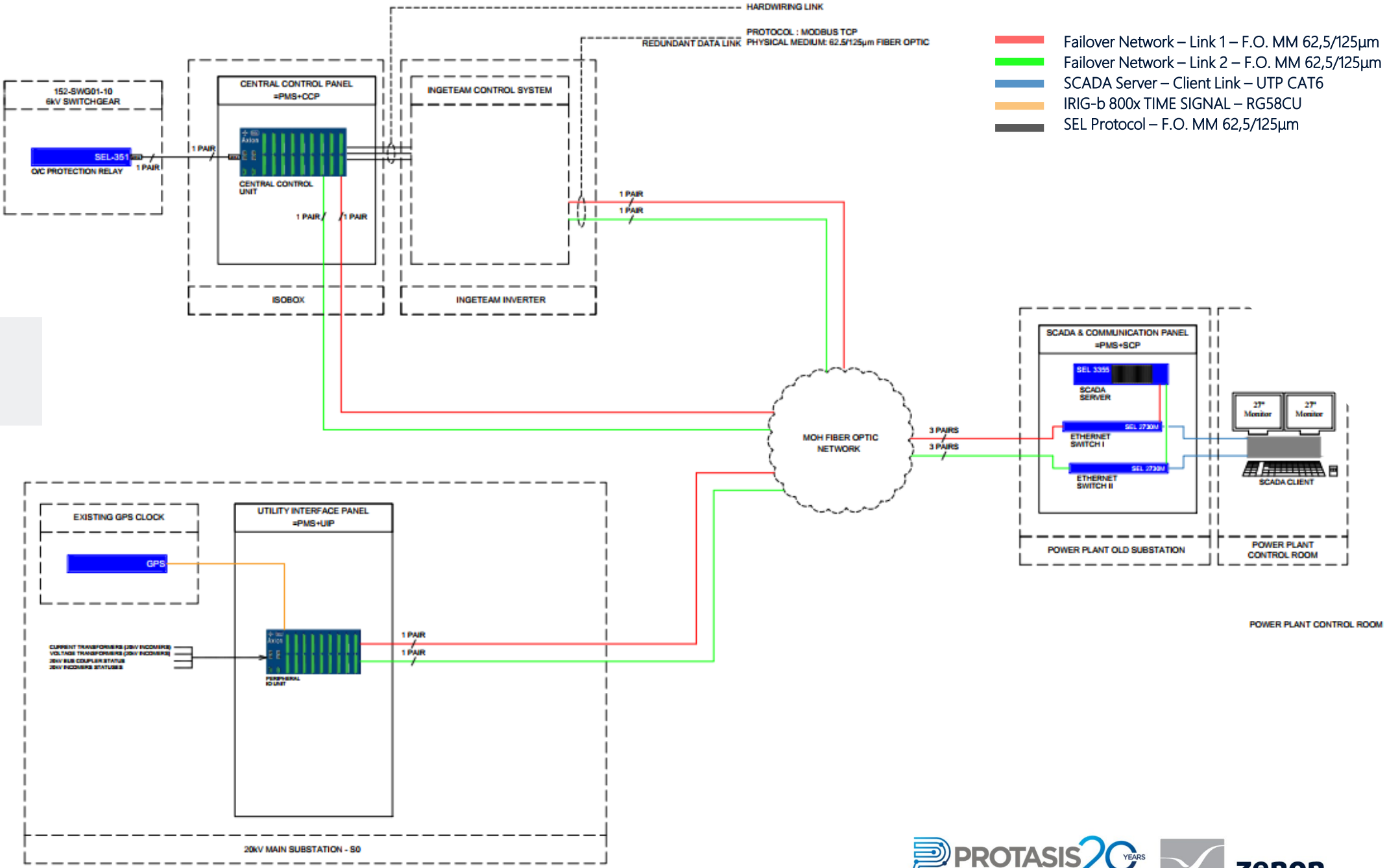
1. Central Control Unit (SEL 2240 AXION system)
   - Performs all required control processes
   - Communicates with INGESYS controller through MODBUS TCP redundant link
   - Implements hardwire interface with INGESYS controller for critical signals exchange
   - Collects information from Peripheral I/O unit
   - Interacts with SCADA system

2. Peripheral I/O unit (SEL 2240 AXION system)
   - Collects CT/VT measurements and statuses of Grid interconnection bays
   - Provides information to the Central Control Unit

3. Ethernet switches for data network implementation (SEL-2730M, redundant network)

4. SCADA server / client equipment (SEL-3355 computing system – zenon energy edition software platform)

Data Network Architecture

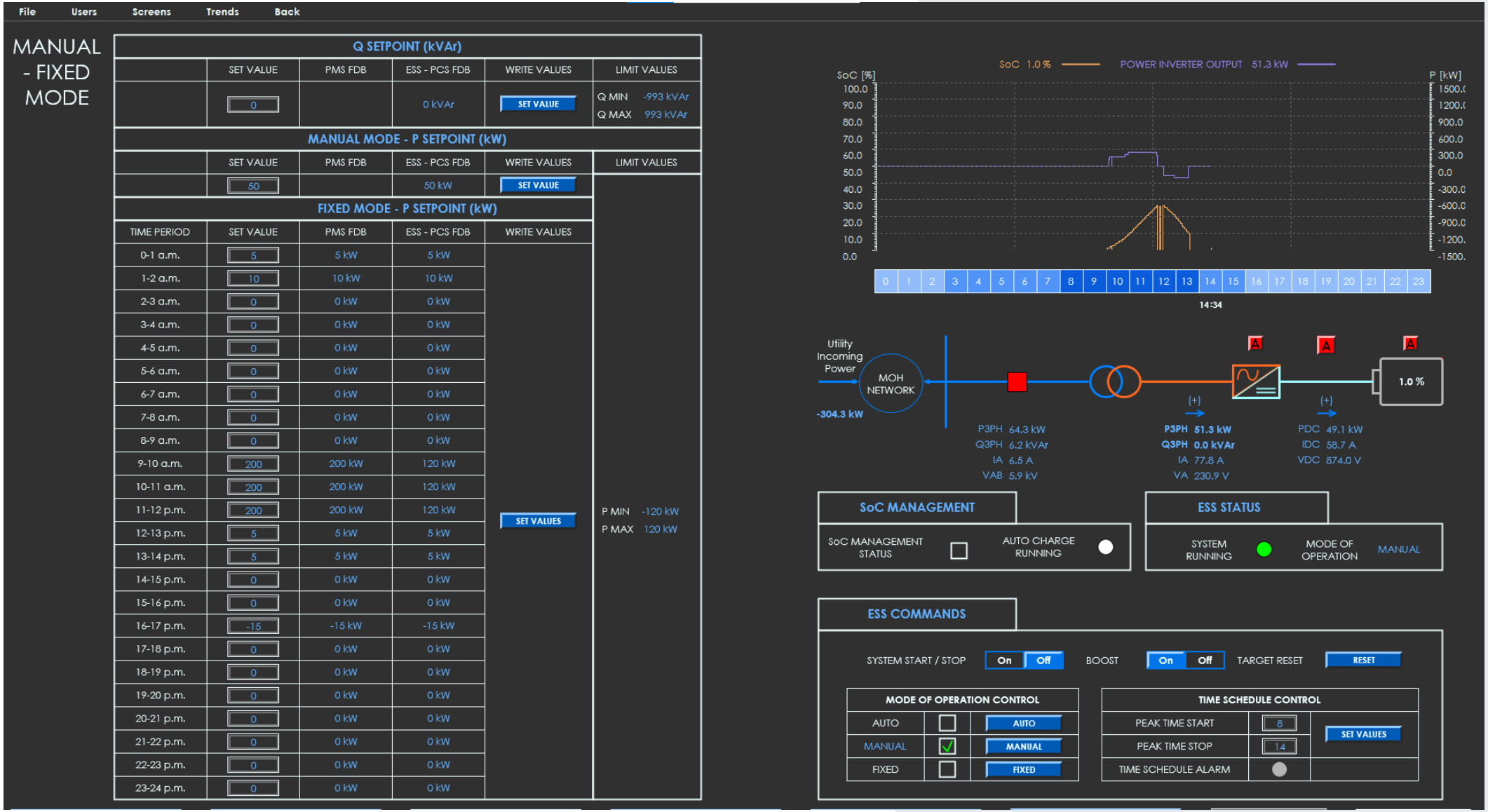


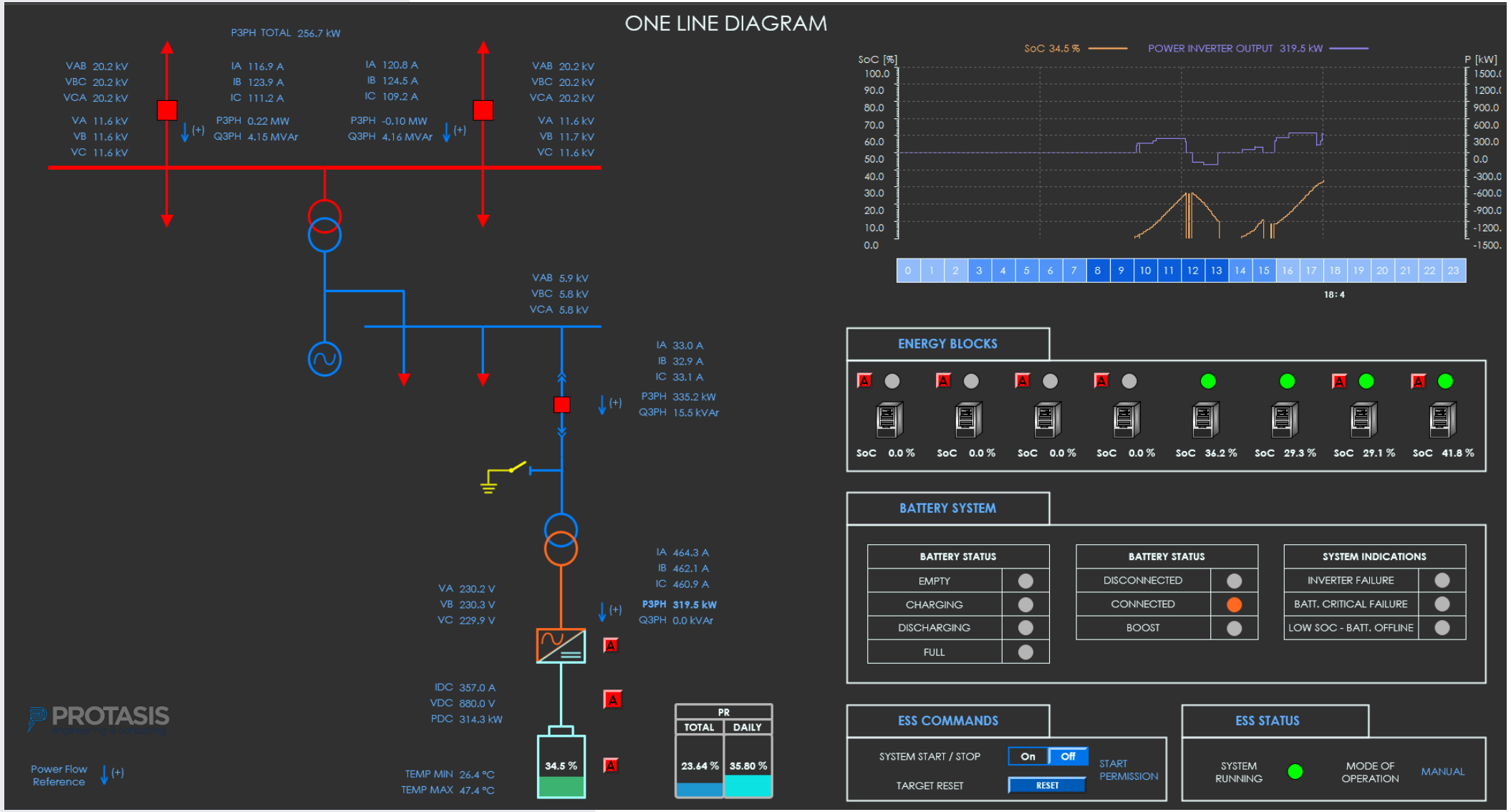
Success Story of BESS integration / The Motor Oil Refinery Project

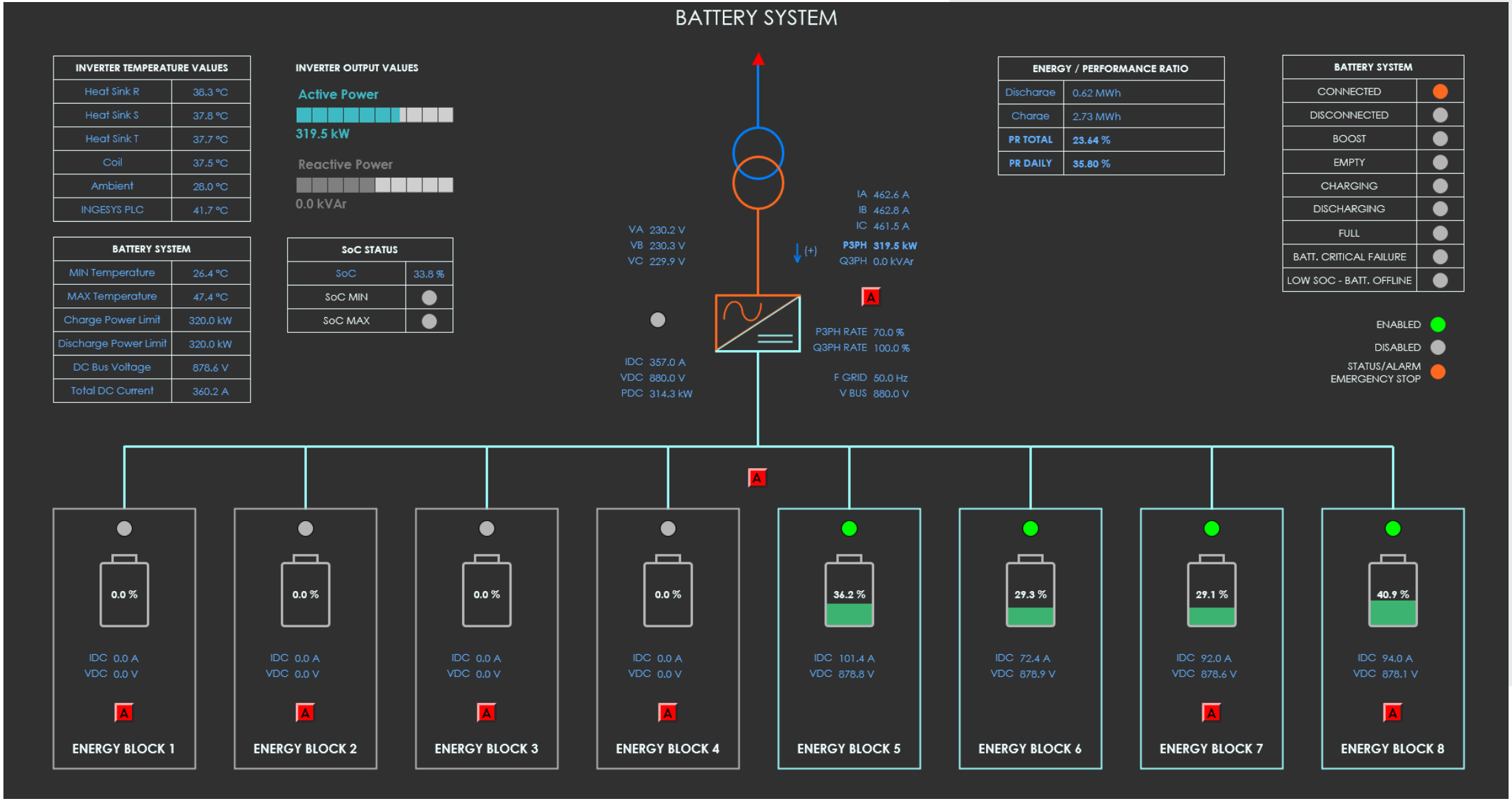
The three options of the power management strategies

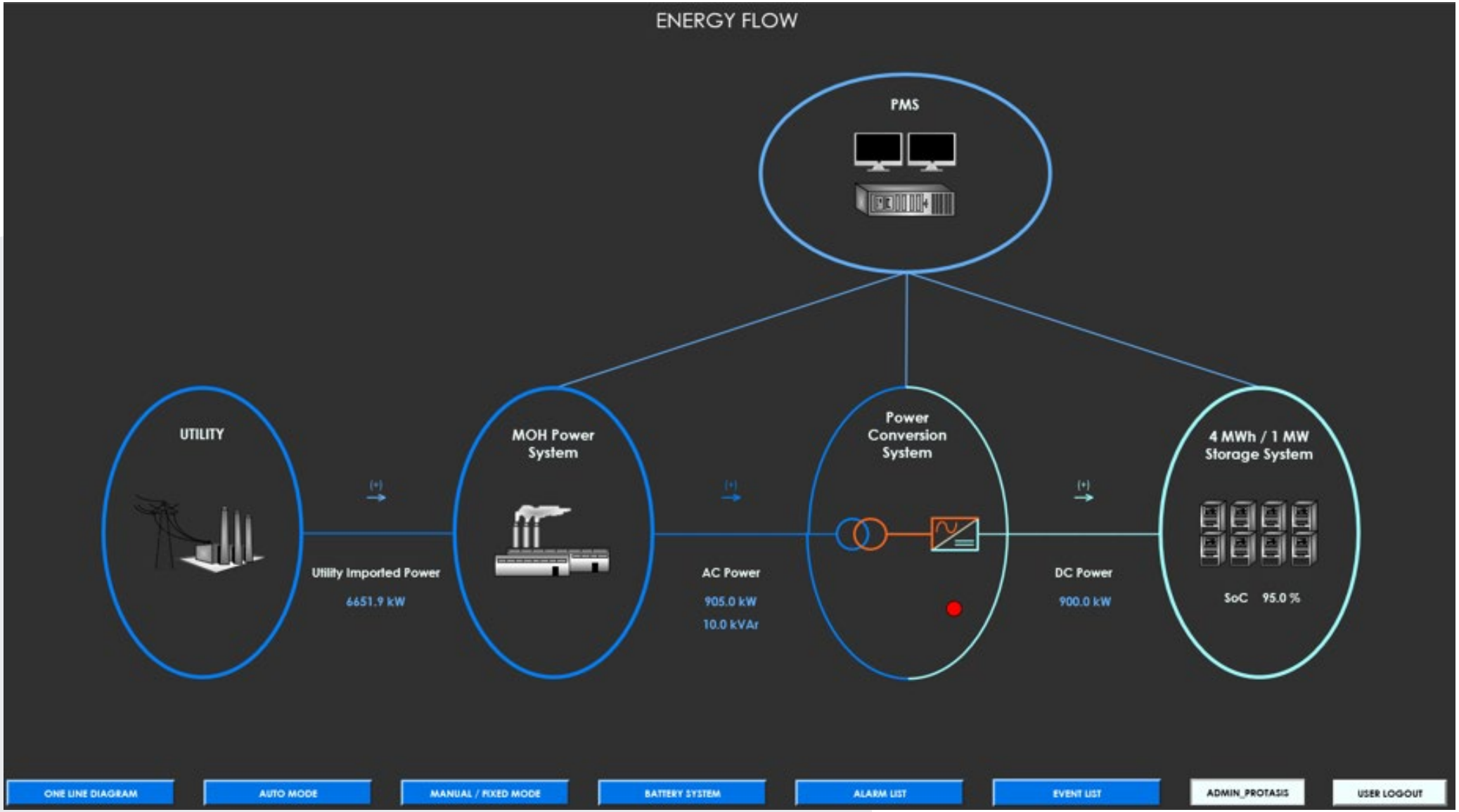
Manual mode	▪Application of active and reactive (P&Q) power setpoints to INGESYS controller through MODBUS TCP protocol
Automatic control	▪Exchange of active power with the central electrical network by a predetermined level during the period of off-peak hours ▪Reduction of active power injection to the main utility grid during peak hours
Fixed 24-hour charge/discharge cycle	▪The PMS function is mainly characterized by supervision of the energy storage system ▪The INGESYS controller performs the programmed charge/discharge cycle based on a daily active power curve


AUTO MODE
ESS INDICATIONS
RAISE PULSE
LOW PULSE
PULSE RESPONSE ALARM
Q SETPOINT (kVAr)
SET VALUE
ESS - PCS FDB
WRITE VALUE
LIMIT VALUES
0
0 kVAr
SET VALUE
Q MIN -1000 kVAr
Q MAX 1000 kVAr
OFF PEAK PERIOD - P SETPOINT (kW)
DESCRIPTION
SET VALUE
PMS FDB
ESS - PCS FDB
WRITE VALUES
LIMIT VALUES
Utility Power Exchange
0
0 kW
SET VALUE
P MIN 5478 kW
P MAX 5478 kW
Utility P3PH Without ESS - Daily Average
5477.5 kW
Utility P3PH Curves
TREND
UTILITY SETPOINT - ESS CHARGING POWER LIMITATION
UTILITY SETPOINT - ESS DISCHARGING POWER LIMITATION
DESCRIPTION
SET VALUE
STORED VALUE
ACTIVE VALUE
WRITE VALUES
LIMIT VALUES
ESS Minimum Power
0
0 kW
0 kW
SET VALUE
P MIN 0 kW
P MAX 0 kW
ESS Charging Power
0
0 kW
0 kW
SET VALUE
P MIN 200 kW
P MAX 0 kW
OFF PEAK TO PEAK PERIOD - P SETPOINT (kW)
DESCRIPTION
SET VALUE
PMS FDB
ESS - PCS FDB
WRITE VALUES
LIMIT VALUES
ESS Charging Power
250
250 kW
0 kW
SET VALUE
P MIN 200 kW
P MAX 0 kW
PEAK PERIOD - P SETPOINT (kW)
DESCRIPTION
SET VALUE
PMS FDB
ESS - PCS FDB
WRITE VALUES
LIMIT VALUES
Peak Discharge
0
0 kW
0 kW
SET VALUE
P MIN 0 kW
P MAX 0 kW
Utility Power Exchange Threshold
4
4 kW
SET VALUE
P MIN 0 kW
UTILITY POWER EXCHANGE THRESHOLD VIOLATION - DISCHARGE LIMITATION
ESS RELEASED FOR PEAK DISCHARGE POWER
PEAK TO OFF PEAK PERIOD - P SETPOINT (kW)
DESCRIPTION
SET VALUE
PMS FDB
ESS - PCS FDB
WRITE VALUES
LIMIT VALUES
ESS Charging Power
458
458 kW
0 kW
SET VALUE
P MIN 200 kW
P MAX 0 kW
SoC 95.0 %
POWER INVERTER OUTPUT 905.0 kW
SoC [%]
P [kW]
11:48
Utility Incoming Power
MOH NETWORK
6736.7 kW
5831.7 kW Without BESS
P3PH 100000.0** kW
IA 0.0 A
VAB 5.8 kV
P3PH 905.0 kW
IA 1455.0 A
VA 232.9 V
PDC 900.0 kW
IDC 1800.0 A
VDC 500.0 V
95.0 %
SoC MANAGEMENT
SoC MANAGEMENT STATUS
AUTO CHARGE RUNNING
ESS STATUS
SYSTEM STOPPED
MODE OF OPERATION
MANUAL
PEAK PERIOD CTRL ERROR -905.0 kW
OFF PEAK PERIOD CTRL ERROR -905.0 kW
ESS COMMANDS
SYSTEM START / STOP
On
Off
TARGET RESET
RESET
MODE OF OPERATION CONTROL
AUTO
MANUAL
FIXED
TIME SCHEDULE CONTROL
PEAK TIME START
18
PEAK TIME STOP
23
SET VALUES
TIME SCHEDULE ALARM
ONE LINE DIAGRAM
AUTO MODE
MANUAL / FIXED MODE
BATTERY SYSTEM
ALARM LIST
EVENT LIST
ADMIN_PROTASIS
USER LOGOUT


File
Users
Screens
Trends
Back
MANUAL - FIXED MODE
Q SETPOINT (kVAr)
SET VALUE
PMS FDB
ESS - PCS FDB
WRITE VALUES
LIMIT VALUES
0
0 kVAr
SET VALUE
Q MIN -993 kVAr
Q MAX 993 kVAr
MANUAL MODE - P SETPOINT (kW)
50
50 kW
FIXED MODE - P SETPOINT (kW)
TIME PERIOD
0-1 a.m. 5 5 kW 5 kW
1-2 a.m. 10 10 kW 10 kW
2-3 a.m. 0 0 kW 0 kW
3-4 a.m. 0 0 kW 0 kW
4-5 a.m. 0 0 kW 0 kW
5-6 a.m. 0 0 kW 0 kW
6-7 a.m. 0 0 kW 0 kW
7-8 a.m. 0 0 kW 0 kW
8-9 a.m. 0 0 kW 0 kW
9-10 a.m. 200 200 kW 120 kW
10-11 a.m. 200 200 kW 120 kW
11-12 p.m. 200 200 kW 120 kW
12-13 p.m. 5 5 kW 5 kW
13-14 p.m. 5 5 kW 5 kW
14-15 p.m. 0 0 kW 0 kW
15-16 p.m. 0 0 kW 0 kW
16-17 p.m. -15 -15 kW -15 kW
17-18 p.m. 0 0 kW 0 kW
18-19 p.m. 0 0 kW 0 kW
19-20 p.m. 0 0 kW 0 kW
20-21 p.m. 0 0 kW 0 kW
21-22 p.m. 0 0 kW 0 kW
22-23 p.m. 0 0 kW 0 kW
23-24 p.m. 0 0 kW 0 kW
SET VALUES
P MIN -120 kW
P MAX 120 kW
SoC 1.0 %
POWER INVERTER OUTPUT 51.3 kW
SoC [%]
P [kW]
14:34
Utility Incoming Power
MOH NETWORK
-304.3 kW
P3PH 64.3 kW
Q3PH 6.2 kVAr
IA 6.5 A
VAB 5.9 kV
P3PH 51.3 kW
Q3PH 0.0 kVAr
IA 77.8 A
VA 230.9 V
PDC 49.1 kW
IDC 58.7 A
VDC 874.0 V
1.0 %
SoC MANAGEMENT
SoC MANAGEMENT STATUS
AUTO CHARGE RUNNING
ESS STATUS
SYSTEM RUNNING
MODE OF OPERATION
MANUAL
ESS COMMANDS
SYSTEM START / STOP
On
Off
BOOST
TARGET RESET
RESET
MODE OF OPERATION CONTROL
AUTO
MANUAL
FIXED
TIME SCHEDULE CONTROL
PEAK TIME START
PEAK TIME STOP
TIME SCHEDULE ALARM
SET VALUES




BATTERY SYSTEM
INVERTER TEMPERATURE VALUES
Heat Sink R 38.3 °C
Heat Sink S 37.8 °C
Heat Sink T 37.7 °C
Coil 37.5 °C
Ambient 28.0 °C
INGESYS PLC 41.7 °C
INVERTER OUTPUT VALUES
Active Power
319.5 kW
Reactive Power
0.0 kVAr
ENERGY / PERFORMANCE RATIO
Discharge 0.62 MWh
Charge 2.73 MWh
PR TOTAL 23.64 %
PR DAILY 35.80 %
BATTERY SYSTEM
CONNECTED
DISCONNECTED
BOOST
EMPTY
CHARGING
DISCHARGING
FULL
BATT. CRITICAL FAILURE
LOW SOC - BATT. OFFLINE
BATTERY SYSTEM
MIN Temperature 26.4 °C
MAX Temperature 47.4 °C
Charge Power Limit 320.0 kW
Discharge Power Limit 320.0 kW
DC Bus Voltage 878.6 V
Total DC Current 360.2 A
SoC STATUS
SoC 33.8 %
SoC MIN
SoC MAX
VA 230.2 V
VB 230.3 V
VC 229.9 V
IA 462.6 A
IB 462.8 A
IC 461.5 A
P3PH 319.5 kW
Q3PH 0.0 kVAr
P3PH RATE 70.0 %
Q3PH RATE 100.0 %
IDC 357.0 A
VDC 880.0 V
PDC 314.3 kW
F GRID 50.0 Hz
V BUS 880.0 V
ENABLED
DISABLED
STATUS/ALARM
EMERGENCY STOP
0.0 %
IDC 0.0 A
VDC 0.0 V
ENERGY BLOCK 1
0.0 %
IDC 0.0 A
VDC 0.0 V
ENERGY BLOCK 2
0.0 %
IDC 0.0 A
VDC 0.0 V
ENERGY BLOCK 3
0.0 %
IDC 0.0 A
VDC 0.0 V
ENERGY BLOCK 4
36.2 %
IDC 101.4 A
VDC 878.8 V
ENERGY BLOCK 5
29.3 %
IDC 72.4 A
VDC 878.9 V
ENERGY BLOCK 6
29.1 %
IDC 92.0 A
VDC 878.6 V
ENERGY BLOCK 7
40.9 %
IDC 94.0 A
VDC 878.1 V
ENERGY BLOCK 8



Proud of our job!

*The Motor Oil Refinery Project has been awarded in **2022 Energy Mastering Awards (Greece)** in three categories.*

Energy Intelligence Software

Energy Efficiency

Energy Storage Innovation

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Conclusions

- PROTASIS has successfully installed a high-level PMS to control and monitor the BESS unit of Motor Oil refinery electrical network, one of the most modern refineries in Europe
- BESS operation has been smoothly integrated to the existing electrical network and everyday needs of the refinery
- Successful integration with the central monitoring and control system of the refinery electrical network
- Provision of manual and automated regulation of active/reactive power injection
- User-friendly and non-complicated SCADA system for the refinery electrical grid operators supporting a complex system and integrating complex algorithms
- Fully expandable to integrate more power sources

Driving the energy transition with BESS – Q&A

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- Stay tuned for upcoming webinars and blogs
- Visit copadata.com/energy and www.protasis.net.gr

Enjoy driving the energy transition with BESS!

energy@copadata.com