Izazovi i rešenja u integraciji obnovljivih izvora energije u distributivnu i prenosnu mrežu

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OIE SRBIJA

Microgrids & Renewable Integration

Shaping the Energy Transition based on SICAM A8000

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Now is the time for sustainability. For a greener future

Major influences

- Climate Change
- CO_2 emission reduction
- Financial instability
- Data analytics
- Distributed generation
- Prosumers

Benefit from the opportunities the energy transition offers to you.

- Reduce your energy costs
- Manage your microgrid
- Control your PV-Plant
- Increase your energy independence
- Utilize efficiently your distributed generation assets

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Application examples

Hospital

Improve resilience with BESS

Industrial Site

Minimize demand charges

Shopping Center

Reduce CO_2 footprint

Campus

Integrate assets

Parking & Fleet

Decrease peak loads

Critical Infrastructure

Enhance reliability

Remote System

Operate automatically

City District

Control cross-commodity

Island

Downsize fuel consumption

Public Spa

Benefit from thermal control

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Our solutions for you

Renewable Generation

Industrial Prosumers

Grid connection

SICAM applications for

Microgrids
microgrids and decentralized energy systems

Power Management
generation assets and loads (incl. loadshedding)

Dynamic Load Management
e-car-charging infrastructures and other controllable loads

Photovoltaic Power Plants
PV power plants (incl. batteries) and hybrid power plants (incl. wind)

Residential

Commercial

Campus

Transportation

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Microgrid Control – a SICAM A8000 application
enables higher reliability and reduced energy cost

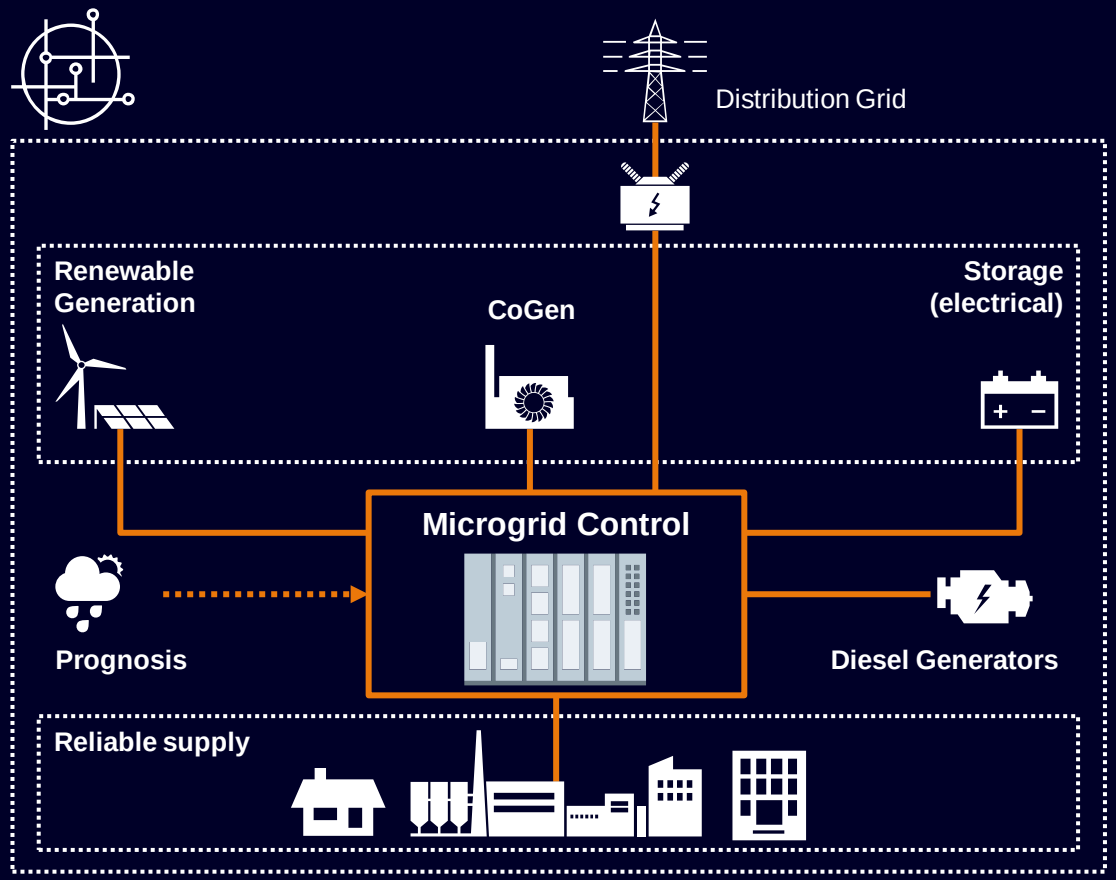
Basic Features

- Measuring
- Monitoring/ Reporting
- Storage Control
- Generation Control
- Archiving
- Load Control

Advanced Features

- Islanding / Black start
- Peak shaving
- Load forecasting
- Generation forecasting
- Load Management
- Generation Market access

Microgrid – Distribution grid with renewable generation, grid infeed and storage



Benefits of Microgrid Control

Own generation
- Ensures continuous load supply and production processes
- Increased independence from grid instabilities

Lower energy costs
- Economic optimization main grid supply vs. own generation

Decreasing CO_2 emissions
- Environmental optimization renewable vs. fossil generation

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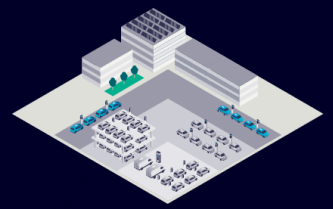
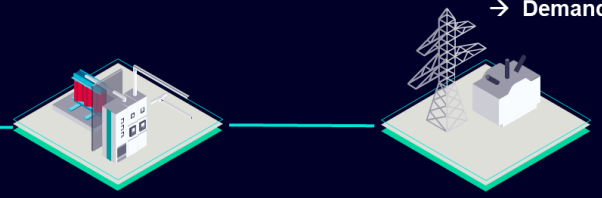
Dynamic Load Management – a SICAM A8000 application
Resilient, open and versatile



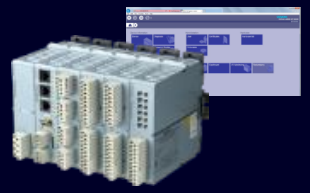
- Bus depots
- “Gas stations” and truck stops
- Logistic depots
- Parking garages and real estates
- Industrial and commercial sites

Avoid grid extension
Avoid transformer overload
→ **Peak shaving**

Peak demand charges
→ **Demand charge reduction**
Grid code (e.g. demand response)
→ **Demand reduction**



Dynamic Load Management



Various load management algorithms
- Split charging
- Split charging with priorities
- Round robin
- First in/ first out
- First in/ last out

Ambiguous connectivity
- OCPP 1.6J
- Modbus TCP
- IEC 60870-5-104, IEC 61850
- DNP 3

Resilient
- Not depending on cloud connectivity
- Rugged hardware

Efficient
- Flexible and open platform
- Minimum OPEX

Sustainable
- Minimum carbon footprint
- Efficient integration of on-site renewables

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Photovoltaic Plant Control – a SICAM application

Maximum efficiency in controlling Photovoltaic Power Plants

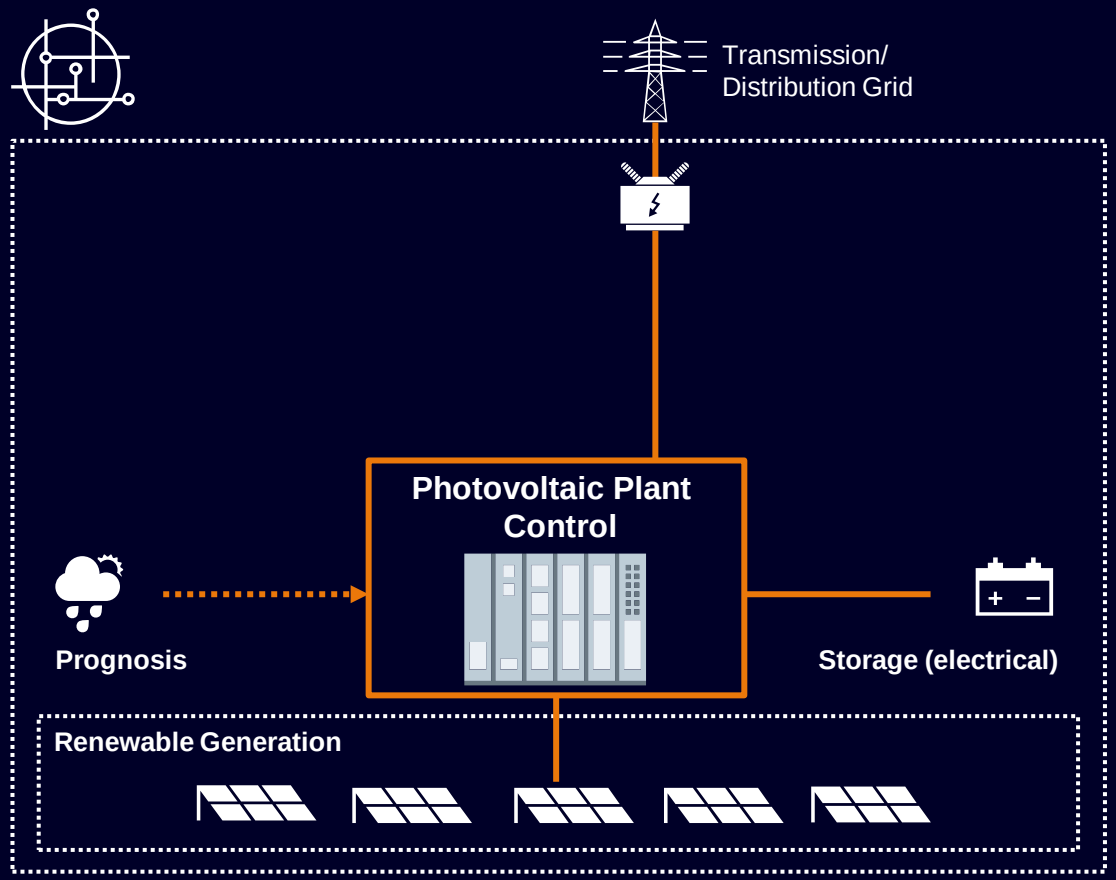
Basic Features

- Measuring
- Monitoring/ Reporting
- Storage Control
- Generation Control
- Archiving

Advanced Features

- Active power control
- Reactive power control
- Grid stability support

Photovoltaic Plant with renewable generation, grid infeed and storage



Benefits of Photovoltaic Plant Control

- Reliable, grid code conform control of supplied power by photovoltaic plants.
- Continuous supply of renewable energy by also integrating capacitor banks and battery storage systems
- Seamless integration and solid interplay between automation and remote control

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One for all use cases, where energy flows – SICAM A8000 Series

The design of the SICAM A8000 equipment series has been specifically tailored to meet market requirements and customer needs.

- From simple to complex, always adapted in line with the actual requirements of the area of application
- Fulfills highest cybersecurity requirements
- Use of standards ensures secure investment
- Reduced stock inventory thanks to modular platform
- Usable along the entire energy supply chain and the critical infrastructure

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SICAM A8000 at Glance …

Standards

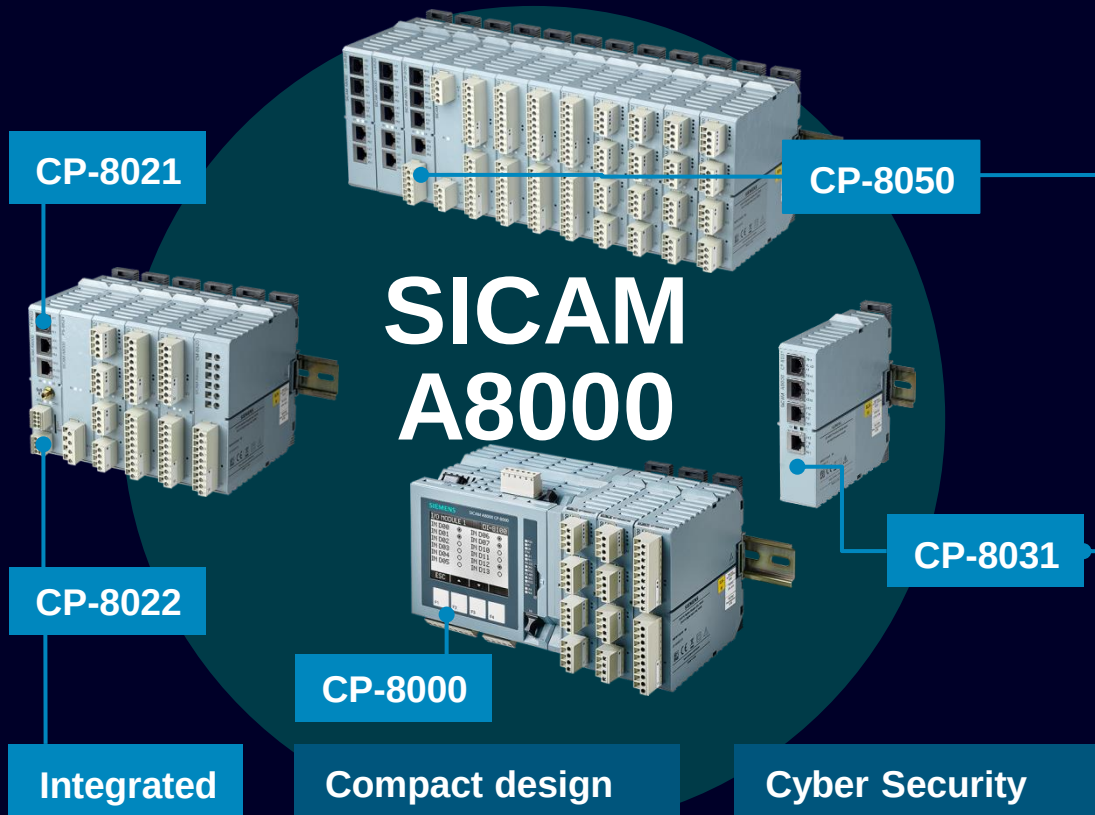
- Standard cable (RJ45, CAT5e)
- Standard technology (Ethernet, Webserver)

Compatibility

- SICAM TOOL BOX II integration
- Further use of CAExplus Logic
- TM I/O module

Reduced complexity

- No proprietary bus hubs (CM-084x)
- SICAM Web online functions in the device available without a license



Integrated GPRS modem

Compact design

- SICAM I/O modules are only 30 mm wide

Cyber Security

- Meets future security requirements

Interfaces

- Max. 8 extension modules
- Max. 16 I/O lines or max. 4 I/O racks
- Max. 34 interfaces (modular)
- Network functionality (TCP/IP protocol architecture, switching, HSR, PRP, RSTP)
- Redundancy

Performance

- Remote SICAM I/O modules possible (electrically or optical)
- Dual core CPU & memory

Interfaces

- Max. 8 extension modules
- 1 I/O line
- 4 interfaces (on board) 2x Ethernet, 2x serial

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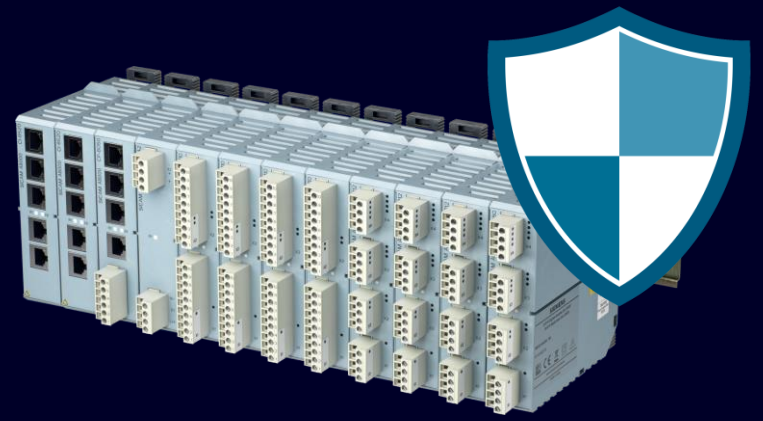
Cyber Security
SICAM A8000 - meeting the requirements of tomorrow



Firewall
For the separation of TCP/IP networks via integrated software firewall or additional hardware-based application firewall

Role Based Access Control
RBAC in accordance with IEC 62351-8 ensures that users may exercise only the rights that correspond to their assigned role

Firmware Signature
Protection against firmware manipulation

TLS encryption
Certificate based encryption acc. IEC 62351-3 for IEC protocols

Hardware-based-Firewall
Hardware-based-Firewall for IEC104 in conjunction with CI-8520. *License key required*

Secure and reliable https protocol
Guarantees the secure transmission of sensitive data

Password-protected access to SICAM TOOLBOX II
Ensures that only authorized persons can access your system

Compliant with BDEW White Paper
Fulfills the recommendations for secure and reliable control and communication systems

Security Logbook
Non-volatile storage of SYSLOG events

VLAN support
VLAN support acc. IEEE 802.1Q on CP-8031, CP-8050 and CI-8520

Configurable System Functions
Selective activation of individual or multiple system functions per communi-cations interface

Network Authentication
Certificate based network authentication acc. 802.1x

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Our control and automation solutions manage and optimize more than 10 GW of microgrids & renewable energy systems worldwide.

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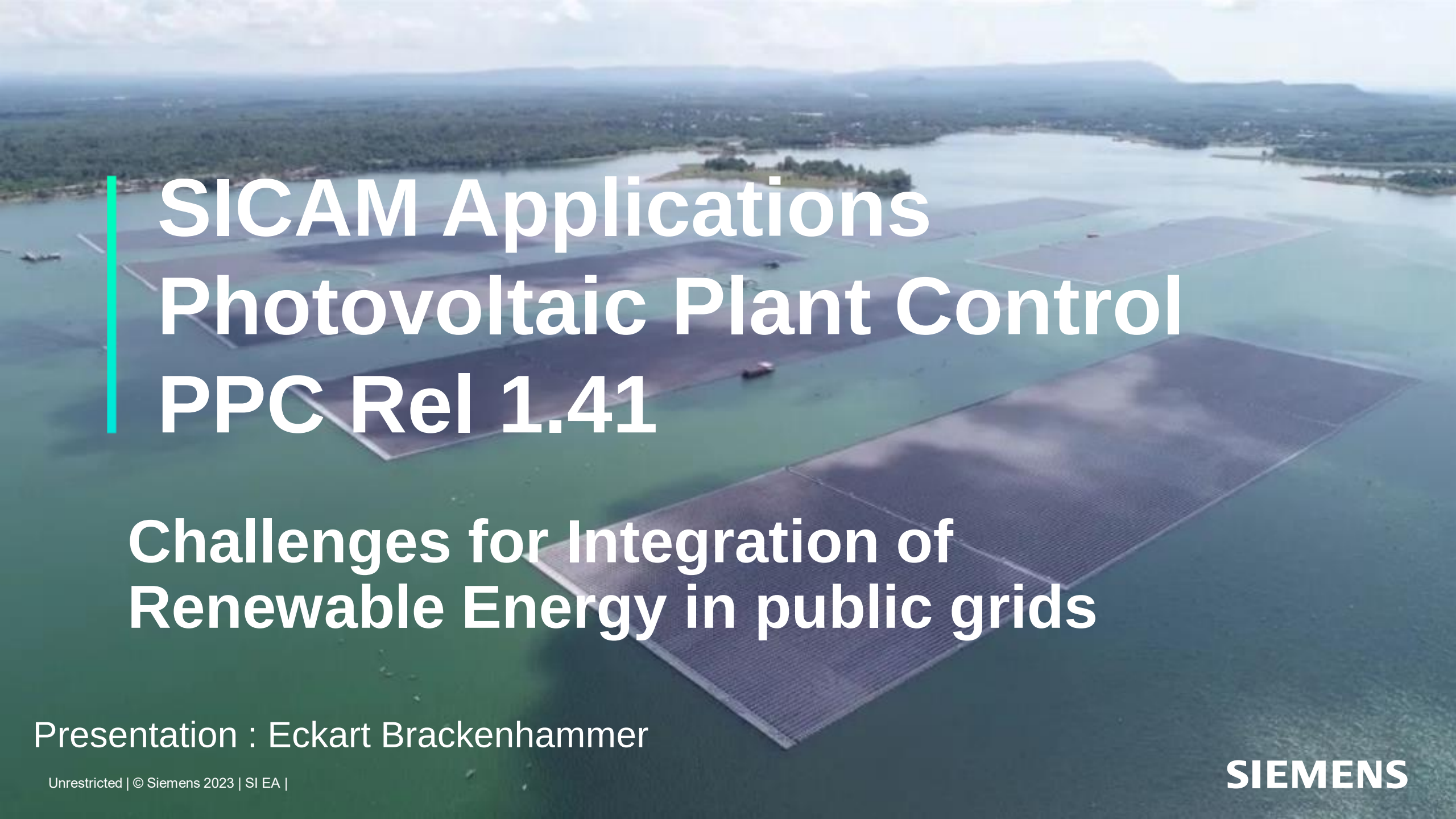

SICAM Applications Photovoltaic Plant Control PPC Rel 1.41

Challenges for Integration of Renewable Energy in public grids

Presentation : Eckart Brackenhammer

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Table of contents

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Introduction

- Renewable Energy power generation
- Inverter based resources (IBR’s)

Photovoltaic power plants basics – continuous development

η_{max} 97.1%

90 W/kg

2008: Powador XP 100

η_{max} 97.8%

330 W/kg

2011: Powador 60.0 TL3

η_{max} 98.5%

710 W/kg

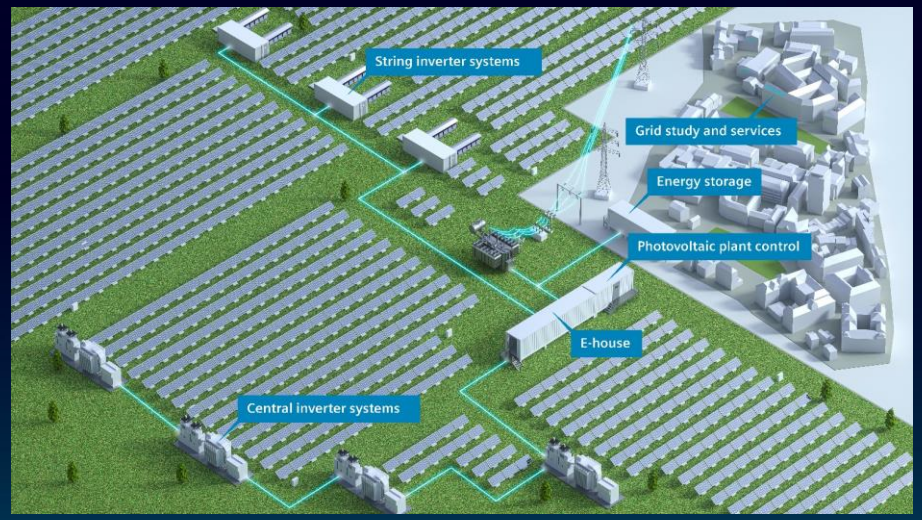
2016: blueplanet 50.0 TL3

η_{max} 99.2%

2,109 W/kg

2020: blueplanet 165 TL3

Photovoltaic power plants basics – Siemens EA's E-BoP & inverter offerings



Solution: PV electrical Balance of Plant (eBoP)

With fluctuating power generation and everchanging demand, innovative ideas are needed for PV installations to ensure consistently stable and reliable grid operation.

The PV eBoP solution from Siemens provides the right answer: a complete package of proven components, modern systems, and comprehensive service offerings.

Central inverter system:
A future-proof skid for large photovoltaic power plants

The PV skid is a convenient "plug-and-play" solution with maximum power density combining inverter, transformer, and ring main unit. The central inverter offers an integrated DC/AC distribution for high efficiency.

String Inverter system:
The centerpiece of decentralized solar power plants

The string inverters are flexible for decentralized design.

They are adapted to extreme climatic conditions and represent a cost-effective solution.

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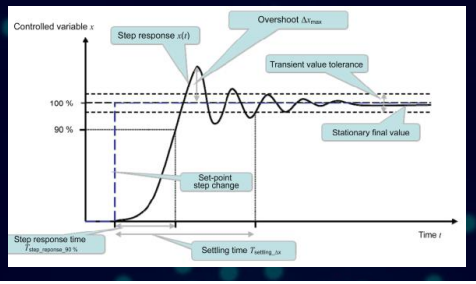
Procedures and Challenges

- General Procedure:
  - International rules and regulations for Grid Code requirements and upcoming challenges
  - Dynamic simulation models and verifying Grid Code compliance (Certification)
  - Commissioning and validating of dynamic models
- Additional Challenges
  - Fluctuating renewable energy
  - Battery energy storage systems (BESS)
  - Power generation forecast for scheduling
  - Power quality aspects

General procedure: Grid Code requirements – Active/reactive power requirements, FRT, …

Key Features - Grid conformity and future aspects



Active power control

Active power control modes

- Frequency dependent active power response
- Active power curtailment at PCC
- Ramp control with fixed gradients

Reactive power control

Reactive power control modes

- Absolute reactive power control
- Advanced reactive power control functions (Q limitation, Q-V-characteristic in over- and undervoltage range)
- Power Factor control (PF control, cos phi)
- Voltage Control

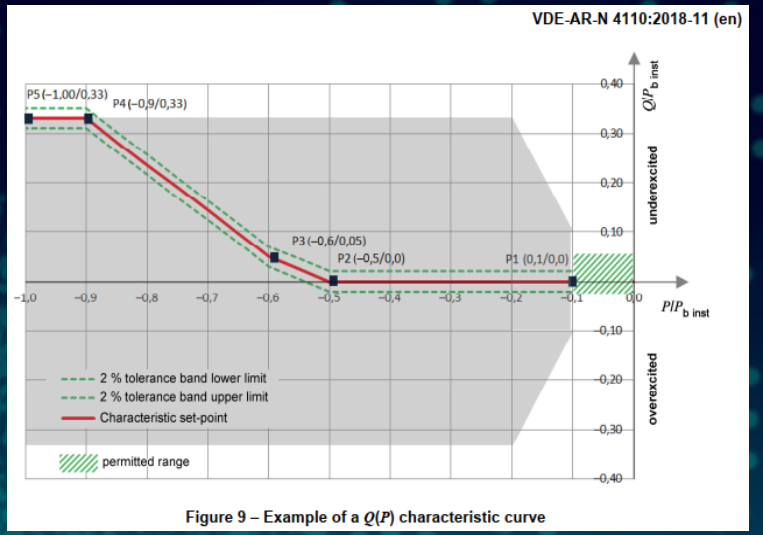
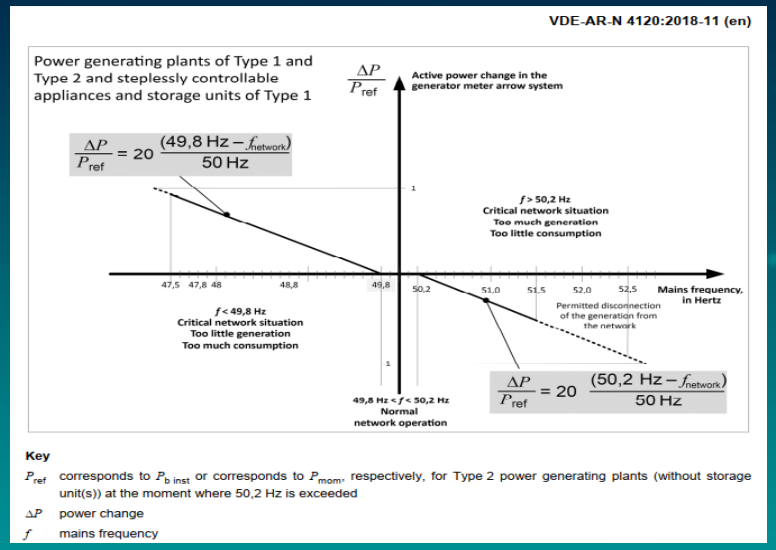


Figure 9 – Example of a $Q(P)$ characteristic curve



Key

P_{ref} corresponds to $P_{b\,inst}$ or corresponds to P_{mom}, respectively, for Type 2 power generating plants (without storage unit(s)) at the moment where 50,2 Hz is exceeded

ΔP power change

f mains frequency

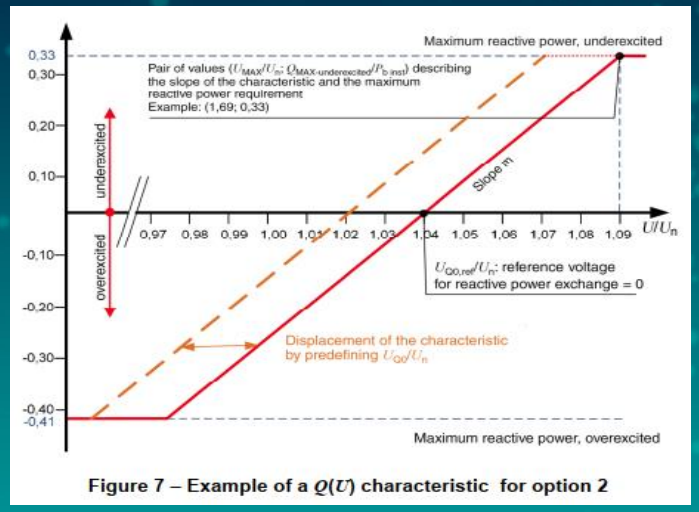


Figure 7 – Example of a $Q(U)$ characteristic for option 2

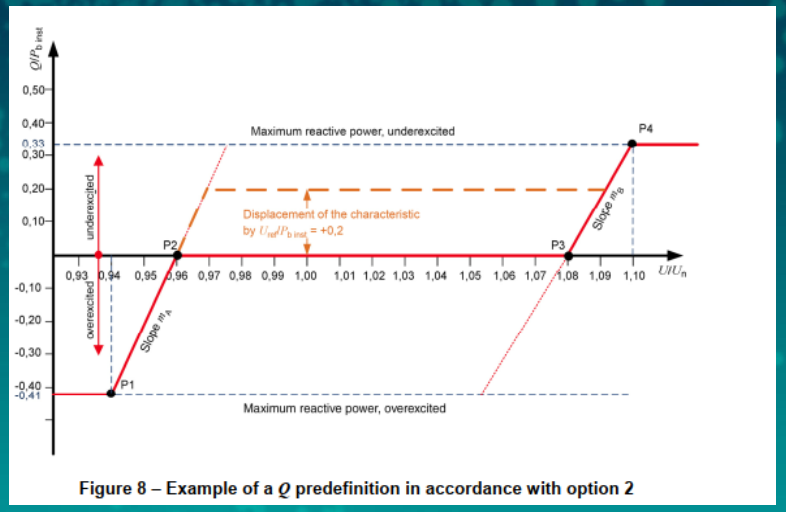


Figure 8 – Example of a Q predefinition in accordance with option 2

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Grid Code requirements – Grid stability support, …

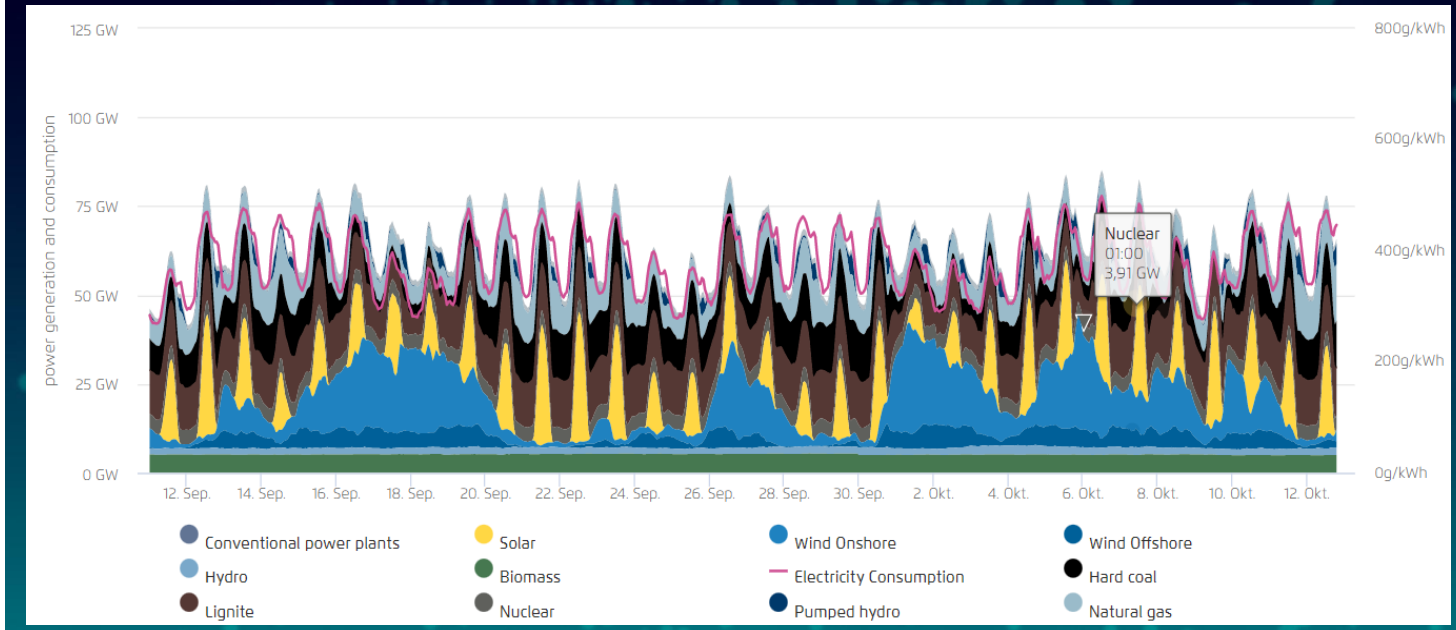
Key Features - Grid conformity and future aspects

Grid stability support

- Reactive power at night / STATCOM operation
- Dynamical power reserve for frequency stabilization
- Coordinated plant startup after grid fault (fixed gradients)

Upcoming

- Energy storage systems
- Forecast of power generation based on external weather data forecast
- Power quality aspects for example supraharmonics
- Grid forming



https://www.agora-energiewende.de/en/service/recent-electricity-data/chart/power_generation/11.09.2022/12.10.2022/today/

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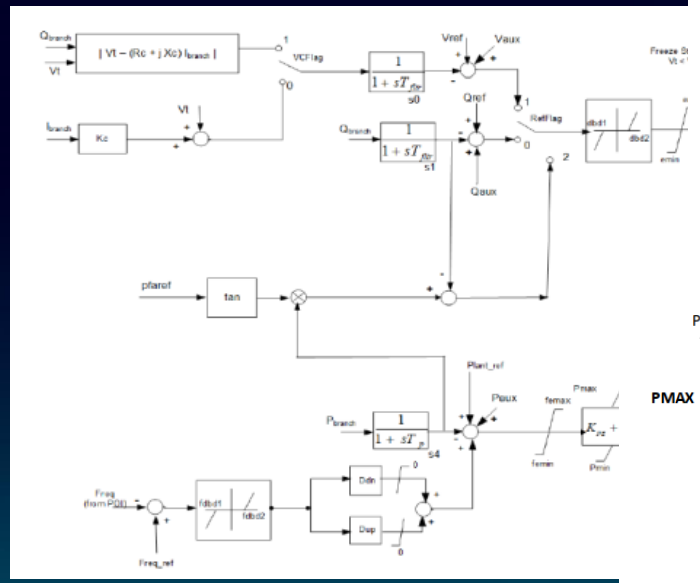
Simulation models of PV-PPC for grid studies and certification

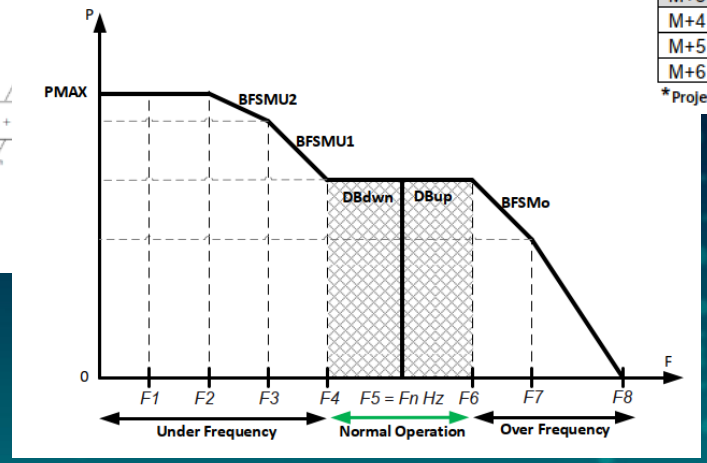
PV-PPC models for different simulation tools available



ICONs	Value	Description
M		Bus number for voltage control (NOTE 2)
M+1		Monitored branch FROM bus
M+2		Monitored branch TO bus
M+3		Monitored branch ID
M+4		VCFlag, droop flag (0: with droop,1: line drop compensation)
M+5		RefFlag, flag for V or Q control(0: Q control, 1: V control, 2: PF control
M+6		Fflag, 0: disable frequency control, 1: enable

ICONs	Value	Description
M	201	Bus number for voltage control *
M+1	2	Monitored branch FROM bus *
M+2	201	Monitored branch TO bus *
M+3	'1'	Monitored branch ID *
M+4	1	VCFlag, droop flag (0: with droop,1: line drop compensation)
M+5	1	RefFlag, flag for V or Q control(0: Q control, 1: V control, 2: PF control
M+6	1	Fflag, 0: disable frequency control, 1: enable

*Project specific details



- **Simulation models can be provided in:**
- **PSS®E, PSCAD®, DIgSILENT PowerFactory**

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SICAM Power Plant Controller

- PPC PV - Functionality
- One integrated system
- Power generation forecast

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SICAM PV Plant Control (PPC) – Complete range of control features
Maximum efficiency in controlling Photovoltaic Power Plants with and w/o Battery Storage systems

Key Features - Optimum control and full grid conformity for maximum yield

Active power control

Active power control modes

- Frequency dependent active power control (F control)
- Active power curtailment at PCC (P limit)
- Ramp control (MPPT)

Reactive power control

Reactive power control modes

- Absolute reactive power control (Q control)
- Advanced reactive power control functions (Q limit, Q-V-characteristic in over- and undervoltage range, Q-P-characteristic)
- Power Factor control (PF control, cos phi)
- Voltage Control

Grid stability support

Grid support

- Reactive power at night / STATCOM operation
- Dynamical power reserve for frequency stabilization
- Coordinated plant startup after grid fault

Battery control

Stabilize grid & PV power generation

- Grid stabilizing mode
- Smoothing mode

Grid Code Compliance

Compliance with many Grid Codes

- AUT, BRA, CHN, GER, INA, ITA, KSA, KUW, MEX, PAK, POR, RSA, SGP, TUN, TUR, UAE, USA, VIE
- Simulation models of PPC in PSSE,PSCAD, DIgSILENT Powerfactory available

Specials

- Internal simulator function
- Heat map of power output of inverter for one view diagnostic
- Forecast of power generation based on external weather data forecast
- Zone control with 4 independent zones included
- Automatic inverter calibration
- New HMI facelift

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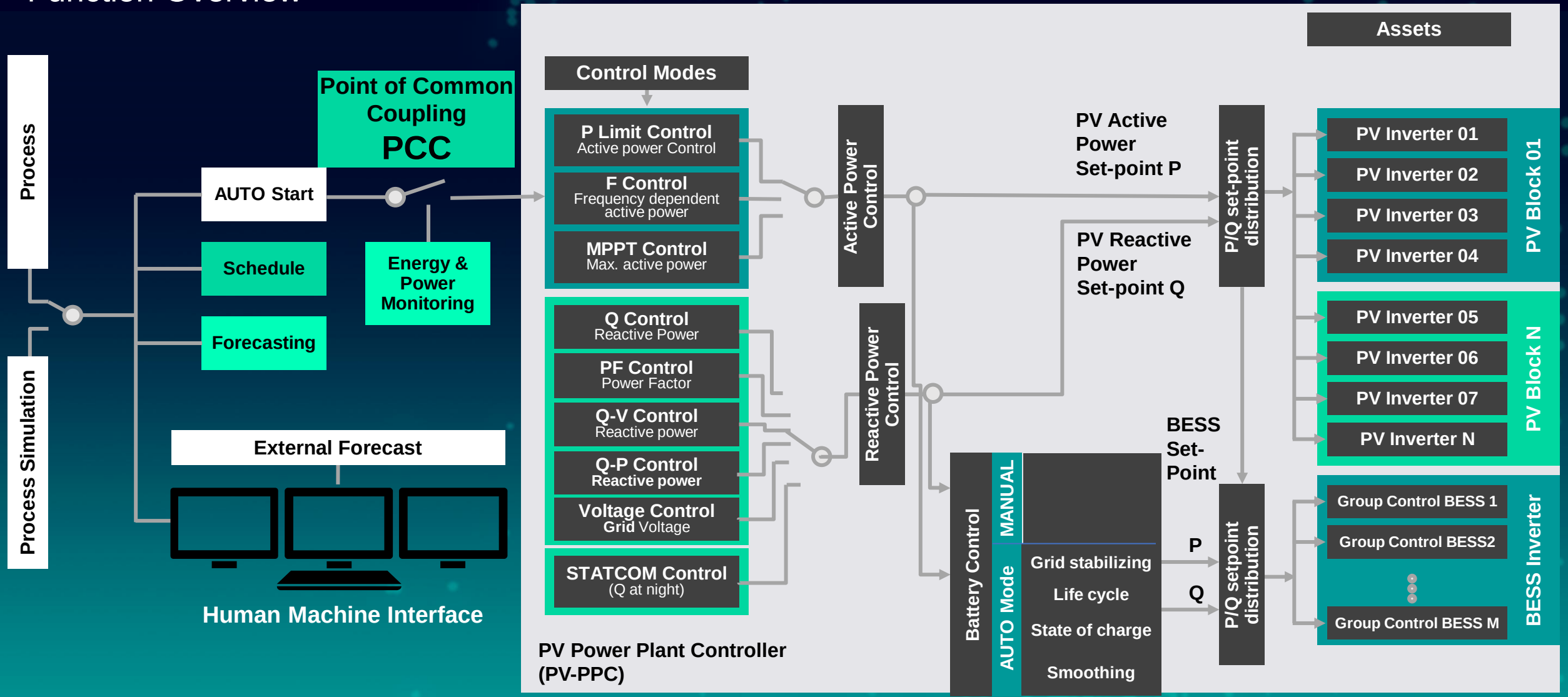
PV plant controller with battery Integration –
Function Overview



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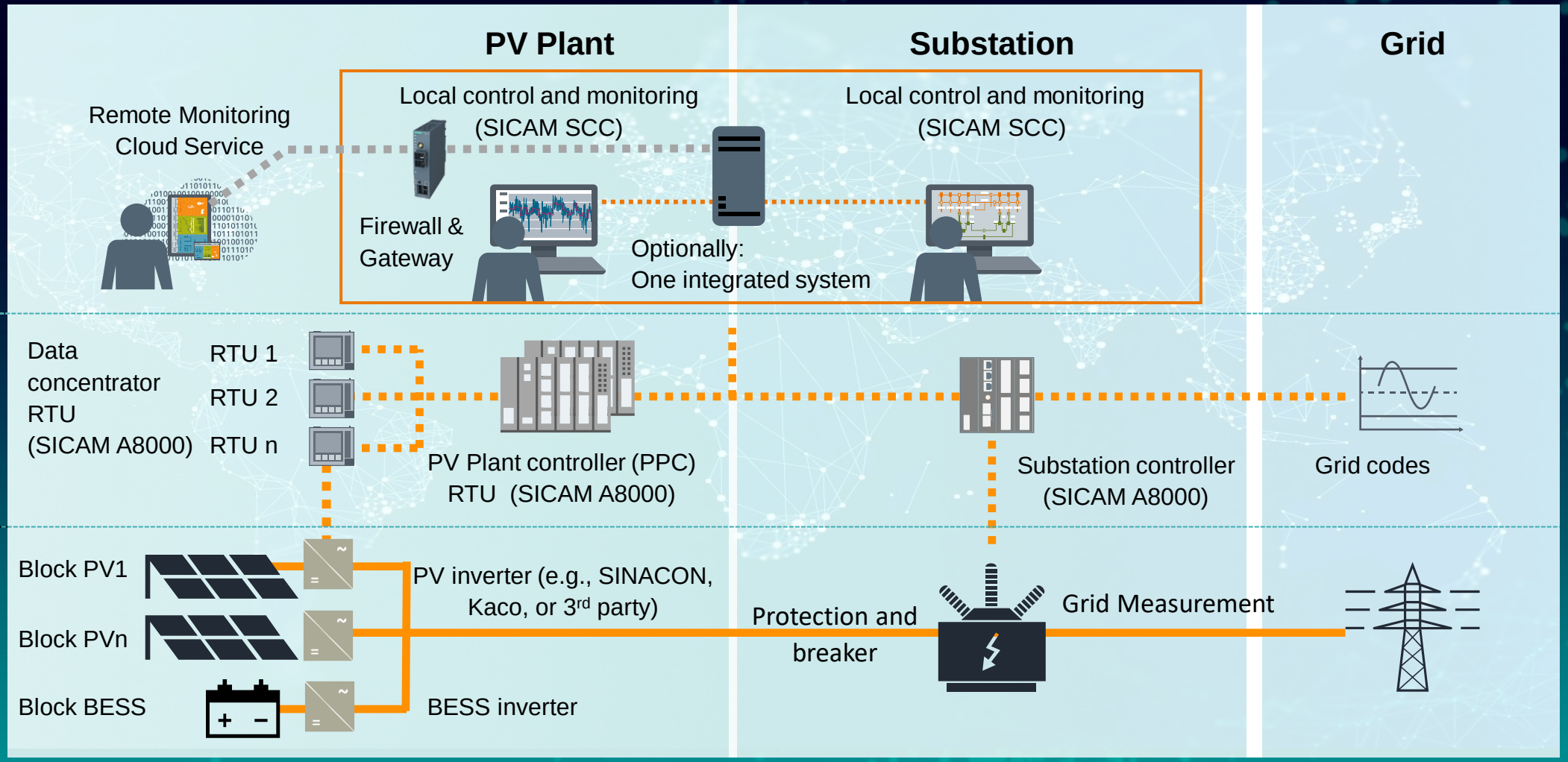
PV Plant Control (PPC) - One integrated SCADA for control & monitoring of PV plants with or without Battery Energy Storage Systems (BESS) and substation automation



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PV Plant Control (PPC) with SICAM A8000 – Intelligent RTU
Technical advantages

Flexible use and adaptation to existing infrastructure ⟩ **Various communication options, independent from inverter type or vendor freely programmable user programs according to IEC 61131-3.**

Can be expanded with up to 8 modules ⟩ **Modular-SICAM I/O modules for current / voltage measurement, analogue inputs, binary inputs and outputs.**

High reliability with various redundancy configurations ⟩ **The proven SICAM A8000 System allows different redundancy configurations, up to two separate controllers and redundant power supply.**

Longterm service ⟩ **World-class services and technical support from the global market leader in energy automation. Extension of product and system lifetime.**

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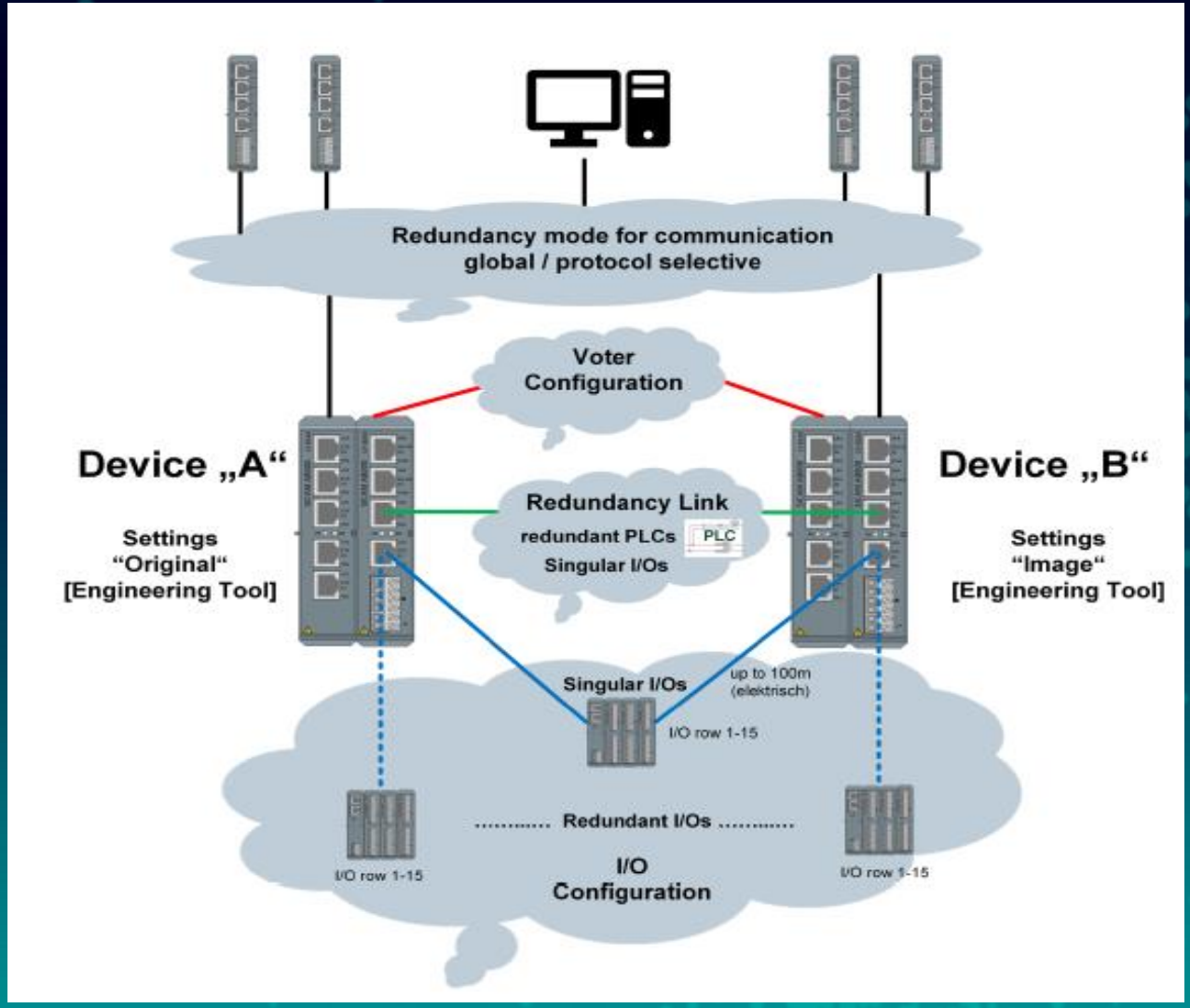
PV Plant Control (PPC) with SICAM A8000 – High reliability
Option: Redundancy concept

Redundancy with two separate controllers



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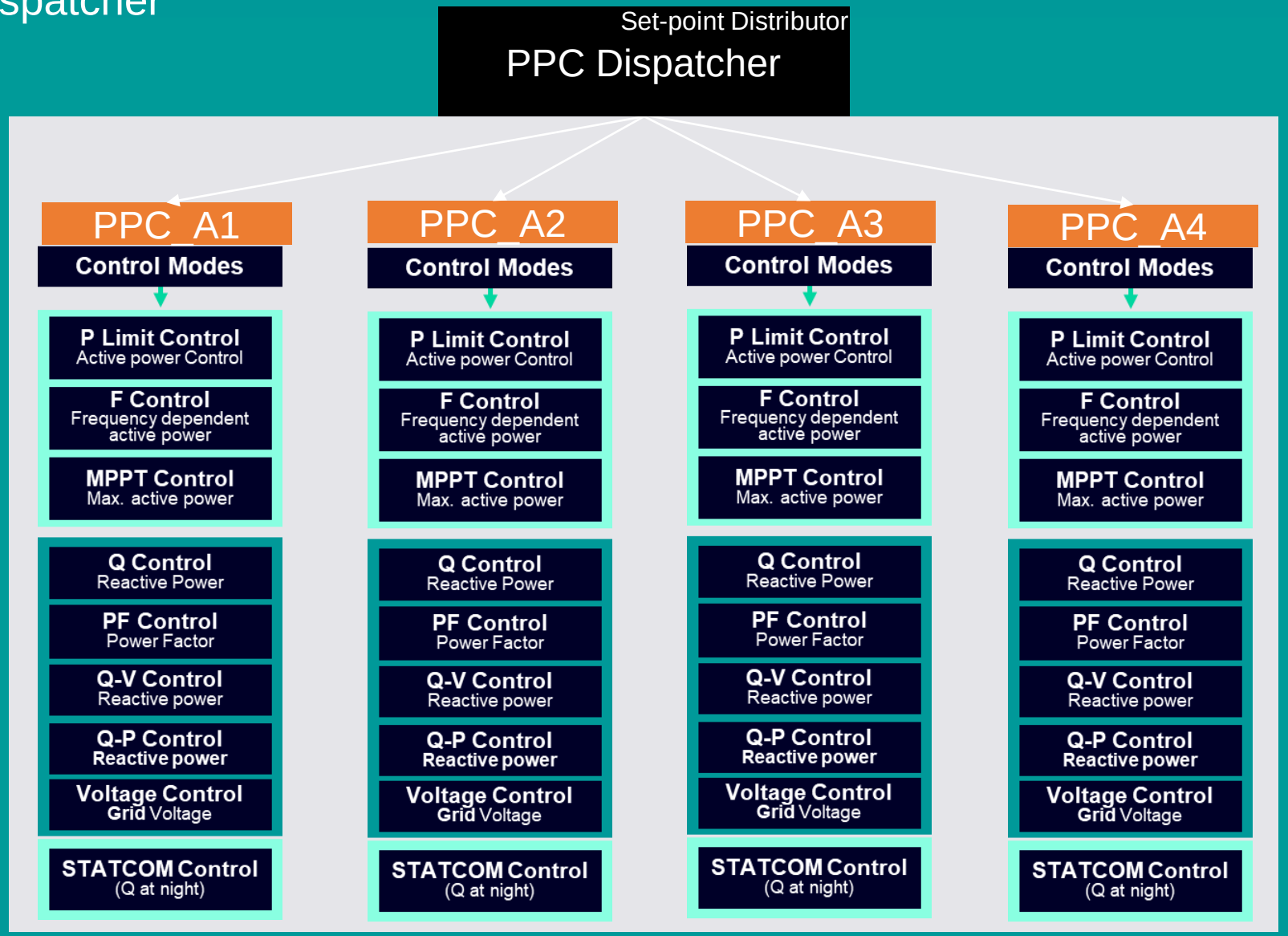
Power plant controller with Dispatcher function -
Function Overview Dispatcher

Four Area Concept:

Each Area has an P/Q closed loop Control functionality and an setpoint distribution calculation

Each Area can be used for different PV areas/plants to control them independent or coordinated together



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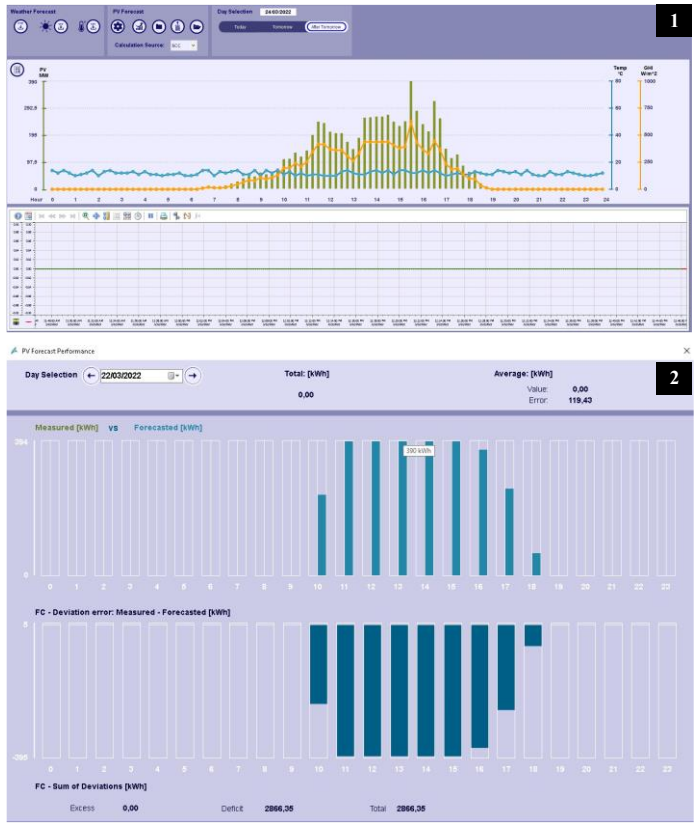
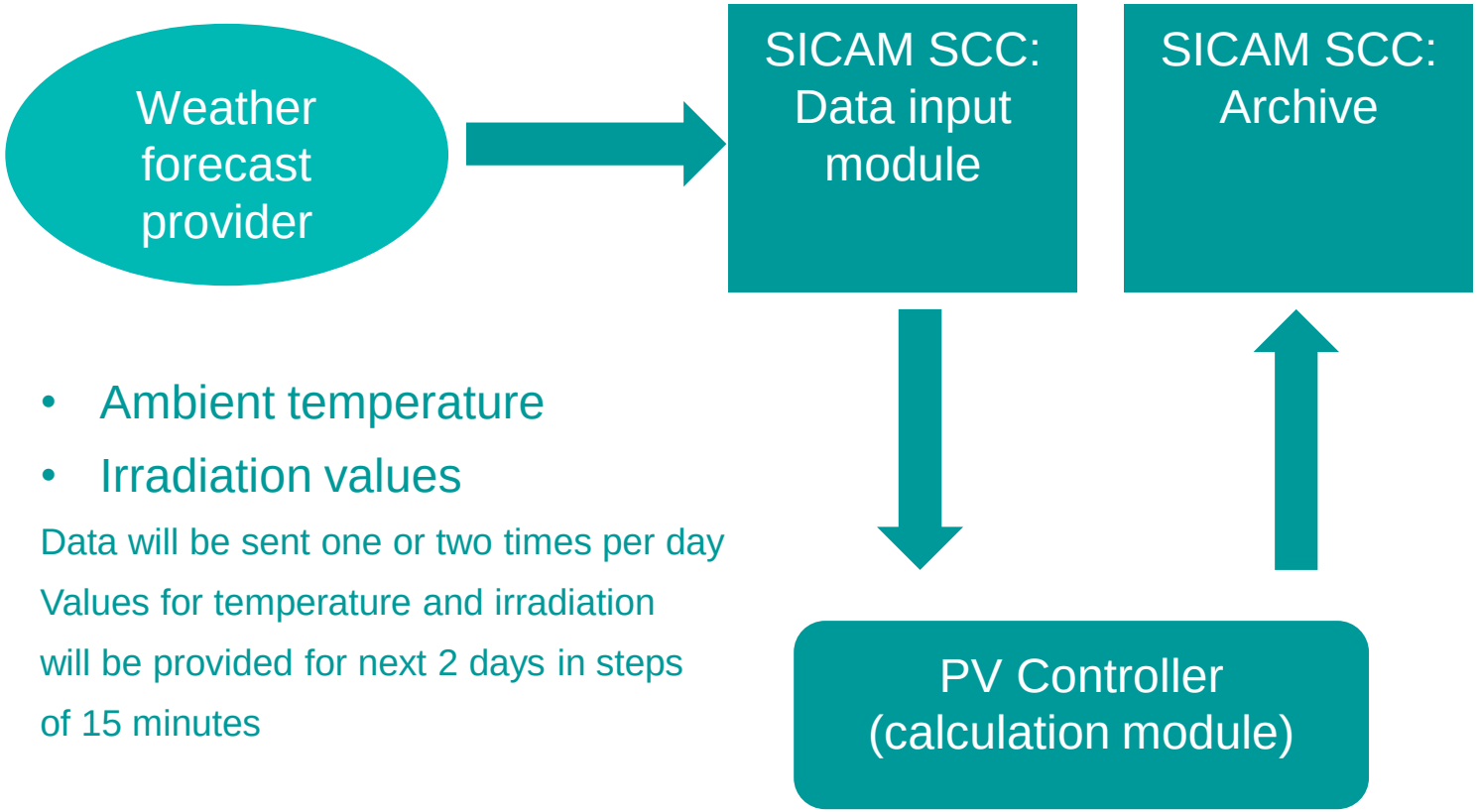
Power generation Forecast application

Weather and power generation forecast





- Ambient temperature
- Irradiation values

Data will be sent one or two times per day

Values for temperature and irradiation will be provided for next 2 days in steps of 15 minutes

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Start-up control sequence

- Sequence
- HMI for Control and Monitoring
- Web- User Interface (UI) for Control application
- Connection to cloud solutions

PV Plant Controller (PPC) with SICAM SCC– Startup PPC

Startup Sequence ⟩

Checks:

- AC voltage on the grid side of the inverters and grid frequency
- PV park connection to the public grid
- During daylight hours: Sunrise time and Sunset time

Interaction:

- Active power: Starts MPPT mode (ramping up to maximum power output) with inverter in AUTOSTART or MANUAL start
- Reactive power: Starts in reactive power with Q compensation (Q setpoint = 0)
- Battery operation: Can be integrated

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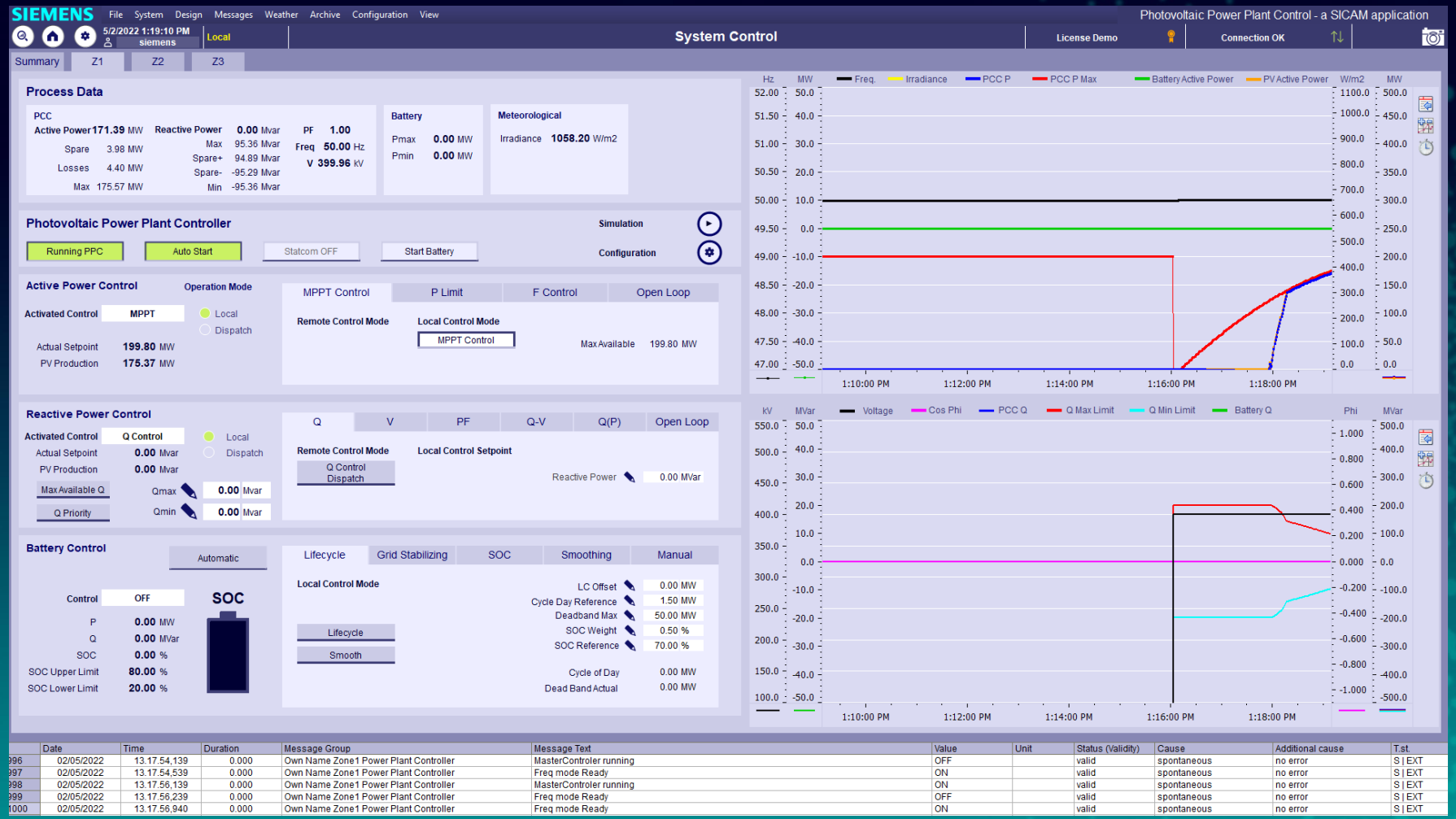
PV Plant Controller (PPC) with SICAM SCC– Scalable Plant monitoring
Clear display of all relevant information for on-site operator



	Date	Time	Duration	Message Group	Message Text	Value	Unit	Status (Validity)	Cause	Additional cause	T.st
996	02/05/2022	13.17.54,139	0.000	Own Name Zone1 Power Plant Controller	MasterControler running	OFF		valid	spontaneous	no error	S | EXT
997	02/05/2022	13.17.54,539	0.000	Own Name Zone1 Power Plant Controller	Freq mode Ready	ON		valid	spontaneous	no error	S | EXT
998	02/05/2022	13.17.56,139	0.000	Own Name Zone1 Power Plant Controller	MasterControler running	ON		valid	spontaneous	no error	S | EXT
999	02/05/2022	13.17.56,239	0.000	Own Name Zone1 Power Plant Controller	Freq mode Ready	OFF		valid	spontaneous	no error	S | EXT
1000	02/05/2022	13.17.56,940	0.000	Own Name Zone1 Power Plant Controller	Freq mode Ready	ON		valid	spontaneous	no error	S | EXT

- Plant control
- Change of control modes
- Adjustment of settings
- Trends

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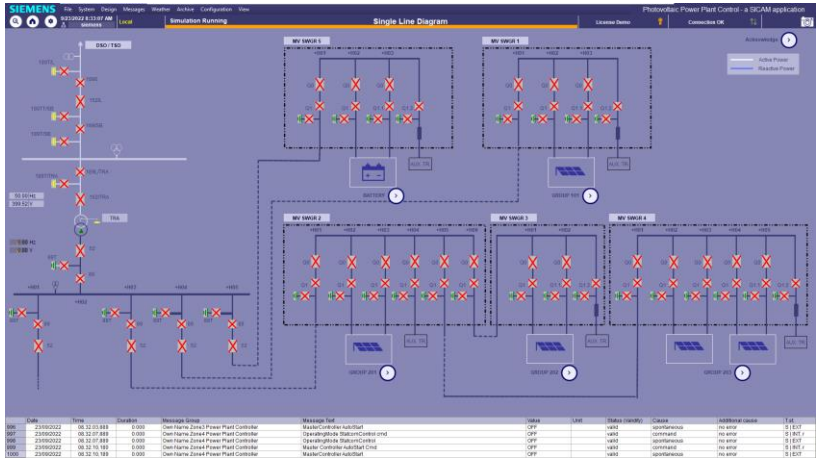
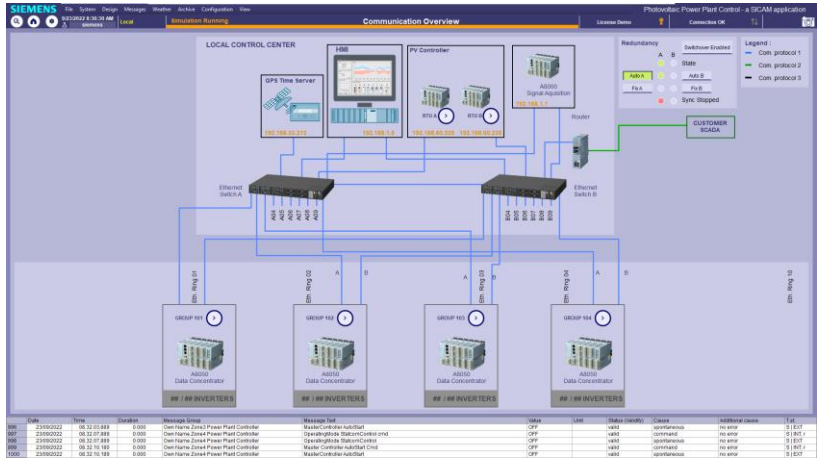
PV Plant Monitoring (PPM) – SICAM SCC screens
Advanced monitoring and control functions based on SICAM SCC

Single-Line/SCADA



- Status of plant
- Protection devices
- Electrical Values
- Status of Circuit breaker and grounding switches

Communication overview



- Status of communication devices
- Redundancy status
- Adjustment of settings

Geographical overview

- Status of inverters
- Geographical plant overview
- Performance heat map
- Link to detail view for PV Blocks

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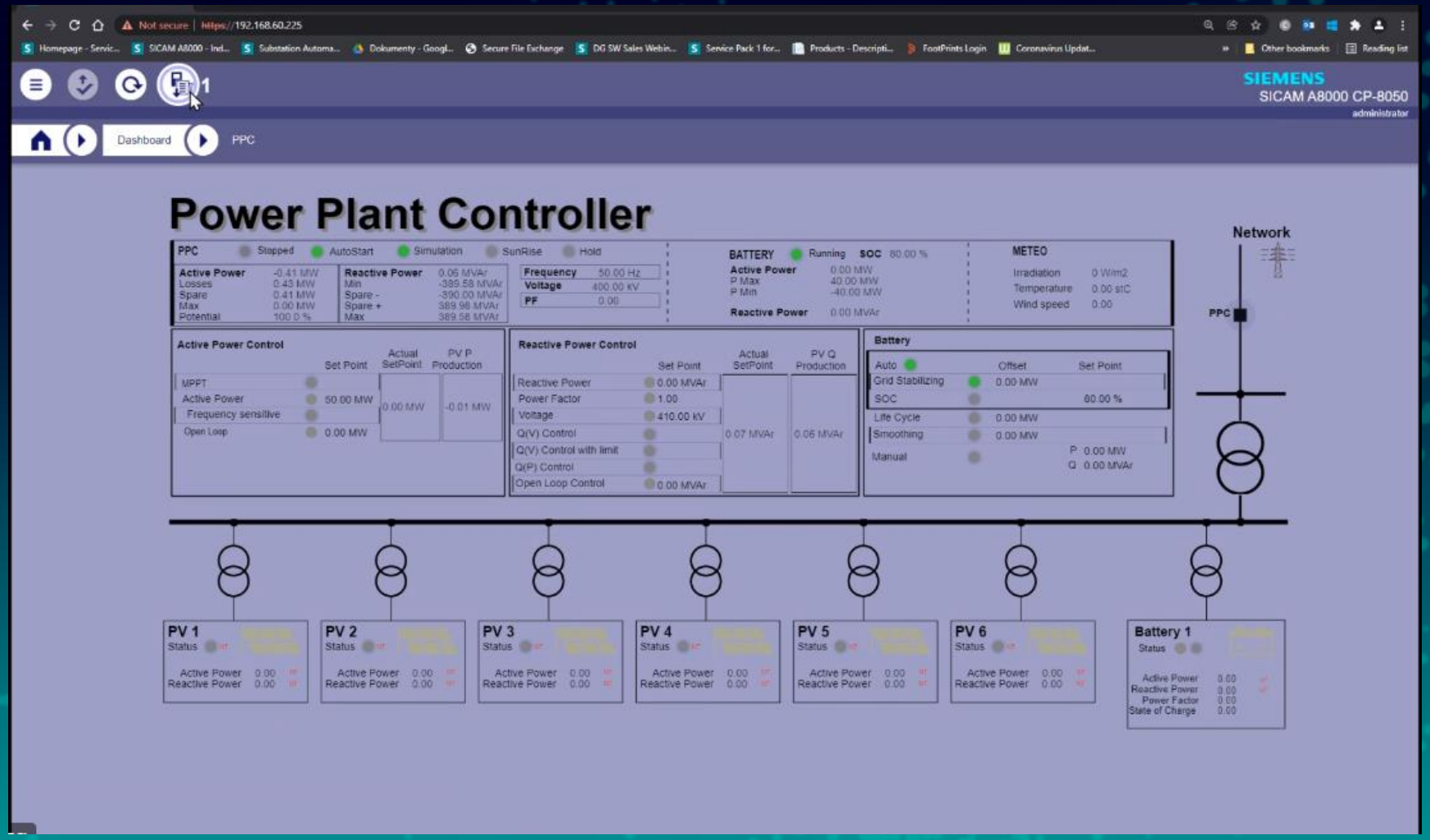
PV Plant Control (PPC) with PPC Dashboard

SICAM Web

- Task oriented HMI for operation and maintenance personnel
- Based on SICAM A8000 RTU integrated web server
- No additional server or licenses required



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Real projects with SICAM PPC

- Trung Nam 2 and 3, Vietnam
- Floating Solar at Tengeh Reservoir, Singapore
- Hydro-Floating Solar Hybrid Plant at Sirindhorn Dam, Thailand

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Trung Nam 2 - 204 MW PV plant in Vietnam

Challenge

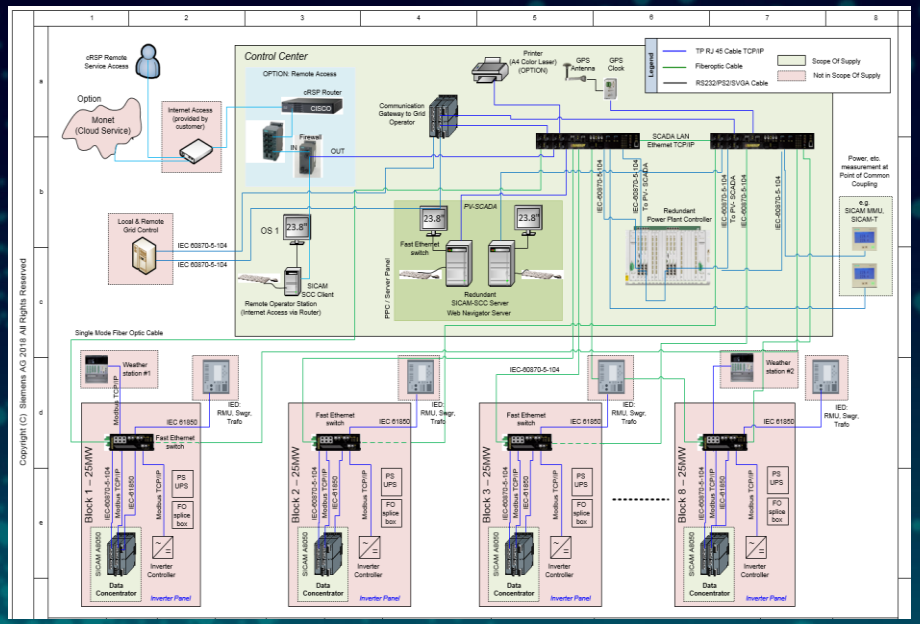
- 45 SINACON PV Inverter, communication via Modbus protocol
- Active and Reactive Power Control from Grid operator station
- Reactive Power at night, new feature

Solution

- PPC & PPM control solution as a SICAM application
- Control and monitoring for PV park operation

Benefits

- Stable and economical operation of the PV park
- High precision closed loop controls
- Good transparency of all inverters including error and warning reporting



Project partner: Trung Nam Solar Power JSC

Country: Vietnam

Siemens Limited Thailand

SIEMENS

Trung Nam 2 - 204 MW PV plant in Vietnam

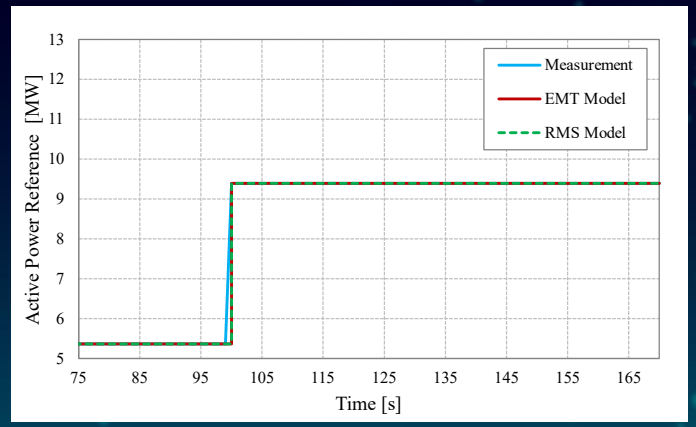
RMS EMT Measurement

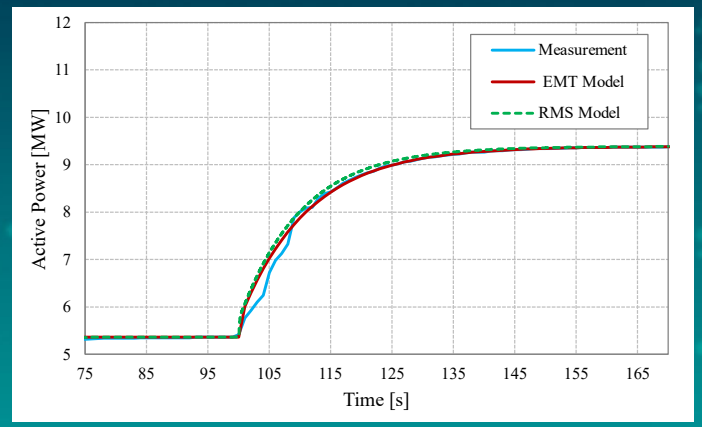
Model validation results against site measurement values for a PV plant installed at customer location

Each block has 5-6 inverters (each of 4.65 MW)

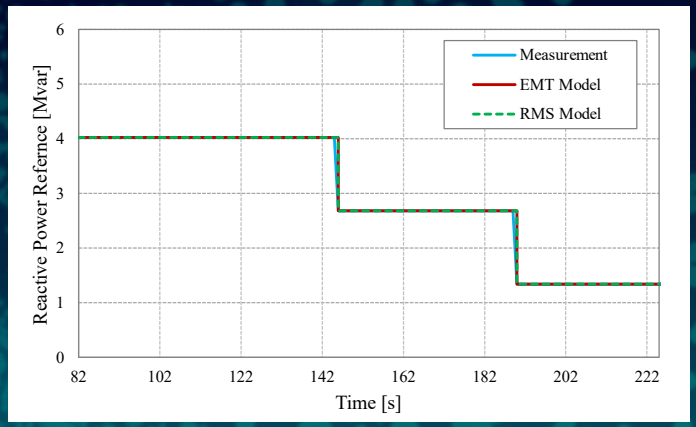
Siemens SINACON PV inveters and Siemens SICAM PPC

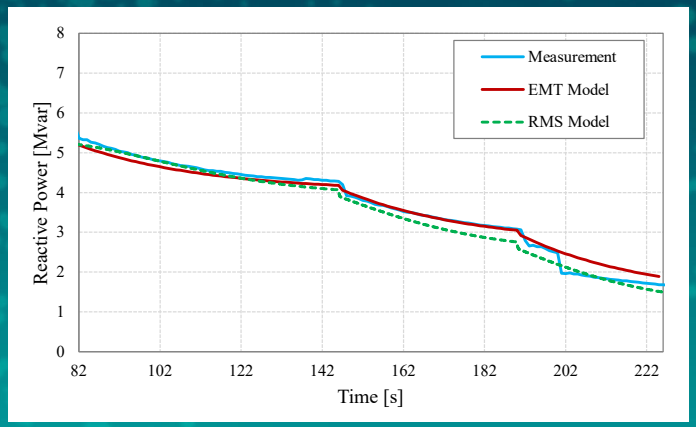
Comparison of response with decrease in Active Power Reference





Comparison of response with increase in Reactive Power Reference





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Trung Nam 3 - 450 MW PV plant in Vietnam

Challenge

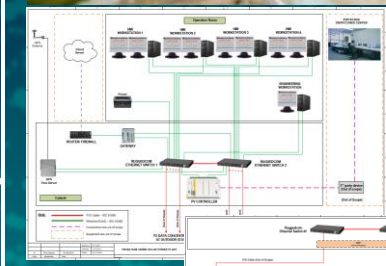
- 102 SINACON PV Inverter, communication via Modbus protocol
- Active and Reactive Power Control from Grid operator station
- Reactive Power at night, new feature
- Integration of the DEOP cloud application
- Forecast of power generation

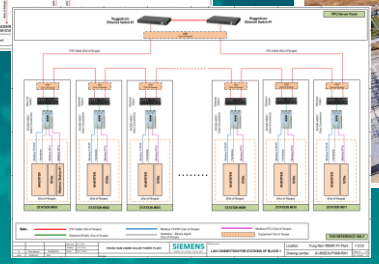
Solution

- PPC & PPM control solution as a SICAM application
- Control and monitoring for PV park operation

Benefits

- Stable and economical operation of the PV park
- High precision closed loop controls
- Good transparency of all inverters including error and warning reporting





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Tengeh Reservoir (Sempcorp)
Floating Solar at Tengeh Reservoir, Singapore

First Pilot
world's largest
Floating Solar Project

60MW
60MWp Solar Power,
122.000 PV panels
45ha

Technology
Photovoltaic plant
controller redundant
SICAM PPC

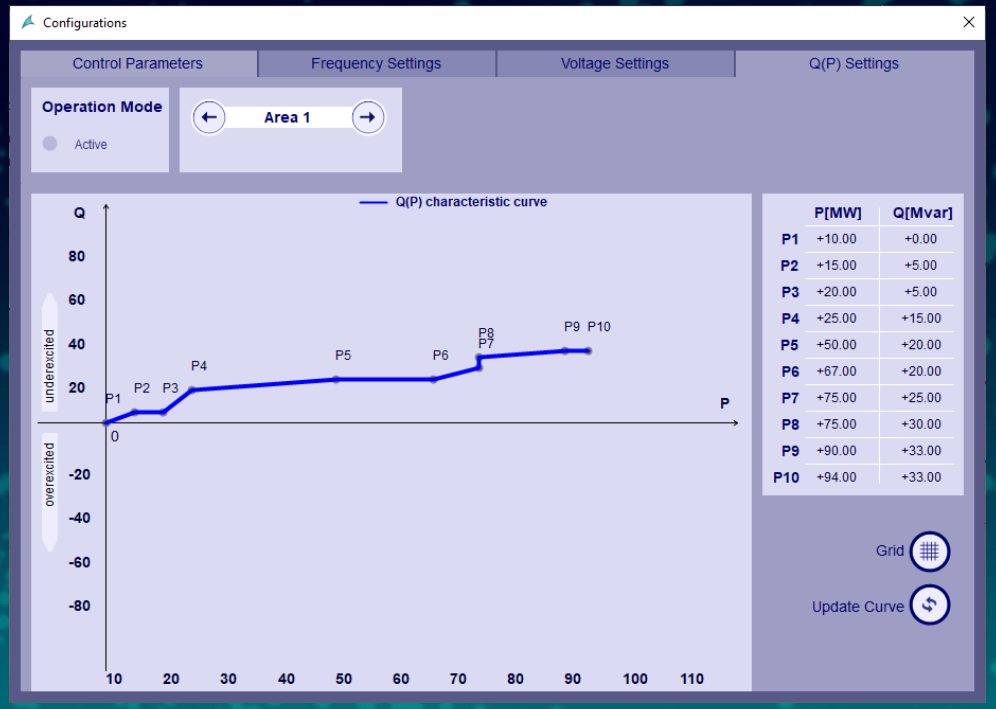
SIEMENS

Tengeh Reservoir (Sempcorp)

Floating Solar at Tengeh Reservoir, Singapore

To ensure accurate models are built according to the grid code and equipment, the performance of the models was also tested.

In compliance with Singapore's grid code requirements, an adaptable Q(P) characteristic curve was implemented in SICAM PPC and simulation models.



Functions of Reactive power control according active power output (Q(P))

Adaptable characteristic for delta active power response
Photovoltaic Plant Control provides additional reactive power control modes which requires no assistance from the operator. The objective for this method is for the power generating plant to feed in reactive power into the network depending on the current active power output point.

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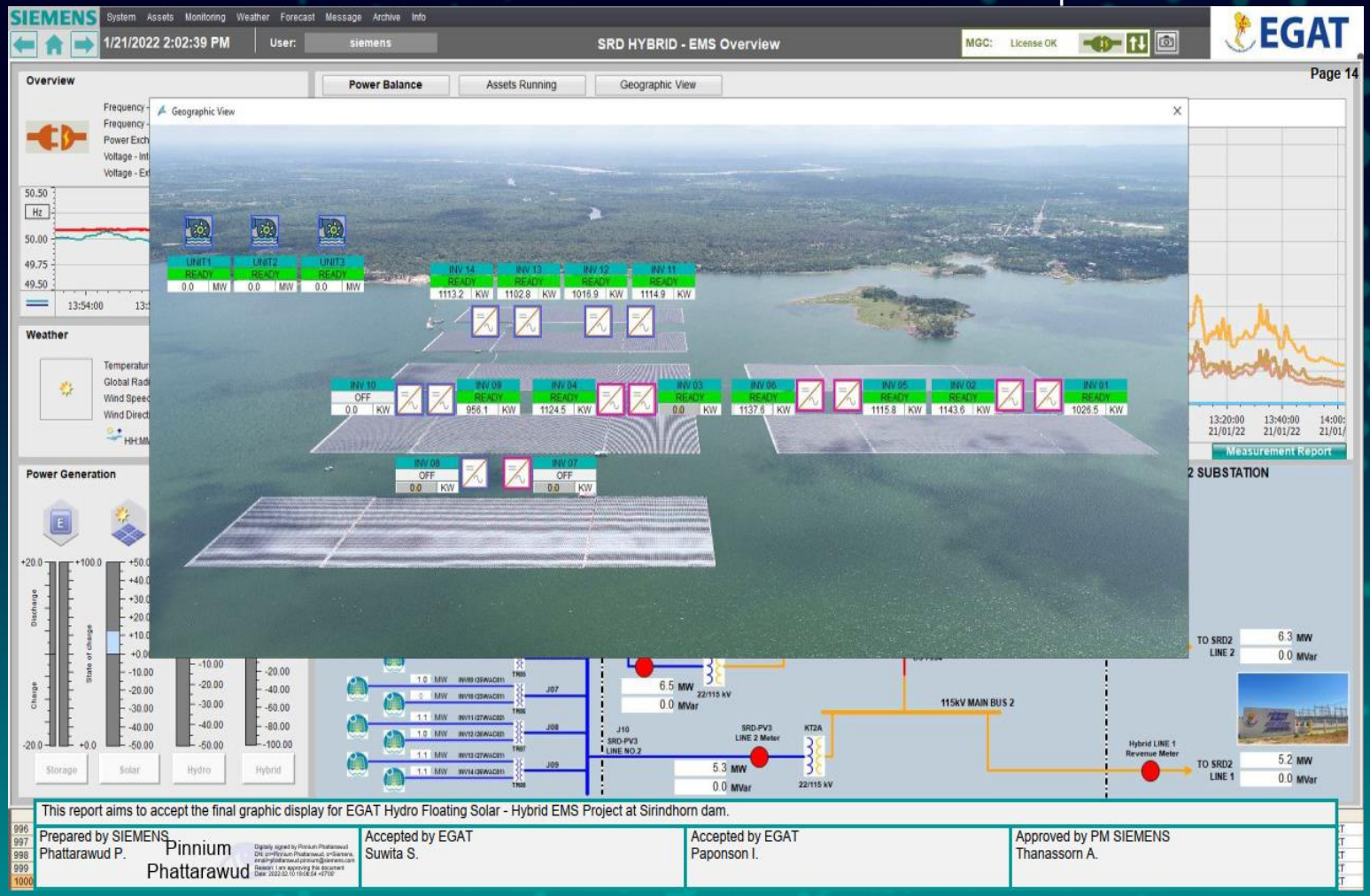
Electricity Generating Authority of Thailand (EGAT)
Hydro-Floating Solar Hybrid at Sirindhorn Dam, Thailand

Technical Details

- 45MW PV
- 36MW Hydro
- 145,000 solar panels (121 hectares)
- Inverter #: SG3400HV
- Inverter Type: Sungrow
- Module-Type: Double-Glass
- Buoys: HDPE

Local Operator Station



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Reference Photovoltaic Plant Examples
Photovoltaic Plant Control & Monitoring

Country	Configuration	Solar Power [MW]	Use case / Demand	Application	Inverter type	No. of SICAM RTU	Year
United Arab Emirates	PPC/PPM	3x 100	Central Inverter	Redundant PV control with STATCOM mode	3x 60x SUNGROW	12 RTU‘s	2021
	PPC/PPM	3x 100	Central Inverter	Redundant PV control with STATCOM mode	3x 60x SUNGROW	12 RTU‘s	2021
	PPC/PPM	3x 100	Central Inverter	Redundant PV control with STATCOM mode	3x 60x SUNGROW	12 RTU‘s	2022*
India	PPC/PPM	2x100	String Inverter	Redundant PV control with STATCOM mode	2x1120x TMEIC	11 RTU‘s	2020
	PPC/PPM	250	Central Inverter	Redundant PV control with STATCOM mode	100x TMEIC	18 RTU‘s	2020
	PPC/PPM	130	Central Inverter	Redundant PV control with STATCOM mode	52x TMEIC	11 RTU‘s	2020
	PPC/PPM	300	String Inverter	Redundant PV control with STATCOM mode	1302x HUAWEI	6 RTU‘s	2021
	PPC/PPM	120	Central Inverter	Redundant PV control with STATCOM mode	2x 24x TMEIC	12 RTU‘s	2022*
Italy	PPC/PPM	103	Central Inverter	Redundant PV control with STATCOM mode	22x WSTECH (SINACON)	8 RTU‘s	2020
Poland	PPC/PPM	70	String Inverter	Redundant PV control with STATCOM mode	306x HUAWEI	3 RTU‘s	2021

*) System has been already installed and commissioning expected soon

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Reference Photovoltaic Plant Examples
Photovoltaic Plant Control & Monitoring

Country	Configuration	Solar Power [MW]	Use case / Demand	Application	Inverter type	No. of SICAM RTU	Year
Portugal	PPC/PPM	15	Central Inverter	Redundant PV control with STATCOM mode	3x WSTECH	2 RTU‘s	2021
Singapore	PPC/PPM	50	Central Inverter	Redundant PV control with STATCOM mode	16x SUNGROW	5 RTU‘s	2021
Spain	PPC/PPM	5	Navy base 60Hz	Redundant PV control with STATCOM mode	6x INGETEAM	2 RTU‘s	2021
Thailand	PPC/PPM	45	Floating PV & String Inverter	Redundant PV control with STATCOM mode	226x HUAWEI	4 RTU‘s	2021
Vietnam	PPC/PPM	204	Central Inverter	Redundant PV control with STATCOM mode	45x WSTECH (SINACON)	10 RTU‘s	2019
	PPC/PPM	250	Central Inverter	Redundant PV control with STATCOM mode	50x SiNeng	4 RTU‘s	2019
	PPC/PPM	50	Central Inverter	Redundant PV control with STATCOM mode	10x SMA	4 RTU‘s	2019
	PPC/PPM	450	Weather & generation forecast	Redundant PV control with STATCOM mode	102x WSTECH (SINACON)	105 RTU‘s	2020
Usbekistan	PPC/PPM	100	String Inverter, Weather & generation forecast	Redundant PV control with STATCOM mode	659x HUAWEI	3 RTU‘s	2021

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Future aspects and outlook on power quality

- View on Power Quality
- Conclusion

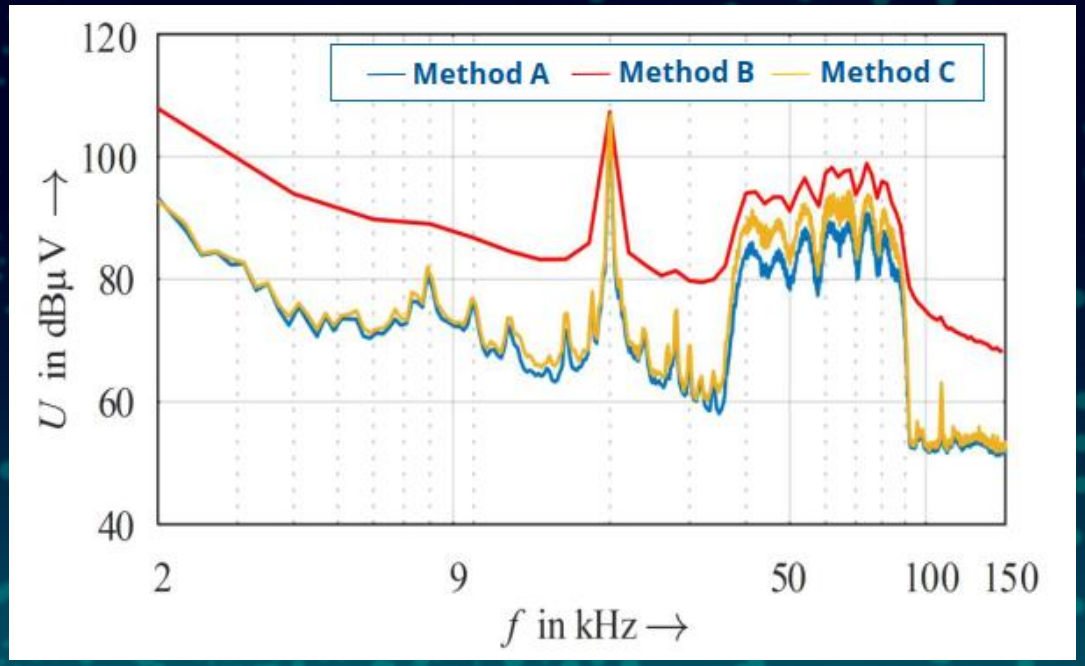
Power Quality and measurement methods

Inverter based power generation causes voltage oscillations with the following effects:

1. Heating which results in temperature problems for sensitive devices.
2. Overvoltage issues. Harmonic voltage caused by the harmonic current can lead to significant overvoltage, leading to equipment failures.
3. Resonance leading to high harmonic current flow.

Each measurement methods are similar, but method B provides higher values and noise level results.

Source: D. Ritzmann, "A proposed framework for 2-150 kHz measurement methods," Apr. 6 2022



Method A: Extension of IEC 61000-4-7 Annex B (200-Hz-bands)
Method B: IEC 61000-4-30 Annex C proposal (2-kHz-bands)
Method C: Digital CISPR 16 method (200-Hz-bands)

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Conclusion

1. Real project experience displaying:
    a. Grid Code compliancy,
    b. Power plant control,
    c. Accurate simulation models, validated against site
    d. Central control solutions and transparency via cloud applications

2. Future demands for renewable base power generation:
    a. Storage
    b. Generation forecast
    c. Grid forming
    d. Power Quality monitoring

Extension of scope

- Meteo stations and dataloggers
- String monitoring and Combiner boxes

Extension of scope

Irradiation measurement

- Measurement of the solar irradiation input is essential to determine the plant efficiency relative to its potential
- redundant measurements increase reliability
- range at least 0 W/m² – 1 500 W/m² and a resolution of ≤ 1 W/m²
- stable mounting to allow setting the tilt angle
- inverter feed-in starting at approx. P_{DC} = 200W

Typical Values

Fully clouded	Sunny, partly clouded	Clear and Sunny
50 … 120W/m²	**120 …500W/m²**	**500 …1000W/m²**

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Extension of scope

Meteo station

Pyranometer

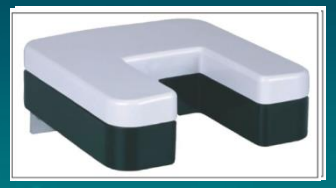
Weather and Thermal Radiation Shield

Data Logger

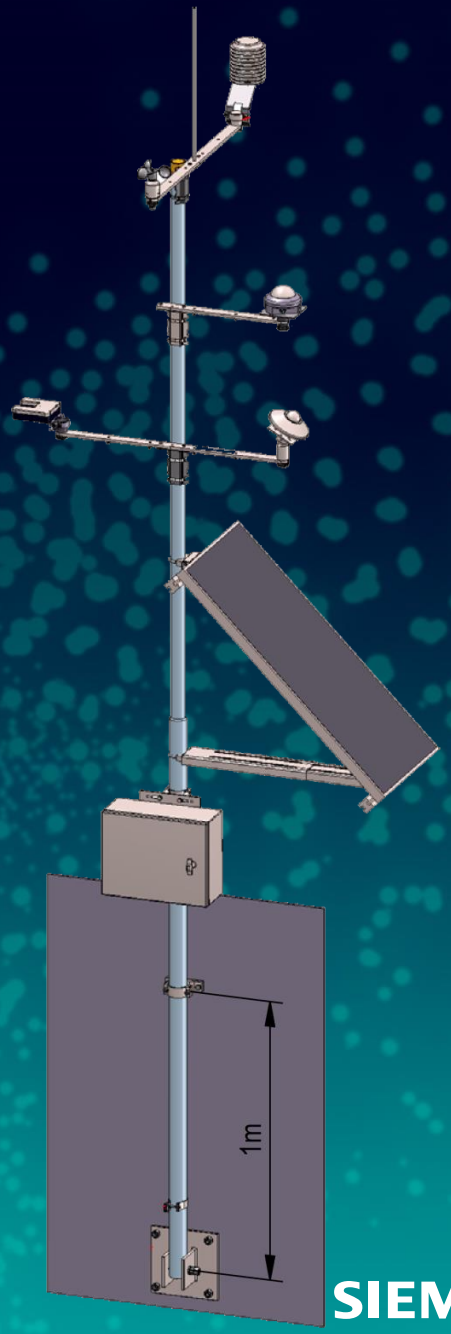
Temperature of PV module

Wind Direction Transmitter
0°… 360°

Wind Transmitter
0,5 … 50 m/s



Precipitation sensor
(Intensity)
mm precipiation / min.



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Extension of scope

String Combiner Box

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PV subsystems

Tracker system

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PV subsystems

Automatic Cleaning Robot System (ARCS)

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Microgrids – dezentralized energy systems

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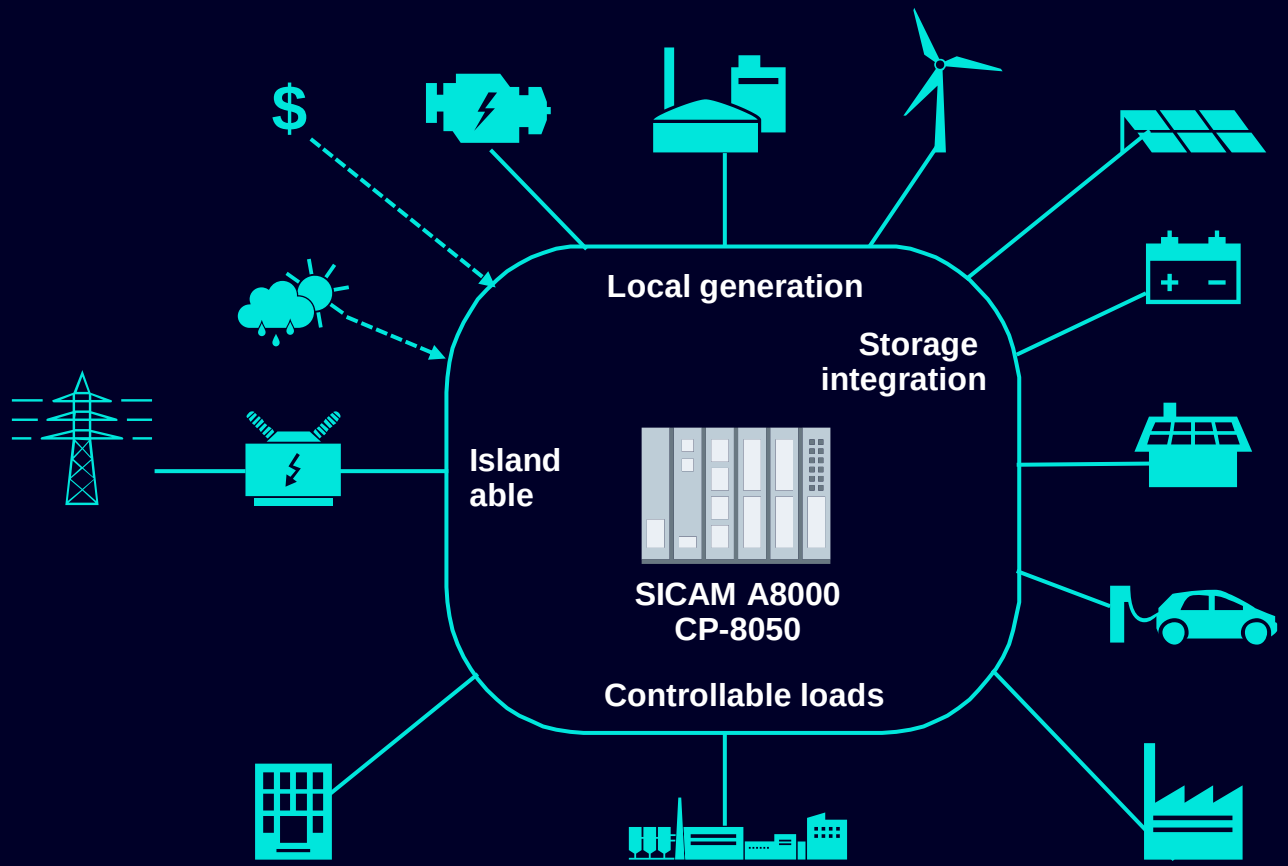
Microgrid Control – a SICAM application
enhances efficiency, resiliency and sustainability



Economic & energy efficiency

- Peak shaving
- Demand charge reduction
- OPEX optimization

Resiliency & reliability

- Blackout detection and black start
- Generation, storage and load control
- Grid synchronization

Sustainability

- Renewable integration
- Green footprint dispatch
- Generation and load forecast

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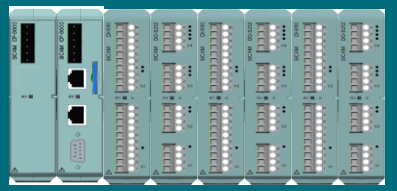
Microgrid Control – a SICAM application
Control architecture with implemented assets

Human Machine Interface

SICAM A8000 CP-8050



allows integration with many standard communication protocols e.g. IEC 60870-5, MODBUS, etc.

Generator

Up to 16*

External Grid

PCC

Up to 1*

Photovoltaic

Up to 3*

Loads

Up to 10*

Battery

Up to 4*

Wind

Up to 3*

* standard configuration

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Microgrid Control – a SICAM application
Standard features overview

Basic Features

- Peak shaving
- Generation Control
- Islanding / Black start
- Load Control
- Storage Control
- Archiving
- Monitoring/ Reporting

SICAM A8000 CP-8050

Small, robust and modular:

For small to medium data volumes

SICAM SCC

Human Machine Interface

Advanced Features

- Load Management
- Utilization of renewable generation for e-car charging
- Demand charge reduction
- Market access
- Load forecasting
- Generation forecasting

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A strong end-to-end Microgrid offering utilizing proven platforms
Automation/ Digitalization portfolio

Transparency

Efficiency and optimization

Resiliency and control

Planning

Back office

Consulting

Technical feasibility & economic simulation

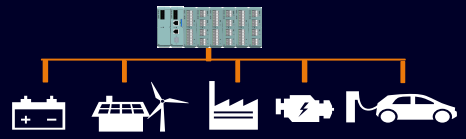
- Optimize cost
- Optimize reliability of supply (RoI)
- Optimize sustainability

On site

Microgrid/ Photovoltaic Plant Control

SICAM Controller incl.

Photovoltaic & Storage Control



- Network Stability
- Generation Control
- Load Management
- Monitoring/ Reporting
- Measuring
- Storage Control
- Peak shaving
- Islanding / Black start

Cloud Services

Monitoring

Digital Services for Microgrid Optimization & Analysis

- Monitoring/ Reporting
- Optimized supply
- Enhance sustainability
- Maximized efficiency
- Archiving
- Price forecasting
- Generation forecasting
- Optimization of own energy usage

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Our offering
Fast Track configuration - Hardware

Optional as standardized Hardware Packages

- Fast Track configuration
- Custom engineering + accelerated commissioning
- Full documentation
- Pre-mounted
- Pre-wired
- Plug & Play

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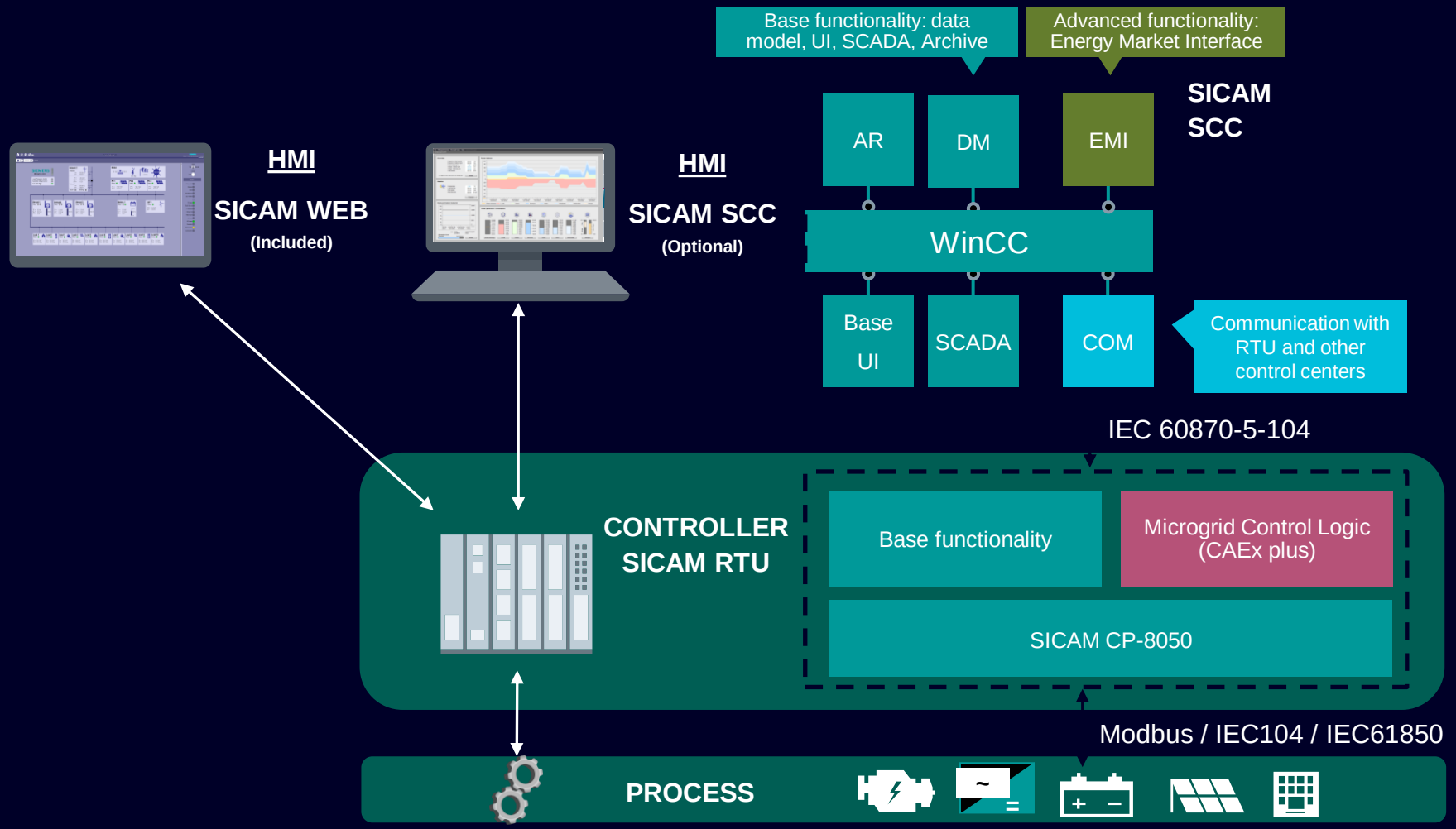
One integrated System, renewable integration & power management for industries

Microgrid Control - Architecture



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Microgrids – References & use cases

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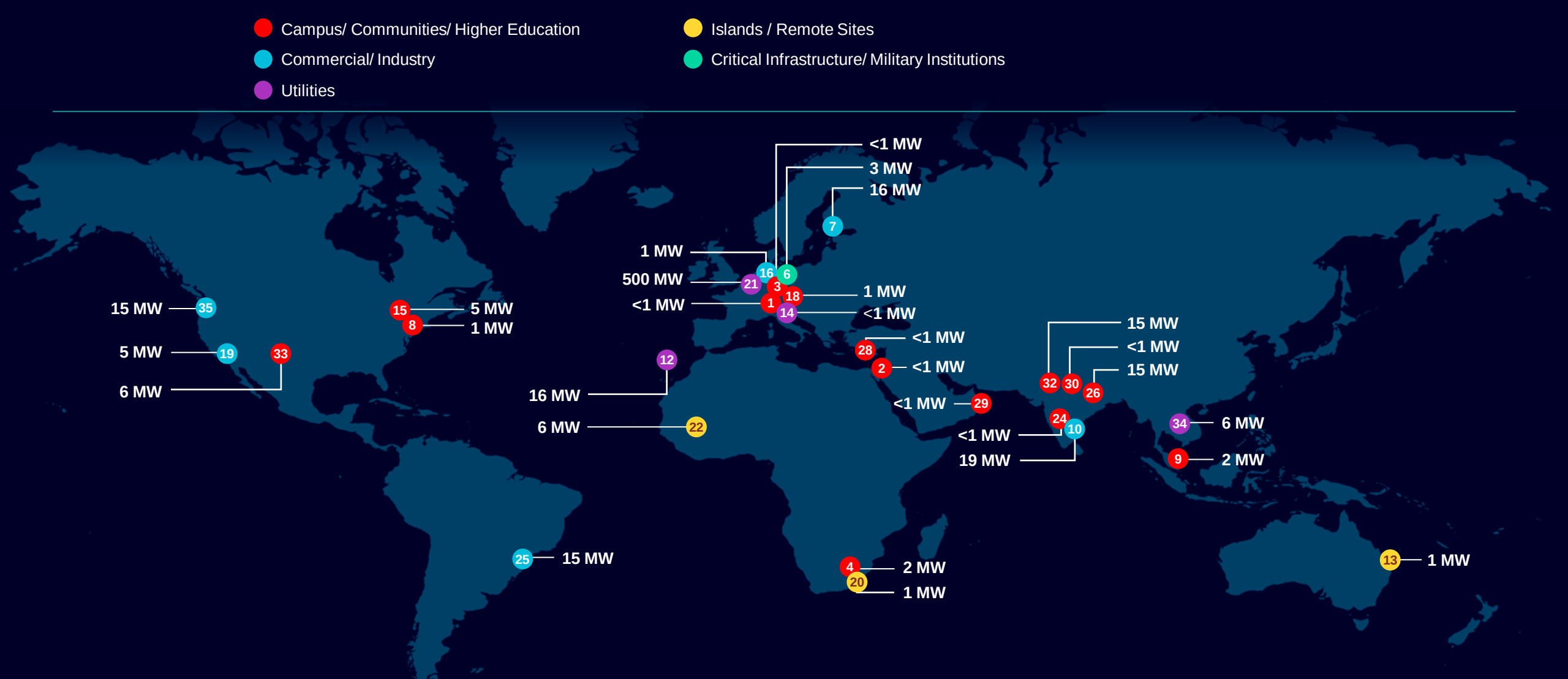

Microgrid Control – a SICAM application worldwide

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Commercial and industry – Improving energy efficiency

Current situation

- Increasing energy costs
- High demand charges
- Potential blackout
- Costly process interruptions
- Control system not prepared for renewable sources
- Lack of performance transparency

Solution

- Decrease energy costs (tariffs, KPIs)
- Optimize peak power consumption
- Optimize/ re-configure energy supply
- Integrate renewable resources and battery systems
- Monitoring and reporting of energy use

Achievements

- Lower energy bill
- Demand charging reduction
- Grid restoration as quick as possible
- Utilization of all generation assets for energy efficiency
- Transparency of energy usage

Microgrid Control helps industries reduce energy cost and improve resilience.

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~2 MW
of managed power

312 kWp
peak output from PV

100 tons
CO_2 saved per year

Siemens Microgrid Campus

Wien, Austria

“Just as the main building of the site, which opened in 2010, that stood for sustainability and energy efficiency, the current project points the way to the future of intelligent energy management solutions.”

Franz Mundigler – *Head of Siemens Real Estate Central Europe*

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Siemens Microgrid Campus, Wien, Austria

Intelligent charging infrastructure, peak shaving and CO_2 reduction

Challenges

- Optimize the electricity and heating requirements on the company premises
- Demand of charging infrastructure for electric vehicles and future-oriented charging management
- Achieve campus-level energy efficiency leveraging existing building automation
- Realize Showcase for Siemens Lead Country Bundle Austria
- Visualization of Energystreams

Benefits

- Power demand optimization (electrical and district heating)
- 100 tons of CO_2 reduced per year
- Energy efficiency
- Building automation
- Reliable control of 2.5 MW which corresponds to the electricity demand of 700 households
- Smart parking and e-charging solutions with Compact Power Charger of 50 kW DC power

Solution

Microgrid Control – a SICAM application installed to optimize local energy demand

- Photovoltaic systems: total area currently 1,600 m2 and peak power 312 kWp
- Battery storage: capacity 500 kWh, output: 500 kW
- Charging stations for electric vehicles
- Building management system Desigo
- Distributed Energy Optimization (DEOP) to be installed in the future
- Data visualization and analytics
- pre5G data communications
- Fire protection power storage: Siemens Sinorix extinguishing system

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Siemens Microgrid Campus, Wien, Austria

Intelligent charging infrastructure, peak shaving and CO_2 reduction

Customer environment

- Data transmission of ~ 1000 values every 15 minutes
- Weather data
- Weather forecast
- Photovoltaic systems
- Battery storage
- Building Automation
- Asset limitation

Use case

- Intelligent e-charging management
- Energy optimization
- CO_2 reduction
- Renewable integration and asset utilization optimization
- Campus peak demand shaving
- Participation in ancillary services market (planned)

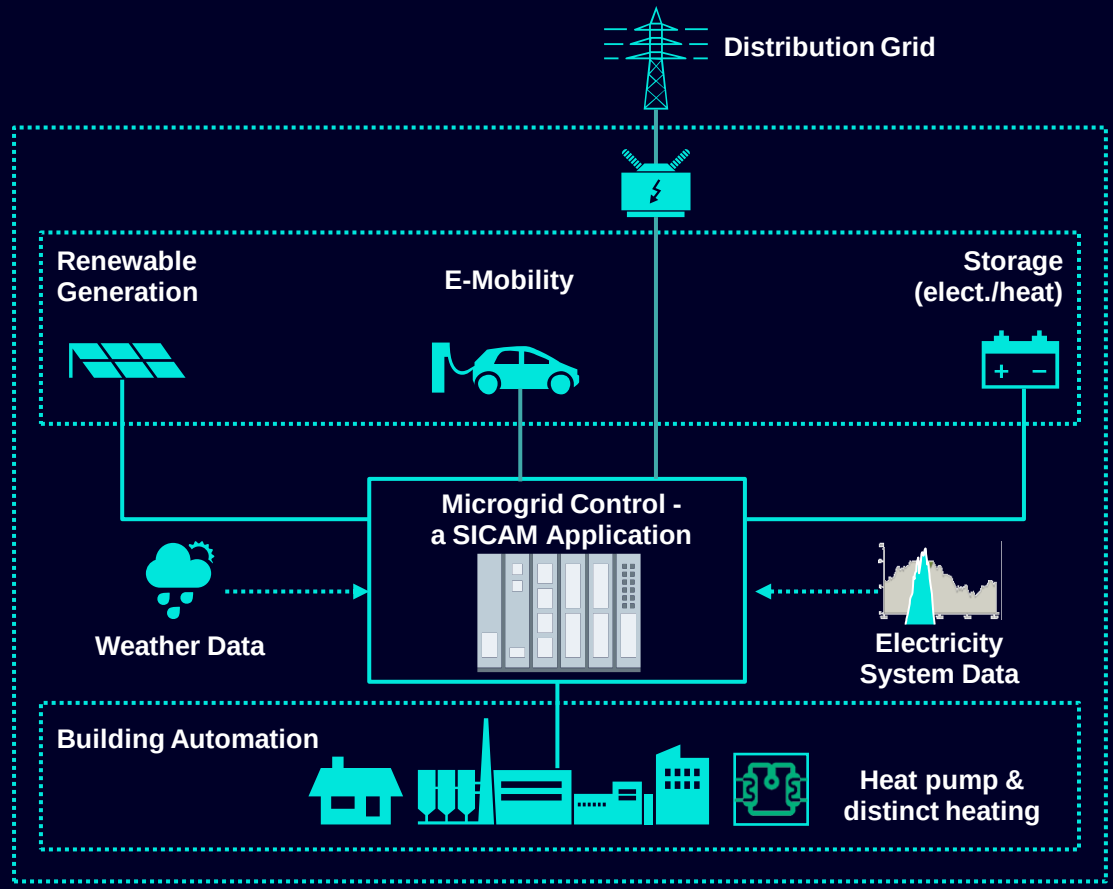
Component

- Microgrid Control – a SICAM application
- Siemens Sinorix extinguishing system
- Siemens Charging Solutions (CPC 50, Versicharge, AC22, TOP Charge)
- Energy IP Data Visualization
- Kaco inverters

Features

- Peak shaving
- Storage control
- Weather forecast
- Alarms
- Data Collection Monitoring and analytics
- E-charging stations & management

Configuration



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Islands and remote sites – Ensuring energy resiliency

Current situation

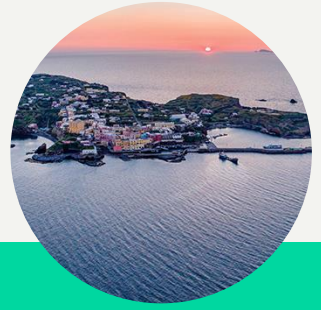
- Reliant on mostly single source energy supply
- Black out
- Dependency on fossil fuels
- control system not prepared for renewable sources

Solution

- Optimize/ re-configure energy supply
- Optimize spinning reserve and fuel consumption
- Integrate renewable resources and battery systems

Achievements

- Improve resiliency
- Black out prevention on the island/ remote site
- Optimize energy mix using fossil fuel and renewable resources
- Optimal use of fossil fuel and renewables integration



Microgrid control helps islands & remote sites ensure resiliency and integrate renewables.

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Island
capability and resynchronization

Self-supply
using CHP, photovoltaics and battery storage

Market
participation for energy and ancillary services

Lemene Commercial Campus, Finland

“Our partnership with Siemens has strengthened even more along LEMENE-project. LEMENE ensures the security of electricity in Marjamäki Business Park, which offers an innovative, intelligent business ecosystem for companies”

Toni Laakso – *CEO, Lempäälän Energia ltd.*

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LEMENE Microgrid, Finland

Revenue generation through market participation and self-sufficient electrical grid

Challenges

- Optimize energy costs through the lowest cost generation mix
- Achieve self sufficiency and energy efficiency leveraging photovoltaics, CHP and battery storage
- Enable advanced Microgrid functionality such as demand charge reduction, energy market participation, ancillary programs such regulating power, and islanding from the grid.

Benefits

- Optimizes energy production and self sufficiency considering heat and electricity demand
- Provides resilience through black start capability, seamless island transfer and operation
- Increase revenue stream by enabling energy and frequency regulation markets participation

Solution

Siemens Microgrid Control – a SICAM application with interface to the energy and ancillary market is installed to integrate, control and optimize 8 MW CHP, 4 MW solar, 3 MW battery, 130 kW fuel cells, utility metered electricity, and more

- Microgrid Control enables use of the most efficient energy mix to maximize the profit for Lempäälän Energia
- Integration and optimization of renewables
- Islanding mode

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LEMENE Microgrid, Finland

Revenue generation through market participation and self-sufficient electrical grid

Customer environment

- Increasing energy cost
- High thermal demand
- Fluctuating load profile
- 8 MW CHP (6), 4 MW solar (2), 3 MW battery (2), 130 kW fuel cells (2), utility metered electricity

Use case

- Energy cost reduction
- Increase resiliency
- Increase energy independence
- Renewable integration
- Energy market participation
- FCR Market participation

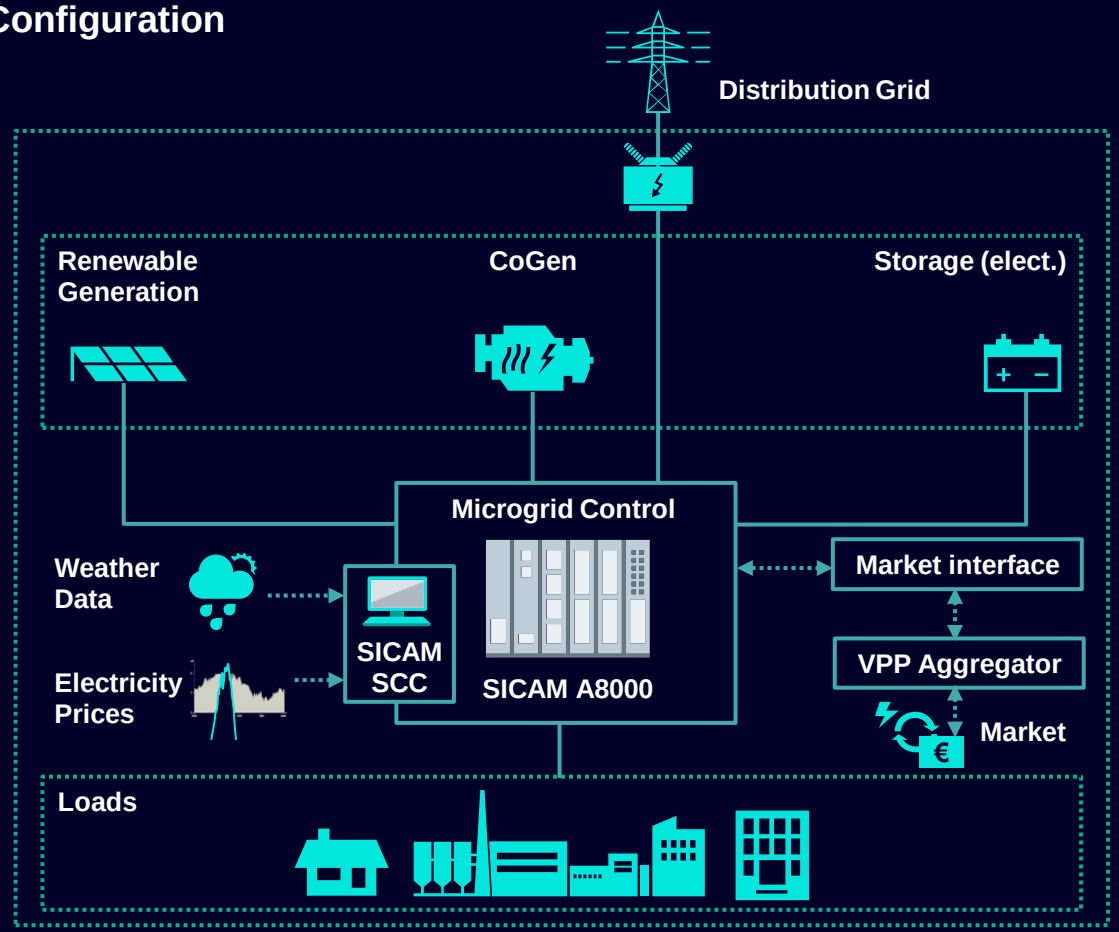
Component

- Siemens Microgrid Control – a SICAM application

Features

- DER control
- Island operation
- Reserve monitoring
- Tie-line control (peak shaving, Energy import/ Export control)
- Blackout detection
- Monitoring, alarms
- Demand charges
- Energy market interface
- Ancillary market interface

Configuration



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Critical Infrastructure/ Military Institutions – ensuring energy resiliency

Current situation

- Reliant on fossil fuels
- Only critical loads are supplied
- Control system not prepared for renewable sources

Solution

- Ensure grid resiliency
- Extend emergency supply also to none critical loads
- Decrease energy costs (tariffs, KPIs)

Achievements

- Grid availability maximization
- Energy cost reduction

Microgrid control helps critical infrastructure ensure energy resiliency.

SIEMENS

Link: EGAT Sirindhorn Siemens Press Release

First Pilot

world's largest Hydro-Floating Solar Hybrid Project, integrated in existing environment

81MW

Balancing between 45MW Solar Power and 3x12 MW Hydro Power

Technology

Grid modernization by Siemens SICAM MGC and redundant SICAM PPC

Electricity Generating Authority of Thailand (EGAT)

Hydro-Floating Solar Hybrid at Sirindhorn Dam, Thailand

"EGAT is committed to grid modernization by leveraging various technologies and innovations. Our main goal is to promote the use of clean energy and reduce carbon emissions to net zero (Net Zero Emissions) in the future in accordance with the National Energy Plan."

Prasertsak Cherngchawano – *EGAT Deputy Governor*

SIEMENS

EGAT Sirindhorn Dam, Thailand
The world's largest Hydro-Floating Solar Hybrid Project

Challenges

- Hybrid technology to enable a stable power-infeed using renewable energy sources.
- Integration in existing grid environment.
- Use areas that were previously unused - protect valuable farmland
- Reduce carbon emissions to net zero (Net Zero Emissions) in the future in accordance with the National Energy Plan

Benefits

Technical benefits

- Grid-serving behavior - supporting grid stability
- Using existing grid environment avoiding expensive extension.
- Real-time data for analytics and decision making for appropriate energy management.

Commercial benefits

- Reducing carbon emissions: 47.000t CO_2 emission reduction per year
- Maximizes efficiency in managing electricity generated from the two sources

Solution

SICAM Microgrid Control with SICAM Photovoltaic Plant Control systems balance the energy mix:

- Solar power generation capacity of 45 MW
- Hydroelectric capacity of 36 MW

- One Platform for both
- Proven, robust
- Easy maintenance
- For PV Control, Plant Control as well as substation automation

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EGAT Sirindhorn Dam, Thailand
Energy Management System

Customer environment

- 3x12 MW Hydro Plant
- 45 MW Floating PV Solar
- Weather Sensor and Sky Imager
- 2x115kV Line to SRD2 (Grid)
- Dispatch control center

Use case

- Renewable integration
- Flexible power generation

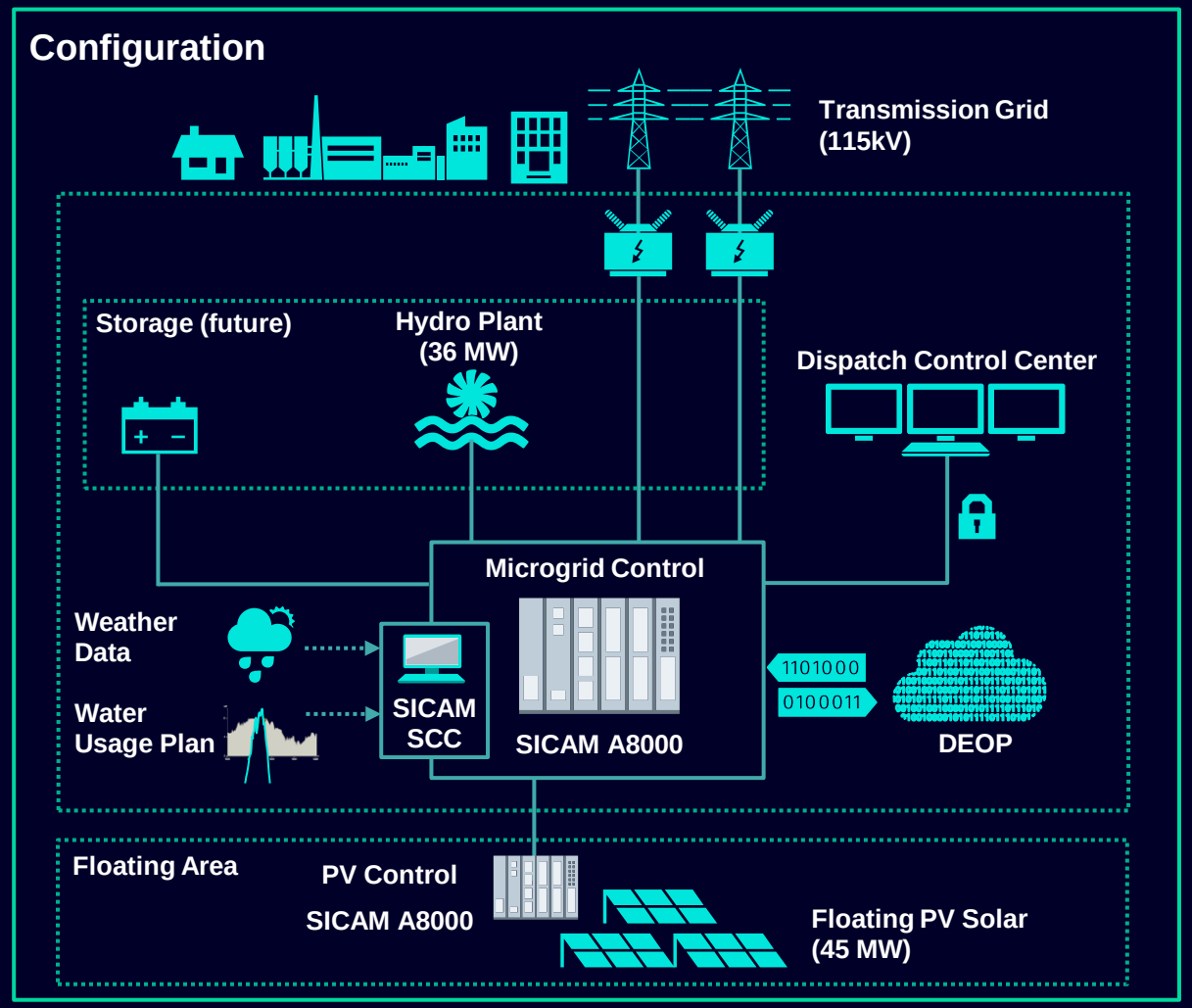
Component

Microgrid Control – a SICAM application
Photovoltaic Plant Control & Monitoring - SICAM applications
Distributed Energy Optimization (DEOP)

Features

- DER control
- Hydro-floating PV integration
- Enhance power delivery response time
- Utilizing forecast data
- Power sharing
- Monitoring, alarms
- Cloud monitoring dashboard

Configuration



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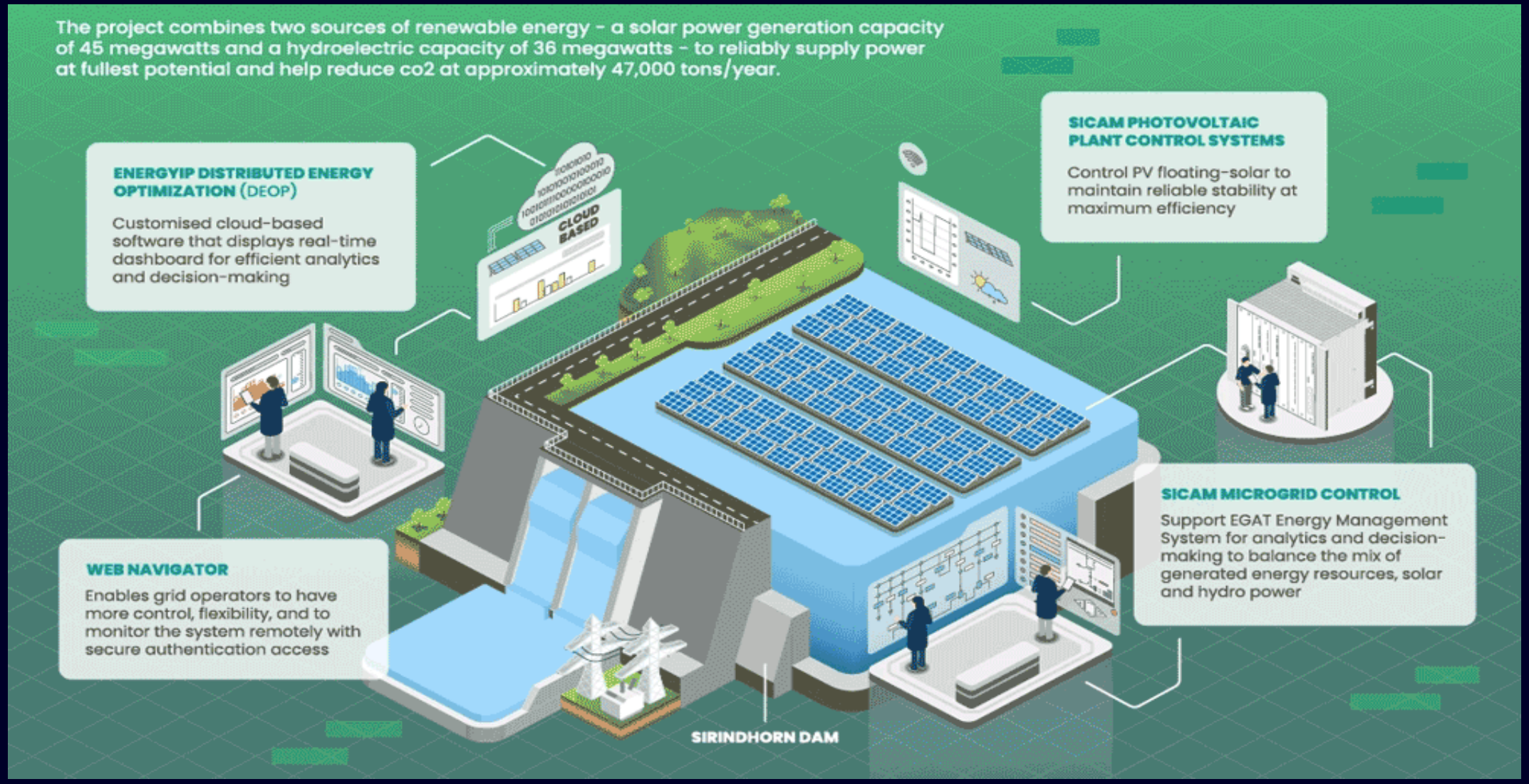
EGAT Sirindhorn Dam, Thailand



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Microgrids – Cyber Security & Standards

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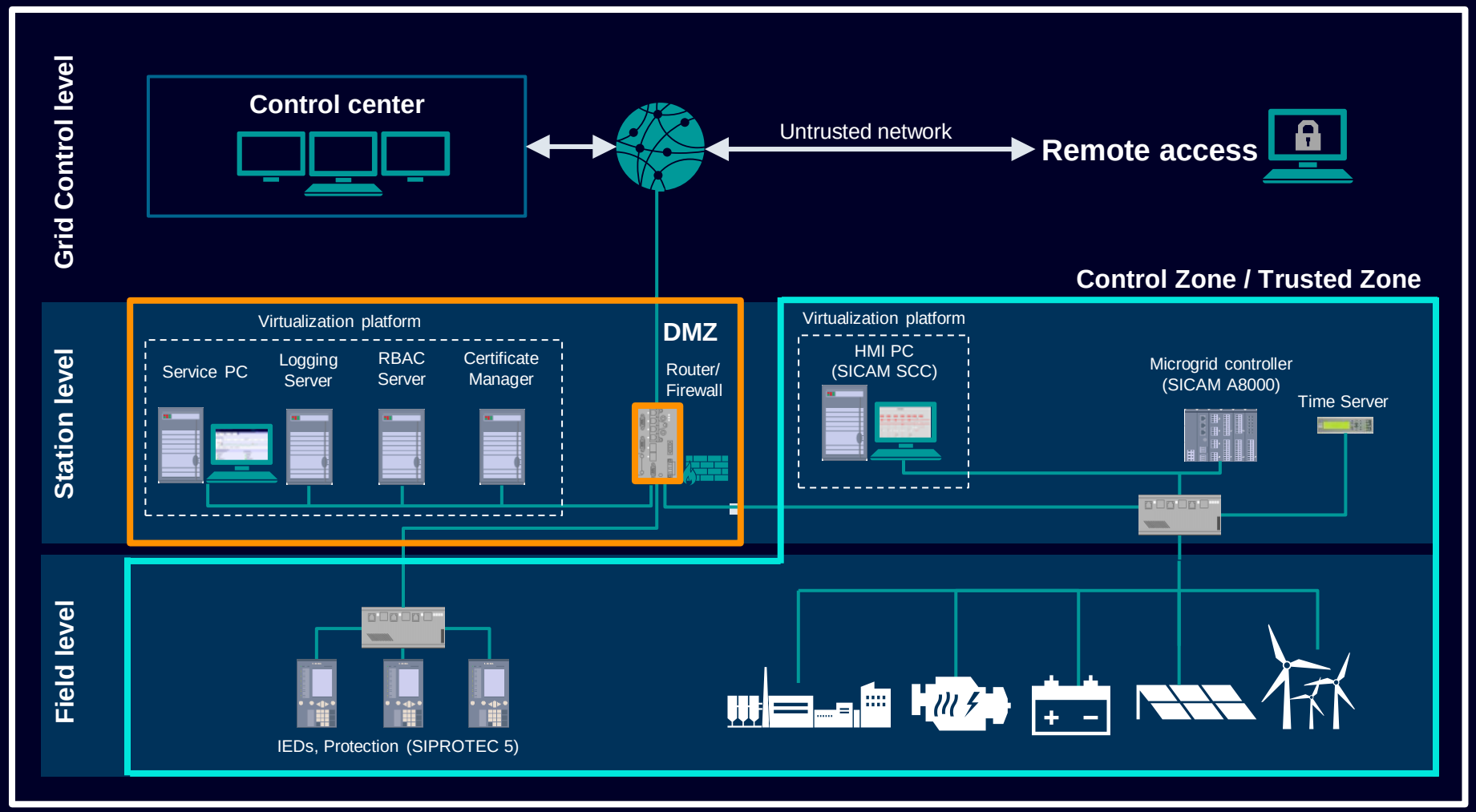
Cyber Security in Microgrids and PV plants

IEC 62443 certified solution



Cyber security measures

- System hardening
- Security patching, Backup and restore
- Malware protection
- Data protection, data integrity and system architecture
- Secure remote access
- Access control and account management
- Security logging and monitoring

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State of the art platform and hardware
for reliable and secured PV plant control and monitoring

Reliable long-term service

- High availability of equipment
- Reduced operational downtime
- Reduced maintenance, operational, and ownership costs
- World-class services and technical support from the global market leader in energy automation
- Extension of product and system lifetime

Certified cybersecurity

- ISO/IEC 27001
- IEC 62443
- IEC 62351
- NERC CIP, BDEW compliant

Utility standards

- More than 400.000 IEC 61850 / IEC 60870-5-104 devices ensure high reliability.
- Engineering tool – Toolbox II and device manager
- Certified according A Level by KEMA

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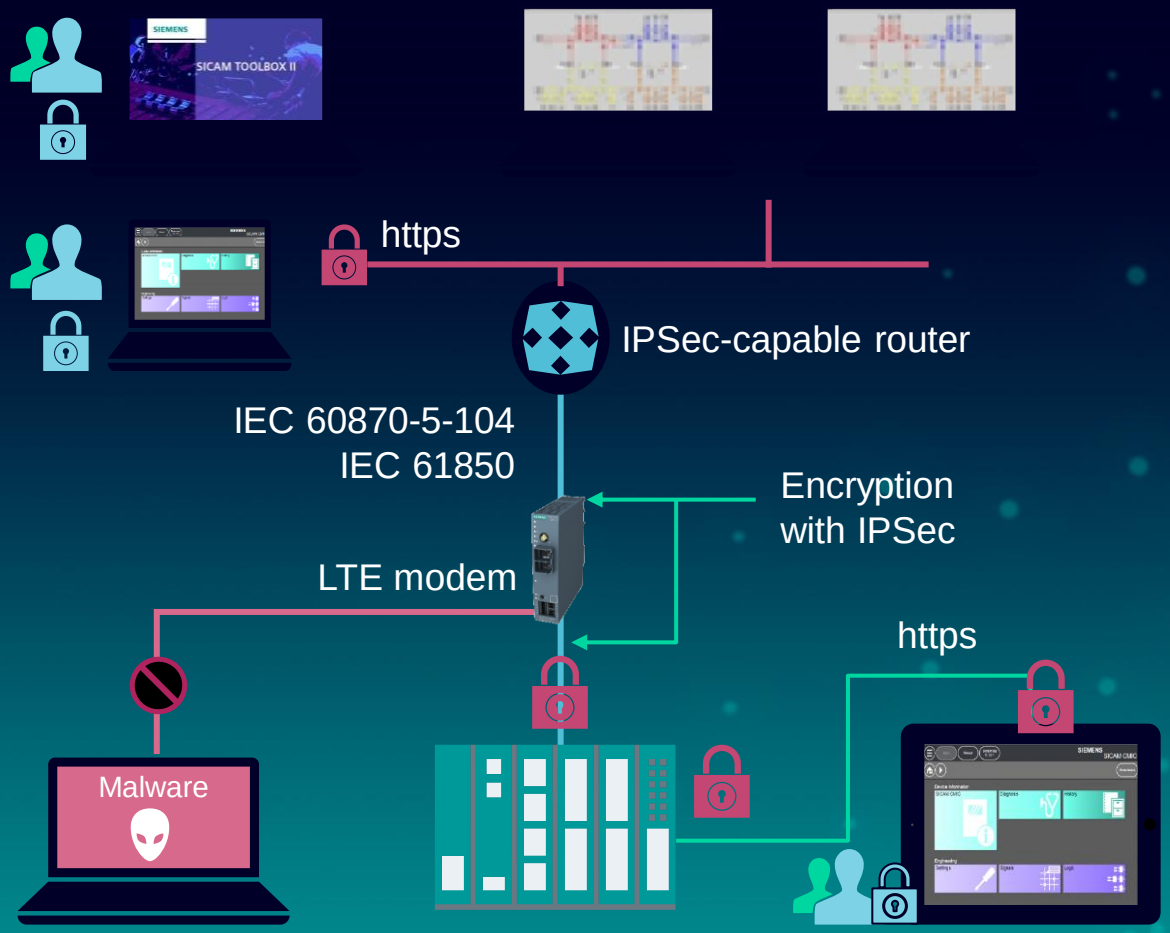
PV Plant – Monitoring & Control
SICAM A8000 - Features for better Security



More security for distribution automation with SICAM A8000

- Secured configuration over https with SICAM TOOLBOX II and SICAM WEB
- End-to-Site secured process communication with IPSec between SICAM A8000 and the control center
- Misuse of the communication stretch between SICAM A8000 and the control center is not possible thanks to IPSec

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International Standards

For Microgrid Control certain international standards are relevant depending on the region. Microgrid Control is compliant to following standards[1)]:

- IEEE 2030.7 Microgrid Controllers
- IEC TS 62898-2 Microgrid Operations

Following standards are applicable for projects using Microgrid Control and are supported by Microgrid Control:

- IEEE 2030.8 Testing
- IEC TS 62898-1 Microgrid Planning

Microgrid Control prototype certification issued from:

- TÜV NORD VDE-AR-N 4110 (Germany)

1) No certification available/ planned

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Hvala na pažnji!

Pitanja?

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