SIPAPER Power Intelligence

Systems for smart power distribution & electrification systems

SIEMENS energy

SIPAPER Portfolio Overview

Integrated **SIPAPER** Solutions

Industry Software
MindSphere, COMOS, XHQ, …

Drive Technology
SINAMICS, SIMOTICS, FLENDER, ...

Industrial Automation
SIMATIC, SIPLUS, …

Energy Management
SIMOCODE, SIVACON, SIPROTEC, ...

Industry Services
Corrective / Preventive / Preventive Services

SIPAPER Digital Fiber™
Continuous improvements in plant performance and maintenance

SIPAPER
Drive Systems

SIPAPER Drives APL

SIPAPER Winder APL

SIPAPER Drives Basic

SIPAPER
Process Automation

SIPAPER DCS APL

SIPAPER QCS APL

SIPAPER APC

SIPAPER XHQ / MIS

SIPAPER
Power Distribution

SIPAPER Power

SIPAPER π
Power Intelligence

SIPAPER
Operations

SIPAPER
Remote Services

SIPAPER
Extended Lifecycle

World-class products   +   **pre-engineered, industry-specific modules**

SIPAPER Power Intelligence Modules

SIEMENS energy

SIPAPER Power Intelligence

Level	Solution "Product"	Technical Aspects	Benefits
1	**Power Base Monitoring**	• Comprehensive and user-friendly monitoring applications for MCC lineups as well as LV and MV switchgear infrastructure • KPI based power dashboards and reports • Technology based on SIMATIC Software	+ **Cost-efficient** due to monitoring only + **Increased transparency**
2	**Advanced Switching and Monitoring (AS&M)**	• Energy Switching and Monitoring on SCADA level based on PCS 7 PowerControl and standardized SIPAPER designs • Switching of LV and MV switchgears, e.g. 3WL and SIPROTEC • Communication via protocols PROFINET, IEC 61850 or PROFIBUS	+ **Comprehensive** and **user-friendly** control + **Unified** PCS 7 platform + **Increased transparency**
3	**Load Shedding Generation Management**	• Intelligent Load Shedding, Load Sharing and Synchronization algorithms to **safely** and **efficiently** run power systems in island and net mode • Integration into existing AS&M base	+ **Avoid blackouts** + **Increased efficiency** in Power Generation + **Increased automation**
4	**Thermal and Electrical Energy Control** (in development)	• Optimization of steam distribution based on needs of the power system • Highly sophisticated models of steam and electrical systems • Interconnection of Power System and Process	+ **Decrease venting** of HP Steam + **Increased Decarbonization**

SIPAPER PI
Hardware

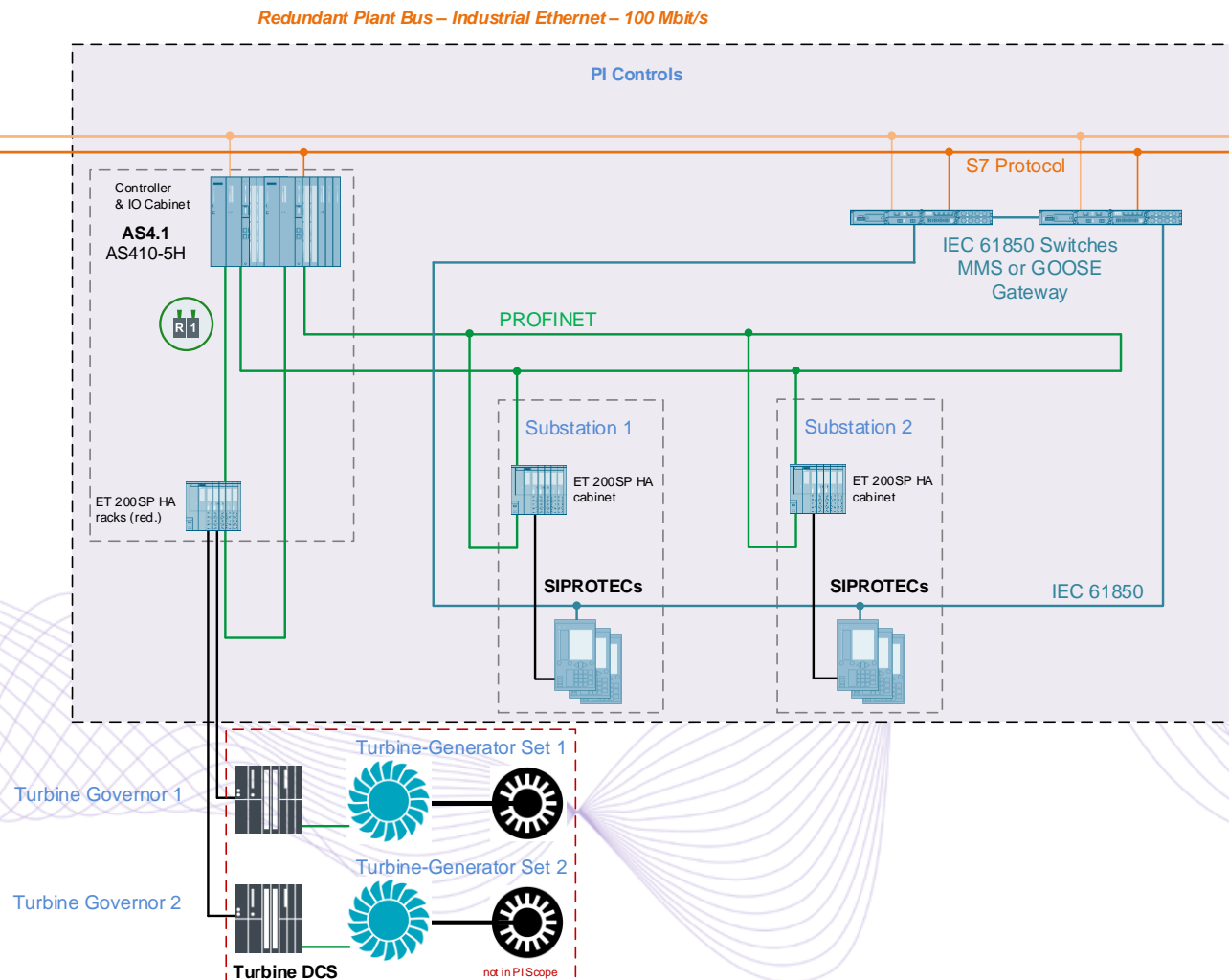# SIPAPER π – Powerful hardware for highest availability
High flexibility on substation field level

Main Features

- Flexibility in topology design: from S1 (no redundancy) to R1 media redundancy with CPU 410-5H controllers and ET 200SP HA modules

- Critical signal exchange via hardwired PROFINET and/or state-of-the-art IEC 61850 communication

- Scalability of power management solutions from SCADA only to intelligent Load Shedding and Generation Management

Customer Value

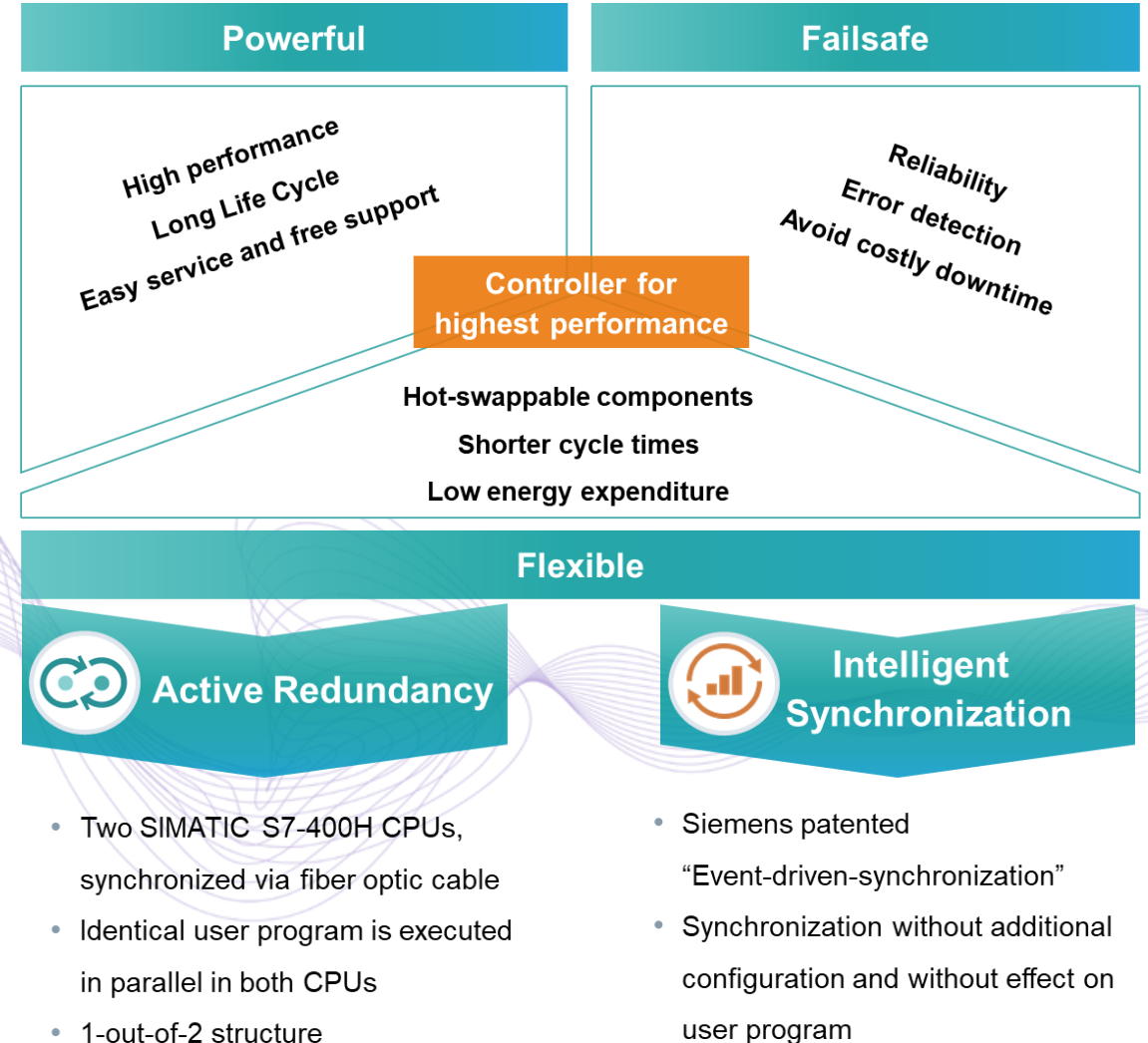- Increased investment security with scalable solutions adjustable to customer's needs

SIPAPER π – Powerful hardware for highest availability
PCS 7 CPU 410-5H controller for power automation

✓ Operating temperature **up to +70°C**

✓ ISA-S71.04 **G3 compliant**

✓ Up to 7.500x I/Os | 250x PROFINET devices per PN interface | 96x PROFIBUS (extendable)

Powerful	Failsafe

Powerful

High performance
Long Life Cycle
Easy service and free support

Controller for highest performance

Failsafe

Reliability
Error detection
Avoid costly downtime

Hot-swappable components
Shorter cycle times
Low energy expenditure

Flexible

Active Redundancy

- Two SIMATIC S7-400H CPUs, synchronized via fiber optic cable
- Identical user program is executed in parallel in both CPUs
- 1-out-of-2 structure

Intelligent Synchronization

- Siemens patented "Event-driven-synchronization"
- Synchronization without additional configuration and without effect on user program

A. Beck | SE O SO FI TS   **6**

SIPAPER π − Powerful hardware for highest availability
PCS 7 ET 200SP HA signal modules for fast load shedding

✚ **Modular I/O series with one of the lowest footprint in process industries DCS**

✚ **Compact dimensions**
- 203 x 163mm (high x depth)
- 16/32 channels at 22,5mm wide card
- up to 56 I/O modules per rack
- Cabinets with highest I/O density

✚ **Ready for the field**
- -40°..+70°C horizontal mounting
- -40°..+60°C vertical mounting
- conformal coating, NE21 conform (ISA-S71.04 G3)
- operation up to 4,000m above sea level

✚ **Highest availability**
- redundant 24V power supply
- redundant PROFINET interface
- redundant I/O modules

✚ **Quick and easy wiring**
- PROFINET connection via RJ45, Fast Connect and fiber optic LC connector
- field wire up to 2.5mm^2 with Push-In
- no screws, no torque testing

✚ **Easy maintenance**
- Online module replacement
- Online hardware configuration
- Online firmware update
- Identification & Maintenance data

New!
- Counter and frequency measurement
- Temperature values 24 Bit resolution
- TIA V16 Integration

✚ **Full Range of I/O functionalities**
- DI 24V with field device supply and 1ms time stamp
- DI 125V DC and DI 120..240V AC
- DQ 24V and RQ changeover relays 240V AC / 5A
- AI 0/4..20mA with multi variable HART
- AI for Thermocouple and RTD
- AQ with HART
- Configurable module with AI / DI / DQ
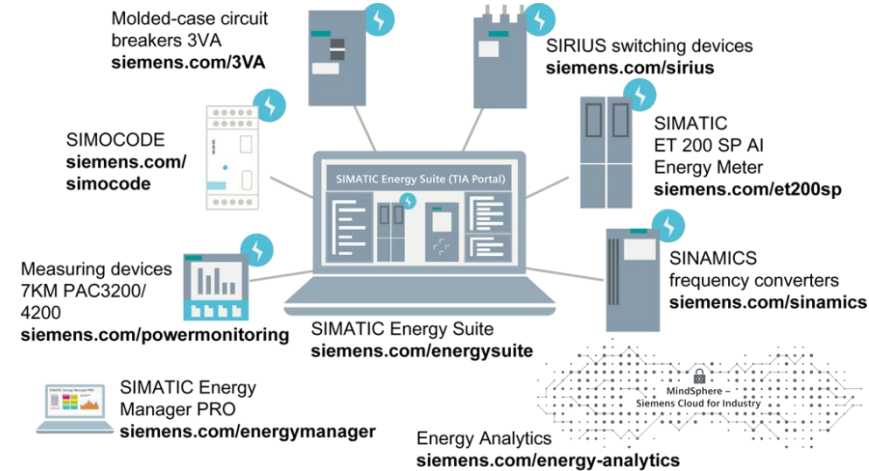- Available soon: Vibration Protection Module for up to 4 vibration signals per module
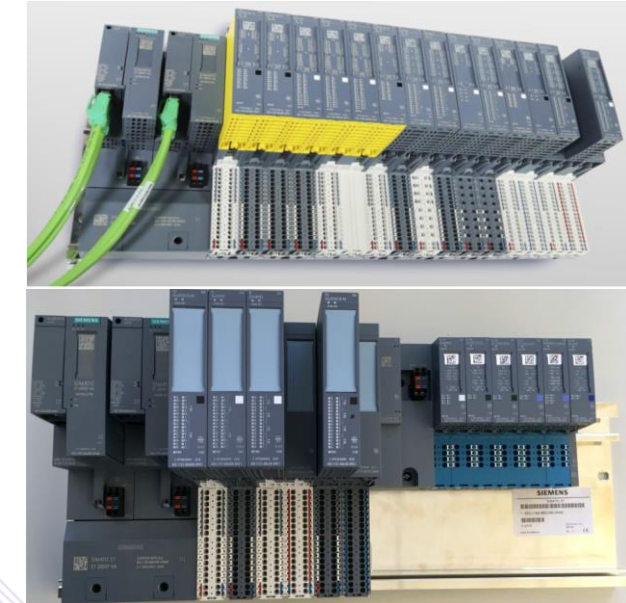
✚ **Certificates**

SIPAPER PI
Power Base Monitoring

SIPAPER π Power Base Monitoring – Features

SENTRON powermanager

+ Cost-efficient
+ Increased transparency
+ Pre-dominantly for small & medium LV applications

- Web-based monitoring of LV metering units
- Communication via MODBUS → monitoring of MV switchgears also possible to some extent

SIMATIC Energy Suite

+ Increased transparency
+ Numerous interfaces
+ Numerous components supplying energy data
+ For small & medium non-critical and MV & LV switchgear monitoring applications

SIMATIC Energy Manager

+ Web-based energy analytics
+ Comprehensive KPI dashboards
+ Cloud connectivity (optional)

- TIA Portal based
- Load management available – however not supporting time-critical fault events

SIPAPER PI
Advanced Switching & Monitoring

SIEMENS energy

SIPAPER π Advanced Switching & Monitoring – Features

SIEMENS energy

User-friendly <u>detailed</u> single line overviews of Fiber Mill power networks based on PCS 7
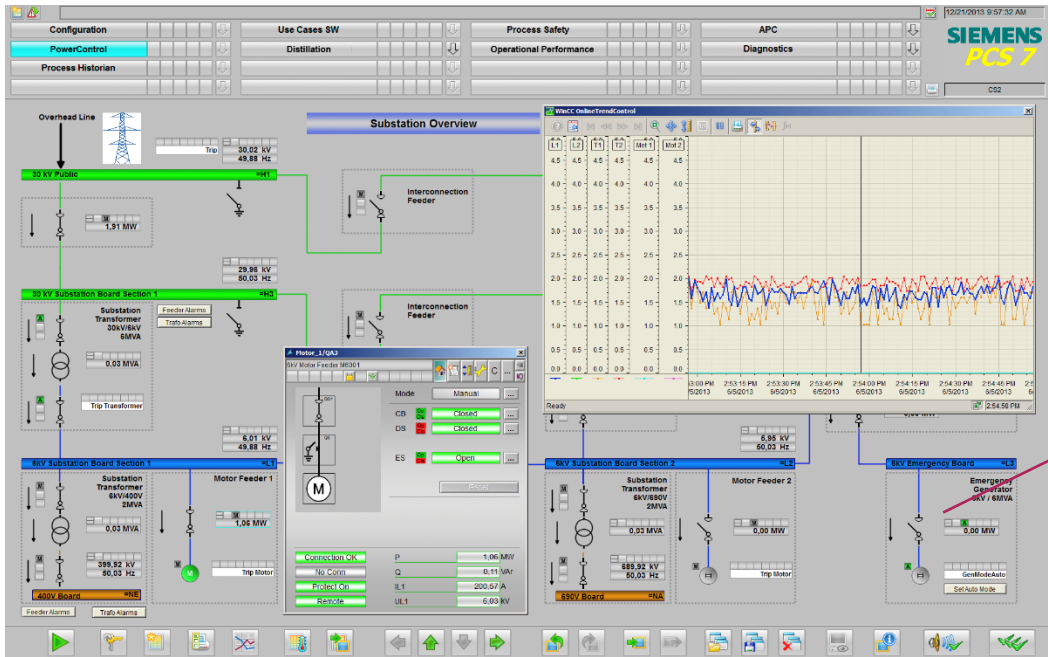
- Detailed IED Faceplates

e.g. SIPROTEC 5 and others

- Robust RUGGEDCOM network components and protocols for highest availability

Meet the standard
IEC 61850

→ **GOOSE**
→ **MMS**

PROFINET

Modbus

PROFI PROCESS FIELD BUS

Media Redundancy &
System Redundancy supported

- Comprehensive Trend Overviews & Reports

Long-term and short-term data storage

Generation of reports for various loads and energy flows

Precise time tracking of individual events (1ms time stamp) based on GPS clocks

Siemens Energy is a registered trademark licensed by Siemens AG.

SIPAPER PI
Load Shedding System

SIPAPER π Load Shedding – Feature overview

Fully **automated shedding** at
- Critical supply outages
- Under-frequency/voltage
- Overload situations
- Power consumption violations

using **intelligent matrix algorithm**

User-friendly and intuitive priority configuration, diagnosis and reporting due to **SIPAPER Look & Feel**

Online simulation of generator, grid and connection trips with simulation reports

Automatic identification of isolated sections and meshed or ring-shaped networks

Fast load shedding with **up to 300 elements**

Real-time load flow calculation and indication
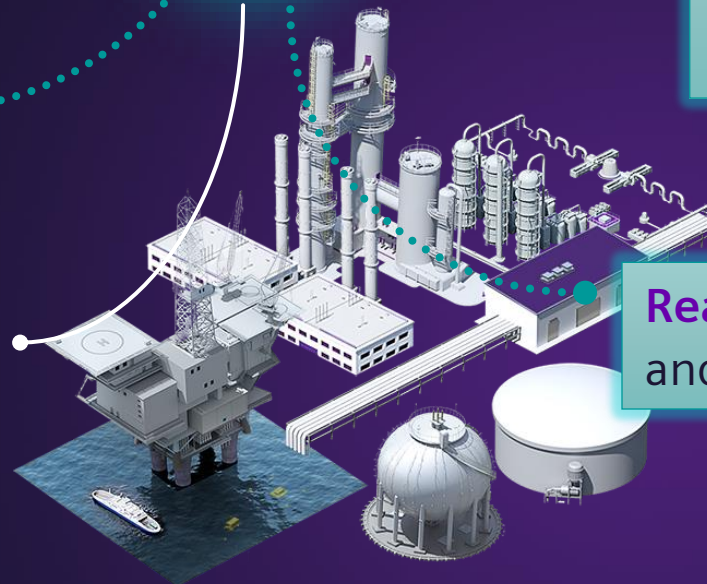
SIPAPER π Load Shedding – Customer benefits

Efficient Engineering & Operation
Cost efficiency through intuitive software engineering and sophisticated HMI design

User-friendly Root Cause Analysis
Diagnostics, operation and monitoring based on well-proven PCS 7 and SIPAPER philosophy

Future-proof Life Cycle Management
Actively managed load shedding software with future updates, improvements and new functions

Increased Availability
Prevention of blackouts and stabilization of the plant's power network

Power Plant 4.0

Efficiency / Performance

Load Shedding Software

Advanced Load Shedding Module

SIPAPER π – Advanced Load Shedding Module Reference – Project example in Brasil

Figure: Screenshot from project example

Technical aspects

- Power system supplying 2 plant parts
- 5 generators
- 3 grid connections
- 3 main busbars
- 117 loads applicable for shedding

Main challenges / requirements

- Fast shedding below 30 ms
- Automatic and dynamic identification of isolated sections, e.g. G2 in island mode because 2D-2E and 2E-2F not closed
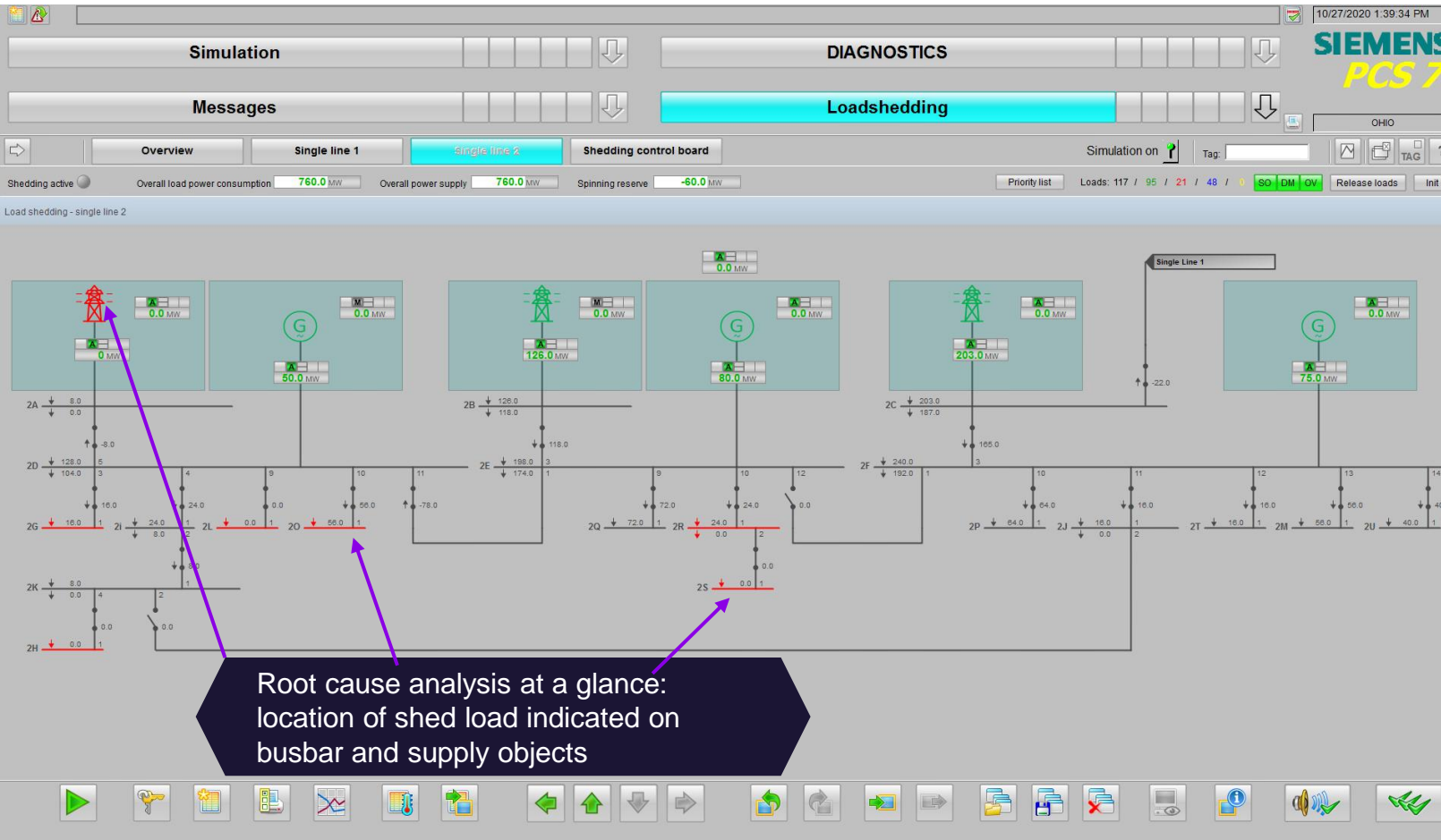
SIPAPER π – Advanced Load Shedding Module
Realtime load flow indication

Figure: Screenshot from project example

Main Features

- Pre-detailed overview of main parts of the electrical system – generating elements, power network topology and bus bar status information
- Realtime load flow indication with arrows next the connections

Customer Value

- Increased transparency at a glance
- Faster localization of failures throughout the plant
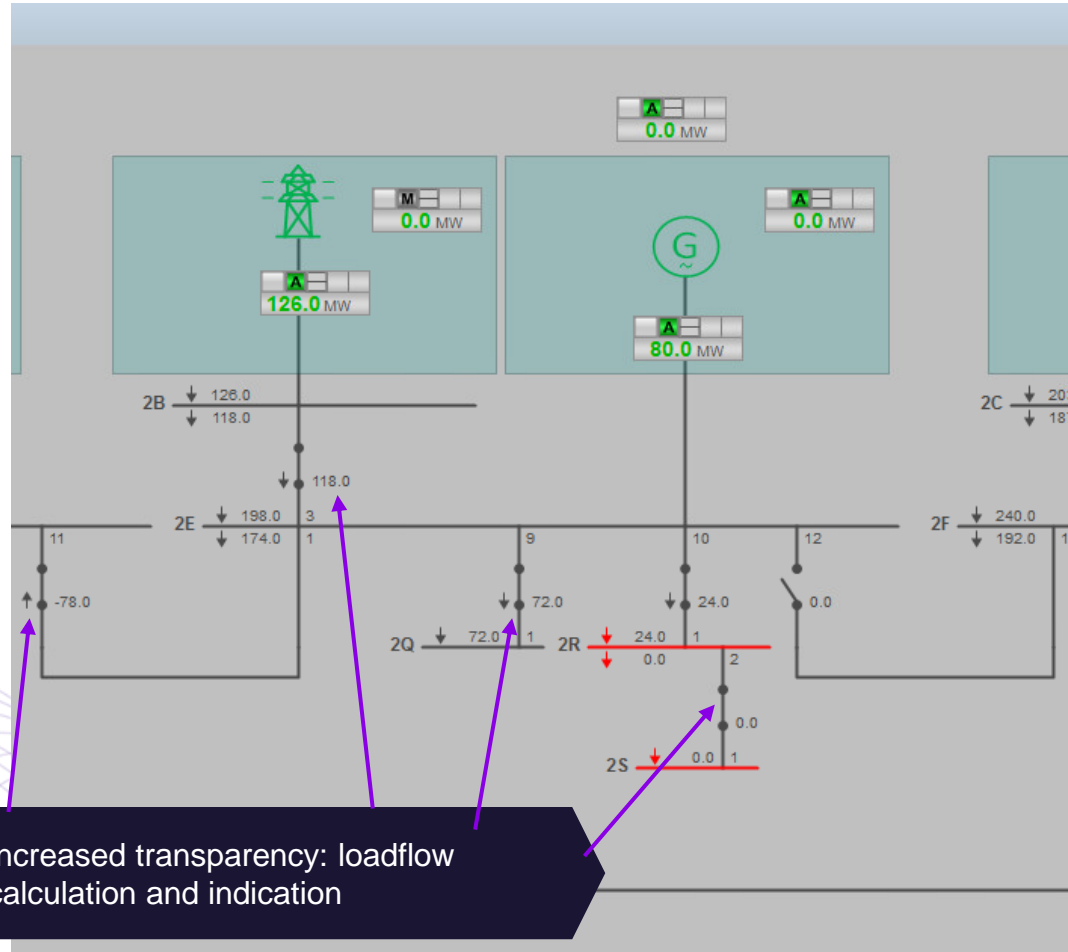
SIPAPER π – Advanced Load Shedding Module
Central shedding control board

Figure: Screenshot from project example

Main Features

- Centralized view on all critical elements of the power system
- Load list with adjustable priorities and priority profiles
- Direct online simulation
- Configurable reporting system

Customer Value

- Fast root cause analysis
- Flexible adjustments of priorities to needs of the process
- User-friendly critical case simulation → preventive decision making
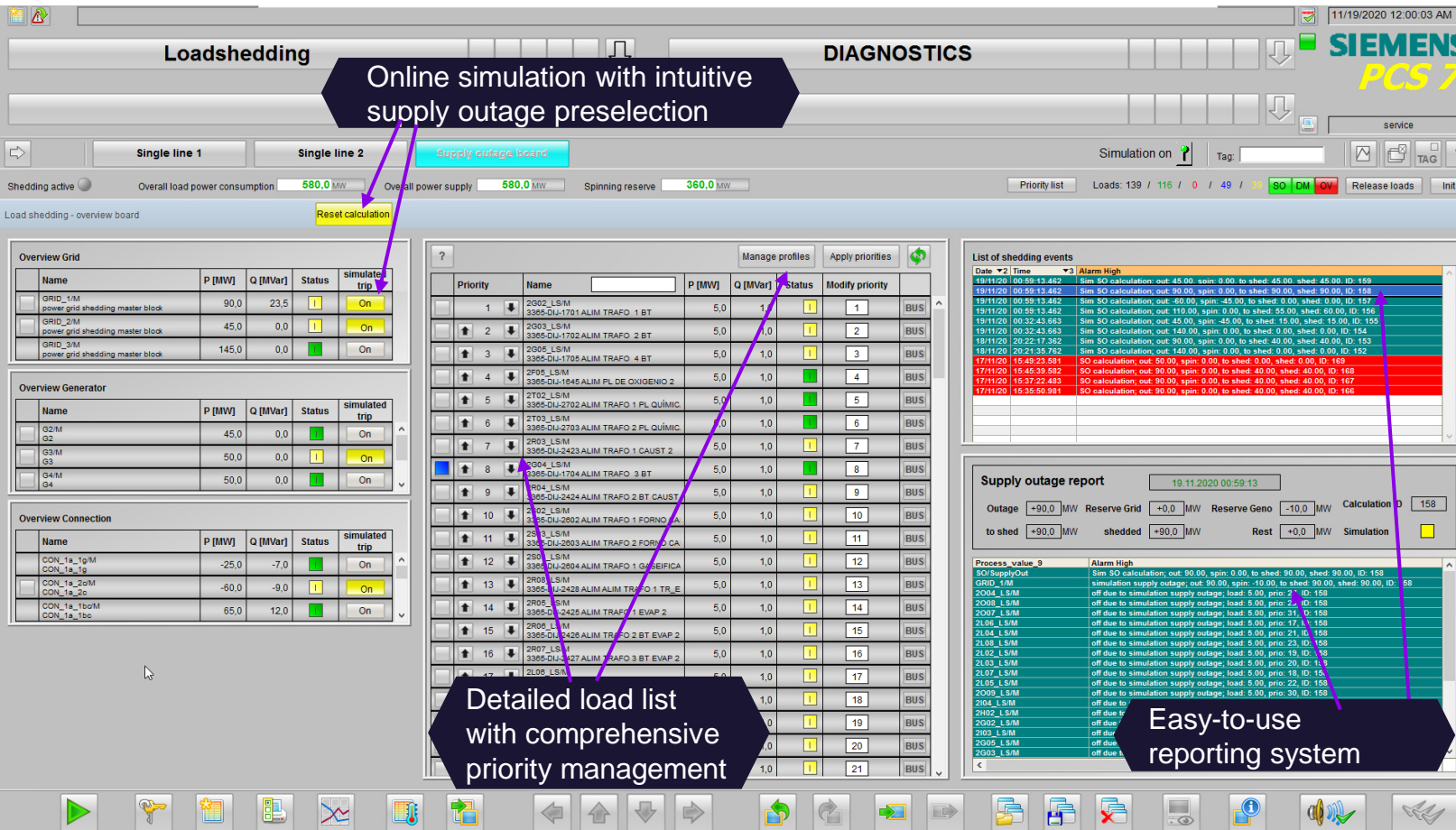
SIPAPER π – Advanced Load Shedding Module
Software based on single line elements – intuitive engineering
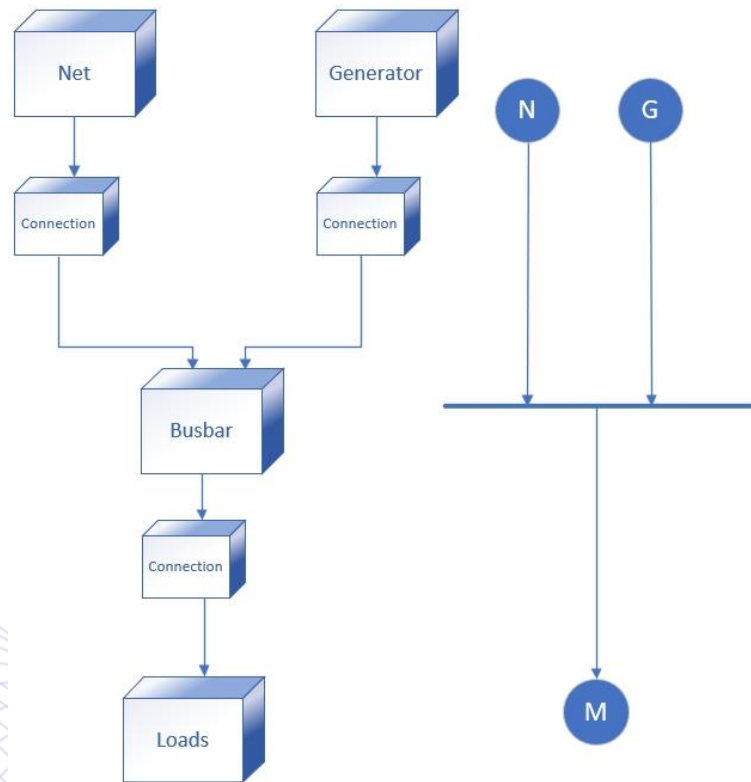
Abstraction of real single line elements

Representation in multi-functional software function blocks

SIPAPER π − Advanced Load Shedding Module
Intelligent matrix algorithm

Matrix_write

Busbar
Connection
Grid
Generator
Load

- connected busbars
- element feedback (On/Off)
- trip signal (OFF pulse)
- active, reactive, apparent power
- max. power values
- overload time intervals
- simulation flags
- priority

Load Shedding Matrix

Value matrix
Connection matrix

Value matrix
- On/Off status
- OFF pulse
- power values
- max. power values
- overload interval times
- simulation status
- priority values

Connection matrix
- connection status of all elements

Matrix_read

Busbar
Connection
Grid
Generator
Load

- element number
- element feedback (On/Off)
- trip signal (OFF pulse)
- active, reactive, apparent power
- max. power values
- overload time intervals
- simulation flags
- priority

Supply outage

- initiation of shedding calculation
- min. load to be shed
- simulation calculation

Connection correction

- initiation of connection calculation
- release

Overload

- min. load to be shed
- break time
- time interval for shedding steps

Supply outage − report data

Report data generation:
- timestamp of shedding event
- tripped power
- spinning reserve
- shed power
- rest of power
- simulation flag

Overload − report data

Report data generation:
- timestamp of shedding event
- tripped power
- spinning reserve
- shed power
- rest of power
- simulation flag

Main Features

- Matrix manages **up to 300 load elements**, reads and writes load element data and inspects if any supplying element or connection is tripped, an overload has occurred, power consumption is violated or frequency has dropped

- **Efficient recalculations** of load system and power data after tripping of a grid, generator or connection element and creation of diagnosis data

- Quick **automatic identification** of the electrical system status

Customer Value

- Highest power system and asset protection with fast shedding reactions

SIPAPER π – Advanced Load Shedding Module
User-friendly and well-organized Load List
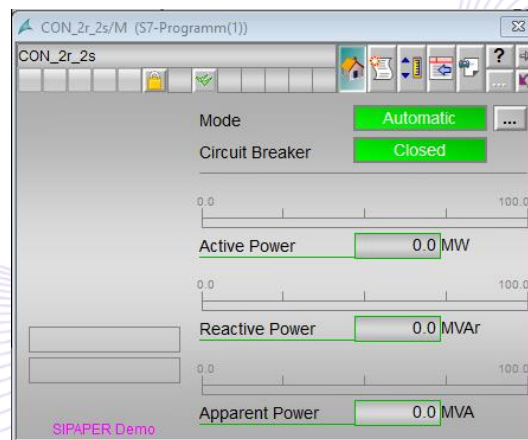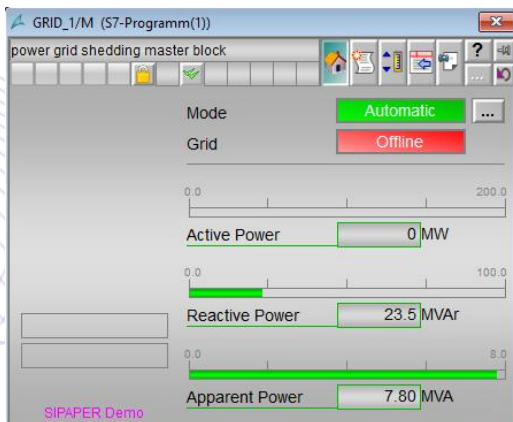

Main Features

- Flexibly scrollable overview of all loads applicable for shedding

- Possibility to flexibly change priorities either by typing or clicking a new priority

- SIPAPER Priority Manager: creation, modification and change of priority profiles for different production scenarios

Customer Value

- Increased transparency

- Increased flexibility in power system adjustments

A. Beck | SE O SO FI TS

SIPAPER π − Advanced Load Shedding Module
SIPAPER operator faceplates
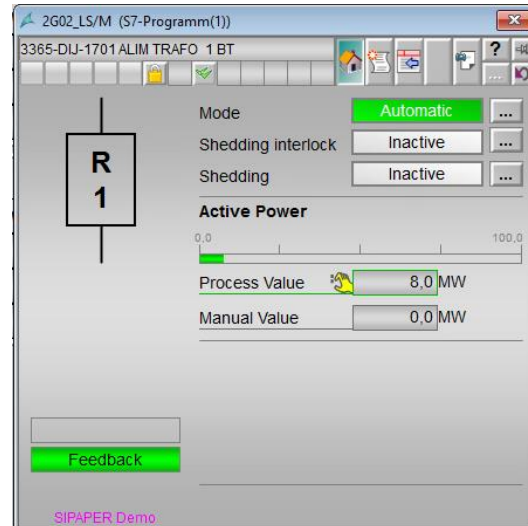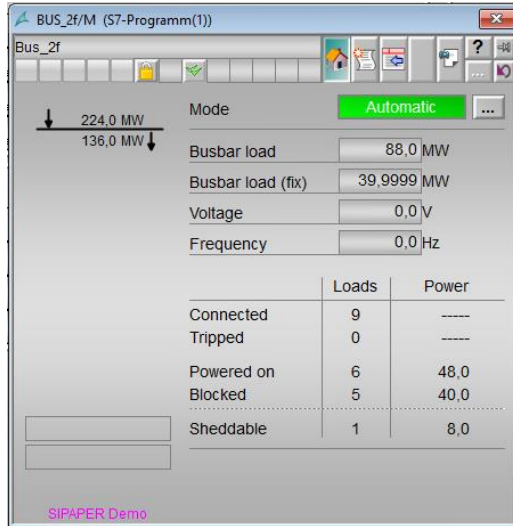
Main Features

- Detailed parameterization of load shedding behavior for each individual element
- Change of operating modes within the load shedding system
  - Automatic – include in load shedding calculation
  - Out of service mode – remove a load from shedding calculation

Customer Value

- Full control and maintenance transparency of the entire load shedding system

A. Beck | SE O SO FI TS   22

November 2020   Siemens Energy is a registered trademark licensed by Siemens AG.

Unrestricted © Siemens Energy, 2020

SIPAPER PI
Synchronization & Voltage Control

SIPAPER π − Synchronization & Voltage Control
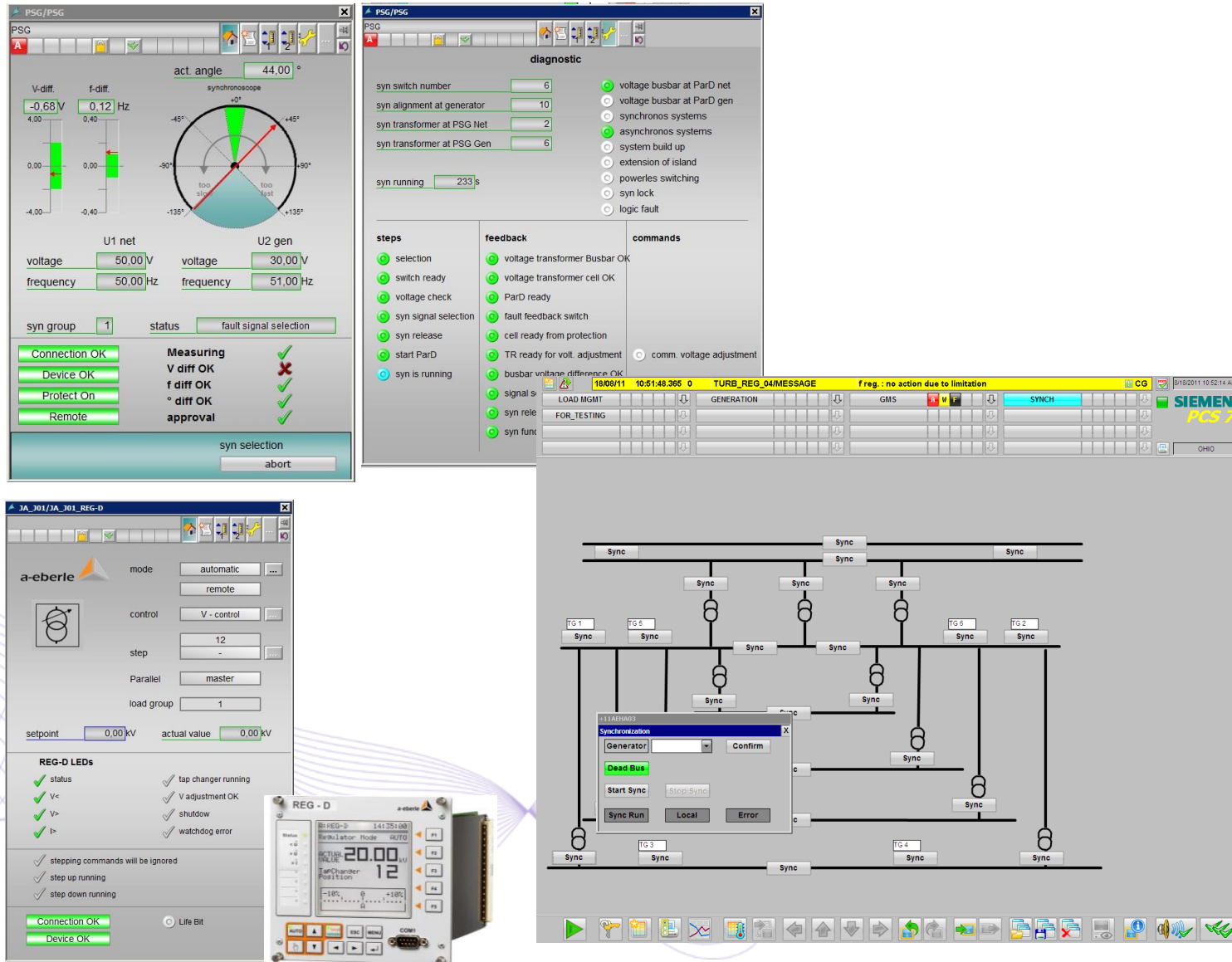
Main features

- Reliable and automatic synchronization and voltage control embedded in the AS&M module
- Integrated WinCC user interfaces for all synchronization points and voltage controllers

Customer value

- Centralized synchronization control
- Unified user interfaces and increased transparency
- Increased automation level for power management

November 2020   Siemens Energy is a registered trademark licensed by Siemens AG.

A. Beck | SE O SO FI TS   24

Unrestricted © Siemens Energy, 2020

SIPAPER PI
Generation Management

SIPAPER π – Generation Management
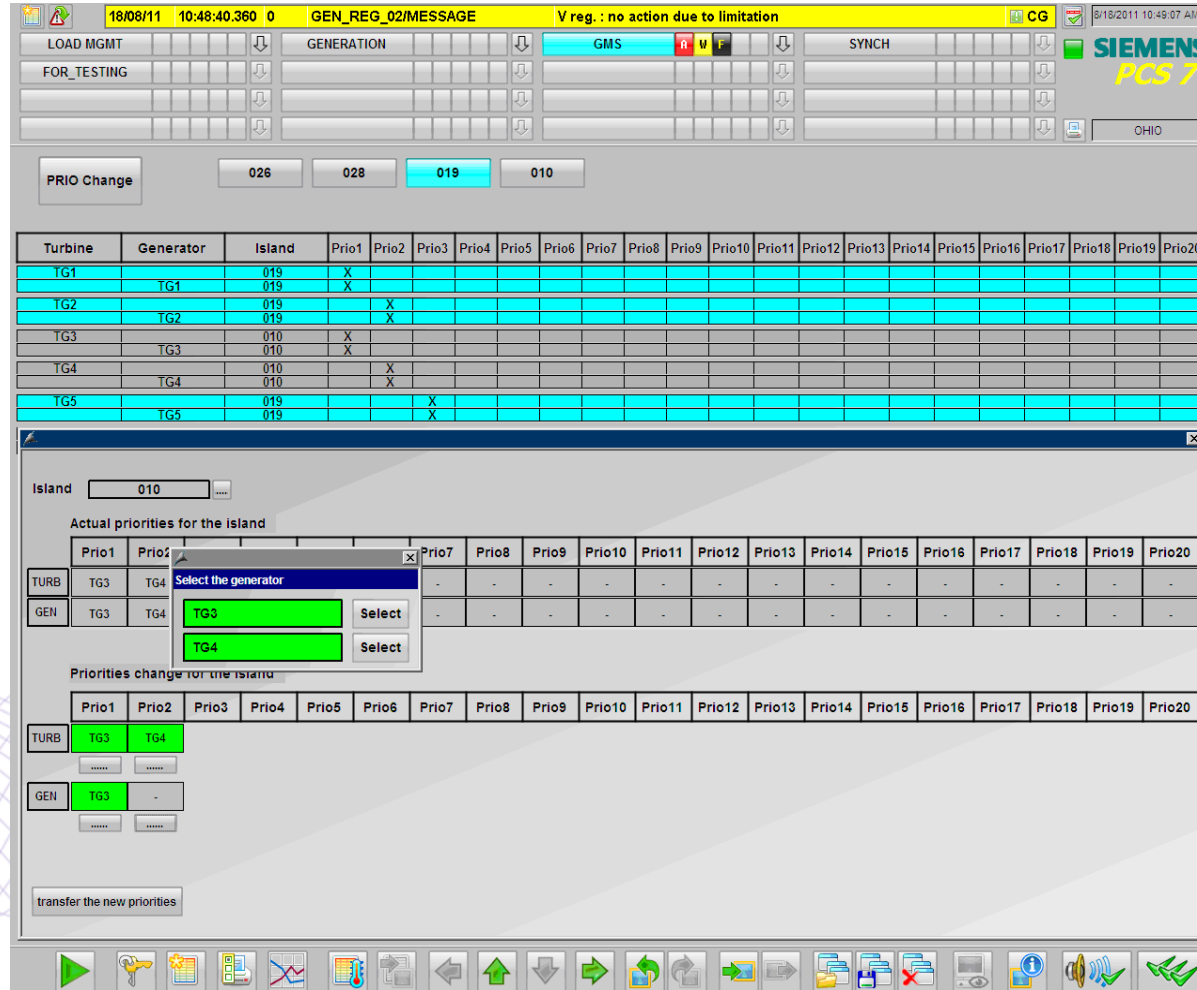## Intelligent load sharing algorithm

Figure: Screenshot from project example

Main Features

- Automated load sharing between all Turbine-Generator Sets supplying the plant Patent protected

- Full control over TG sets, e.g. starting/stopping, spinning reserve configurations

- Protection of assets from over-frequency situations

Customer Value

- Control of generators in most efficient operating range (grid parallel mode)

- High availability of supplying assets in island mode

- Considerably increased automation level of the power generation system

SIPAPER π − Generation Management
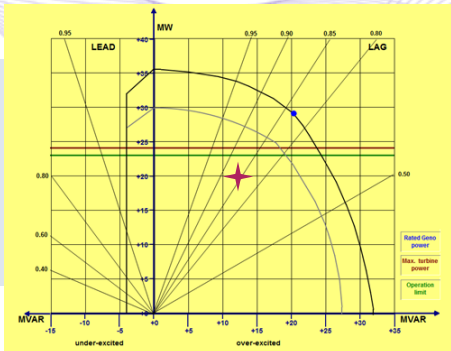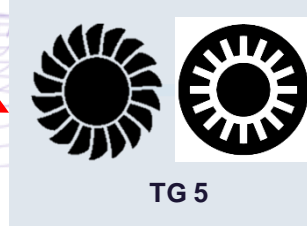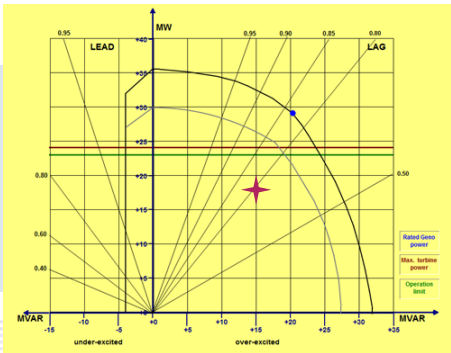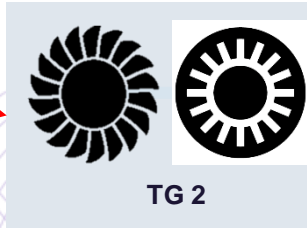## Load sharing overview
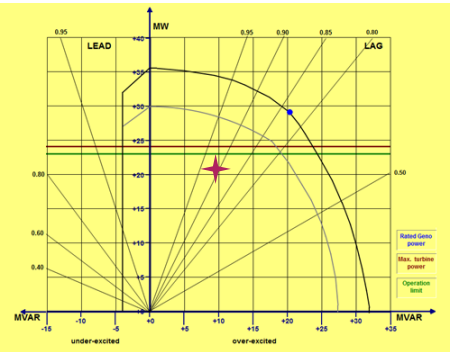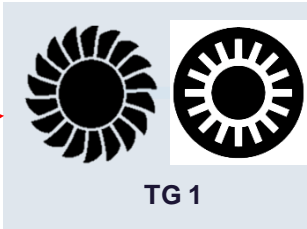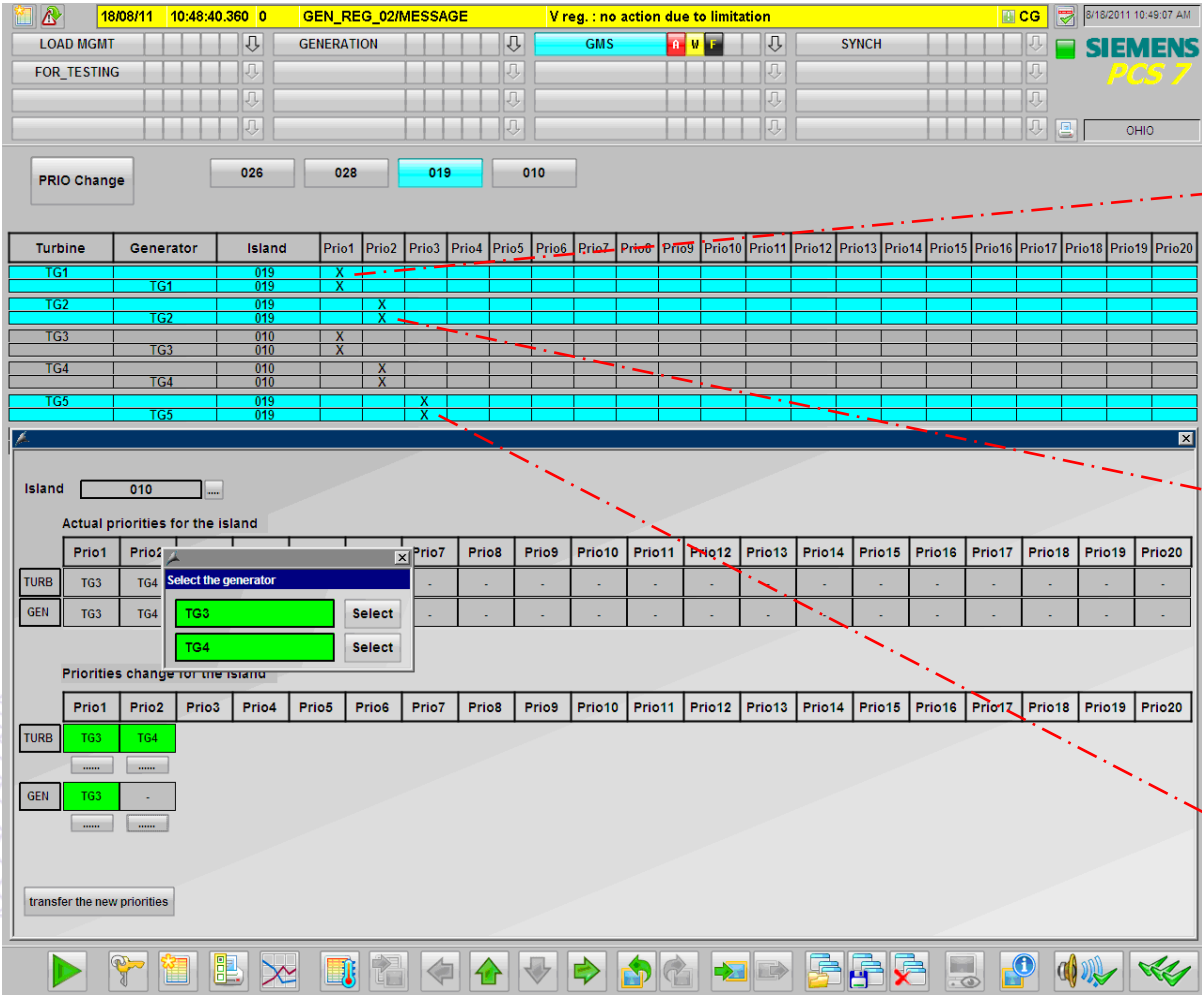
Figure: Screenshot from project example

SIPAPER PI
Advanced Thermal & Power Control
(under development)

SIPAPER π – Load shedding and DCS combined

SIEMENS
energy

Fiber Line

Pulp Dryer

Chemical Plant

Power Consumption
Temperatures
Pressure Values
Tank Levels, etc…

**Process
Controllers**

Meet the standard
IEC 61850

Modbus

PROFI
INDUSTRIAL ETHERNET
NET

OPC

**Process
State A**

**Process
State B**

**Process
State C**

**Process
State D**
*

**Powered by
SIMATIC S7 410-5H + PCS 7**

Shedding /
Inhibition
List A

Shedding /
Inhibition
List B

Shedding /
Inhibition
List C

Shedding /
Inhibition
List D

* PredictiveSuggestion of Shedding priority configuration

Control software under development

SIPAPER π − Combined Steam and Power Cycle

Optimize available power

Decrease venting of HP Steam

Decarbonize

$=$

$f(x) = x^2 + 4xy^3 * 0.5x$

MATHEMATICAL MODEL

$f(x) = sin(x) * y^2 * PI$

A

D

C

STEAM SYSTEM PARAMETERS
- Pressure
- Temperature

GENERATOR & TURBINE PARAMETERS

Powered by
SIMATIC S7 410-5H + **PCS 7**

Recovery Boiler

Power Boiler

Turbine House

Modbus

PROFI NET
INDUSTRIAL ETHERNET

OPC

Turbine & Generator Controllers
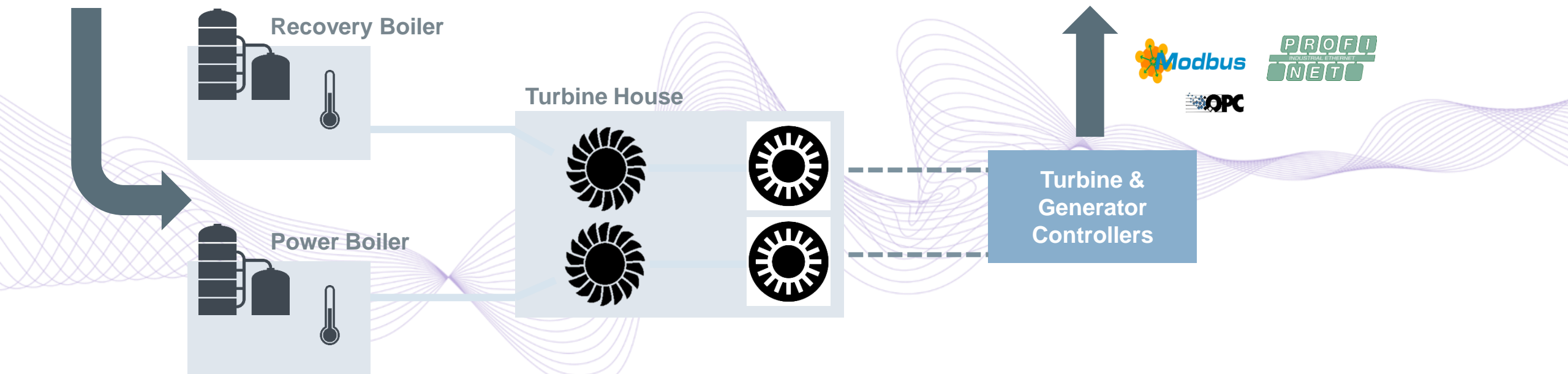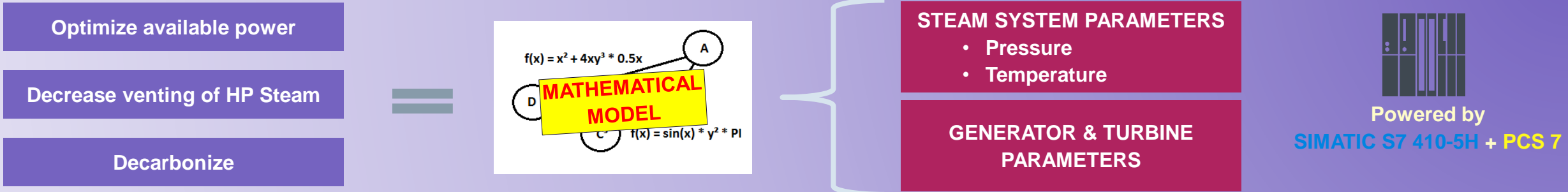
Control software under development

SIPAPER PI
Remote Service & Operation

SIPAPER π – Remote Service & Operation via cRSP

Customer IT Landscape

Front-Firewall

OpenPCS 7 OPC UA Server

DMZ

Back-Firewall

Management Bus – Industrial Ethernet – 1 Gbit/s

Terminal Bus – Industrial Ethernet – 1 Gbit/s

Virtualized Power Intelligence System
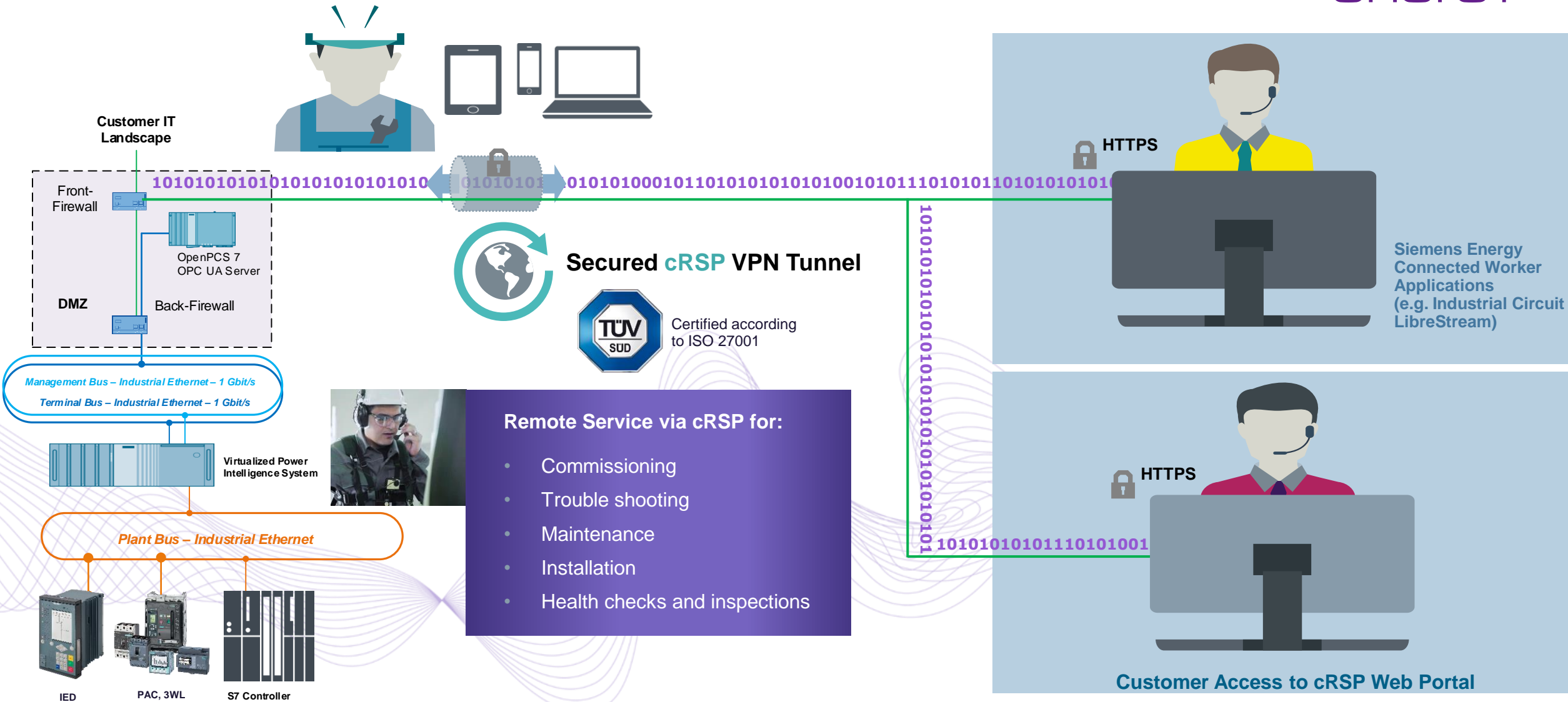
Plant Bus – Industrial Ethernet

IED

PAC, 3WL

S7 Controller

Secured cRSP VPN Tunnel

Certified according to ISO 27001

HTTPS

Siemens Energy Connected Worker Applications (e.g. Industrial Circuit / LibreStream)

HTTPS

Customer Access to cRSP Web Portal

Remote Service via cRSP for:

- Commissioning
- Trouble shooting
- Maintenance
- Installation
- Health checks and inspections

Andreas Beck

Technical Sales & Product Owner SIPAPER PI

Siemens Energy AG

SE GP I SO FI TS

Werner-von-Siemens-Str. 60

91052 Erlangen, Deutschland

Mobile: +49 1522 2873807

beckandreas@siemens-energy.com