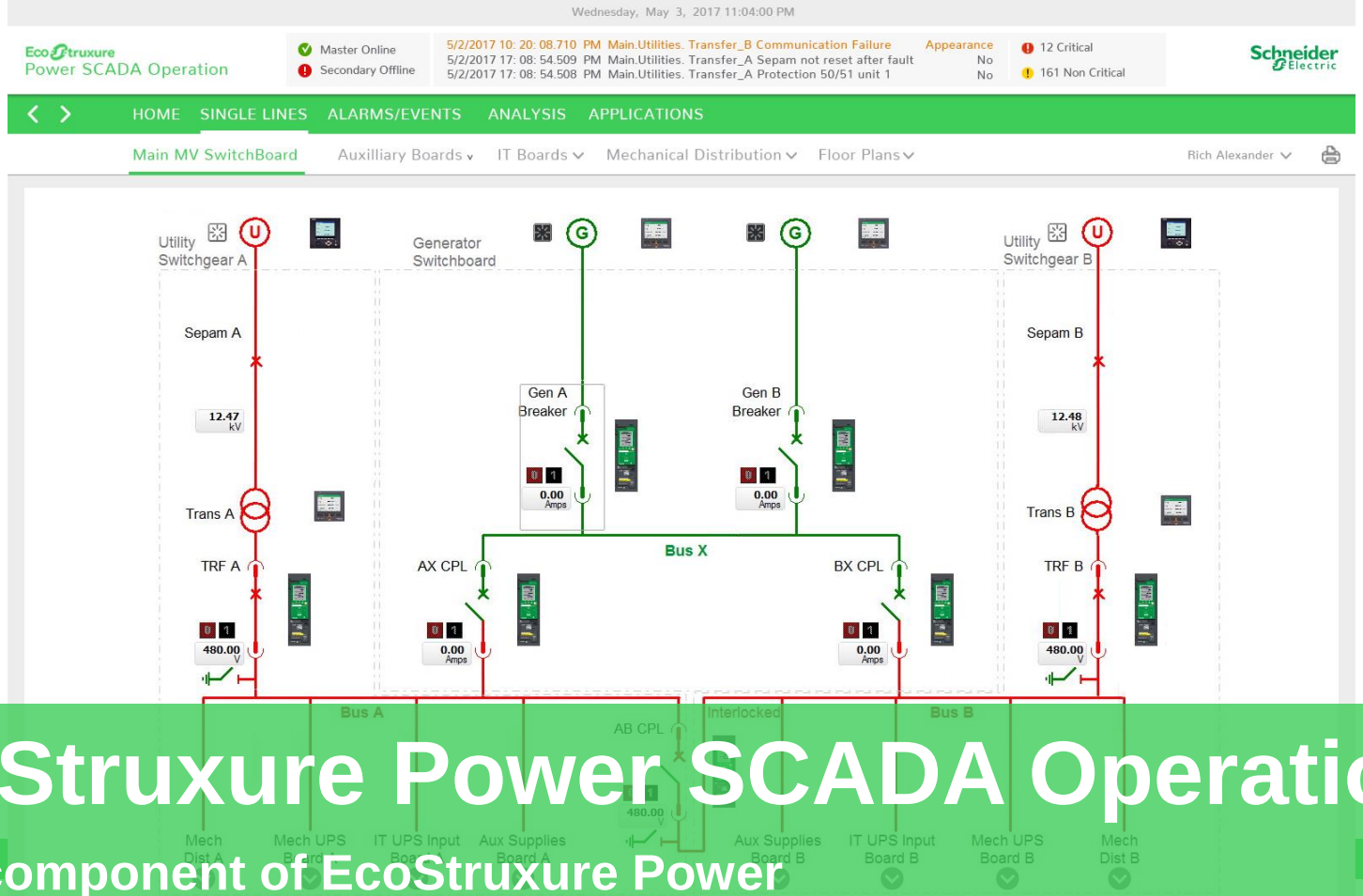

EcoStruxure Power SCADA Operation

A key component of EcoStruxure Power

Schneider Electric

Power SCADA Operation Offer Overview

We have an opportunity to co-create the future as the new energy world becomes




More ELECTRIC

2X

faster growth of electricity demand compared to energy demand by 2040

Source: IEA WEO 2014

More DIGITIZED

10X

more connected devices than people by 2025

Source: United Nations, IHS

More DECARBONIZED

82%

of untapped energy efficiency potential in buildings (and more than 50% in industry)

Source: World Energy Outlook 2012

More DECENTRALIZED

70%

of new capacity additions will be renewable forms by 2040

Source: BNEF

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Innovation at Every Level: Power SCADA Operation

Power SCADA Operation (PSO) brings edge control to power distribution

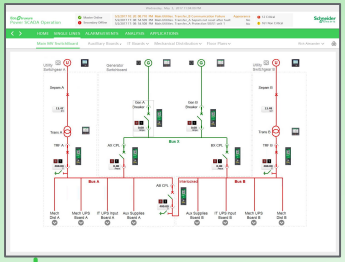
Apps, Analytics & Services

Edge Control

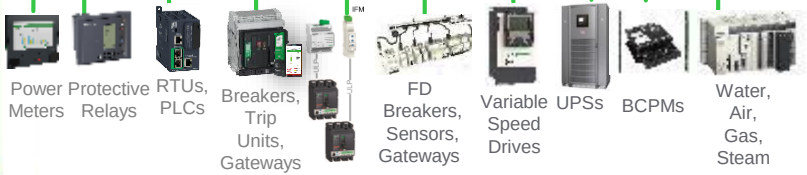
Connected Products

Power Advisor
Digital Services

Power SCADA Operation (PSO)



IP Communications Backbone

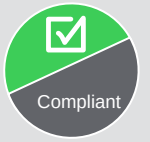


Power Meters | Protective Relays | RTUs, PLCs | Breakers, Trip Units, Gateways | FD Breakers, Sensors, Gateways | Variable Speed Drives | UPSs | BCPMs | Water, Air, Gas, Steam

Protect People and Assets

Optimize Business continuity

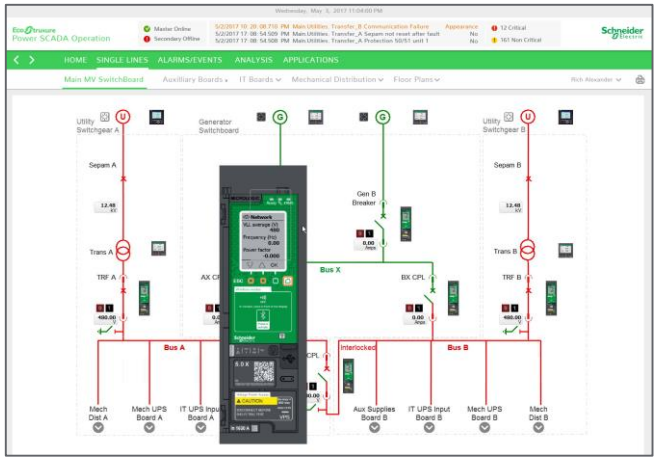
Maximize Lifecycle Efficiency



Simplify Regulatory Compliance

Power SCADA Operation for real-time situational awareness

The power of a **SCADA** uniquely designed for **Power Management Applications**



Power SCADA Operation enables Facilities teams in Power Critical Facilities to monitor, control, and troubleshoot issues in real-time with their electrical distribution systems to maximize power reliability and operational efficiency.

Power Monitoring & Alarming

- High performant real-time communications
- Native system redundancy and scalable architecture
- Extensive protocol support & open data exchange
- Highly customizable with scripting and an open API
- Cyber resilient networks and servers

Source Control

- Monitor complex auto-transfer schemes
- Remotely and safely control breakers

Avoid Disruption via Events Analysis

- Default, rich data integration for connected devices (e.g. Masterpact MTZ, ION9000, PM8000, etc.).
- Sequence of Events Recording (SER) (1ms)
- Power Quality Waveform Analysis (COMTRADE)

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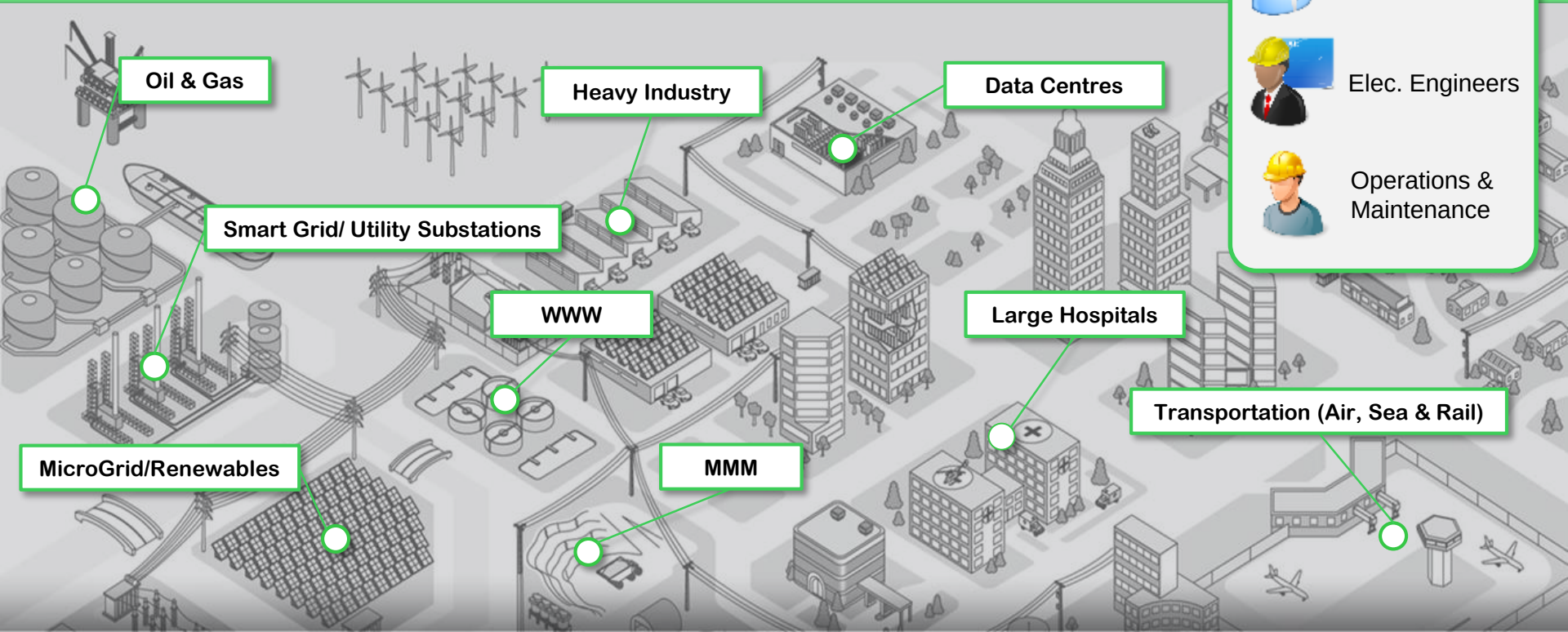
Power SCADA: Markets & Users

Mission Critical Facilities



Facility manager

Energy manager

Elec. Engineers

Operations & Maintenance

The Power of a SCADA

Redundant, scalable, open and high performance

Power SCADA High Level Architecture

Overview of the Components in a Power SCADA system

Open, highly performant and flexible architecture to support the most demanding power critical sites

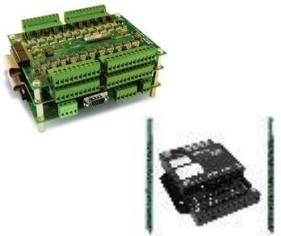
Power SCADA

MV Equipment/relays

LV Equipment/breakers

Power & energy metering & other Modbus devices

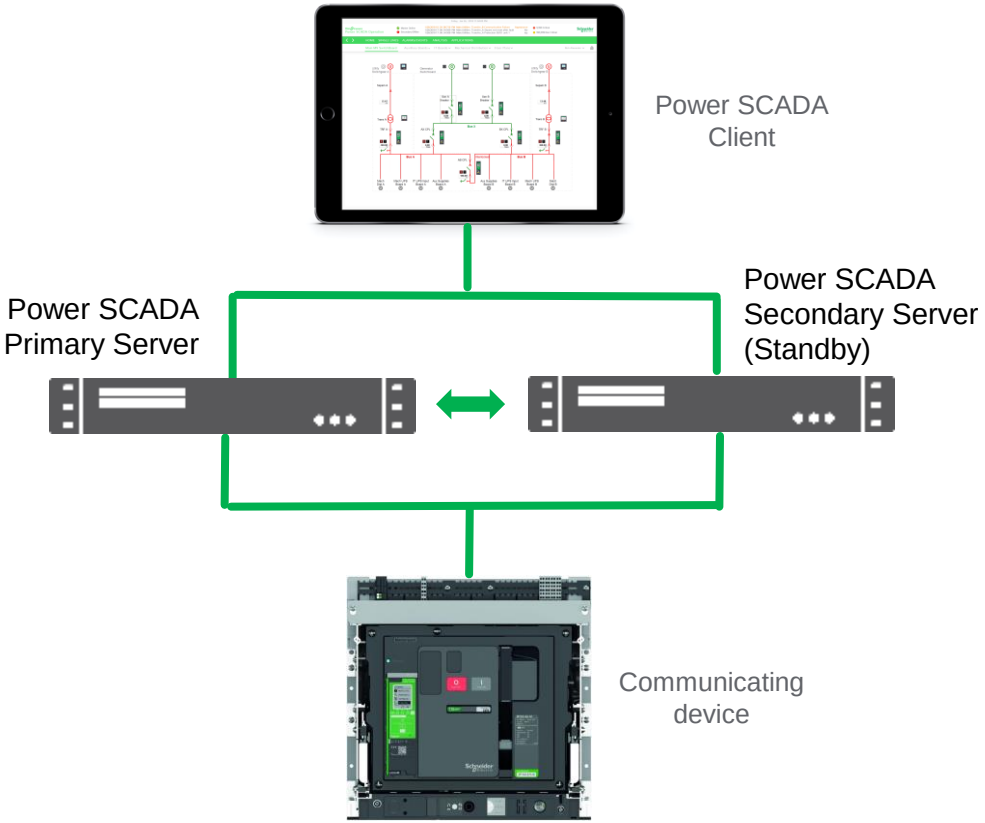
Branch Circuit Meters



PQ meters

Native Architectural Redundancy

Providing peace-of-mind that your system is reliable when the worst case scenario happens



No single point of failure

Redundant alarms and historical data

Full synchronization of data between servers

+ Support for redundant communications network

Open Standard Protocols and Data Exchange

61850 Ed.2 and OPC UA available August 2018

Large variety of protocols allows for vendor agnostic equipment communication

Wide Range of Protocol Support

IEC 61850 — IEC61850 Edition 2

DNP3 Distributed Network Protocol

ION

Modbus

IEC 60870-5-104

SNMPv2

KNX

BACnet

Open Data Exchange

OPC — CERTIFIED FOR COMPLIANCE — SELF-TESTED FOR COMPLIANCE

OPC support

- > OPC UA client
- > OPC DA v2 client & server
- > OPC AE v1 server

Database connectivity

- > ODBC, OLE-DB, SQL

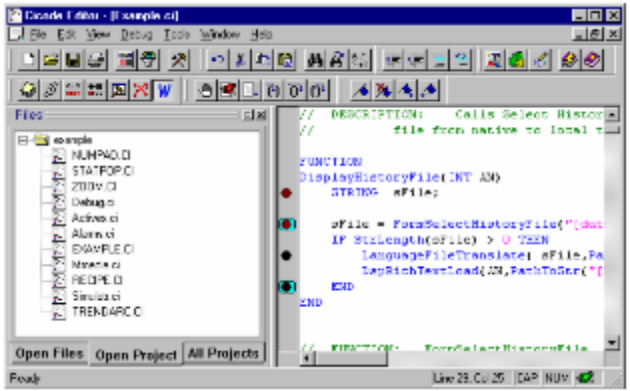
Other Schneider Electric software

- > Web Services to integrate alarms with EcoStruxure Building Operation

Flexible and Extensible

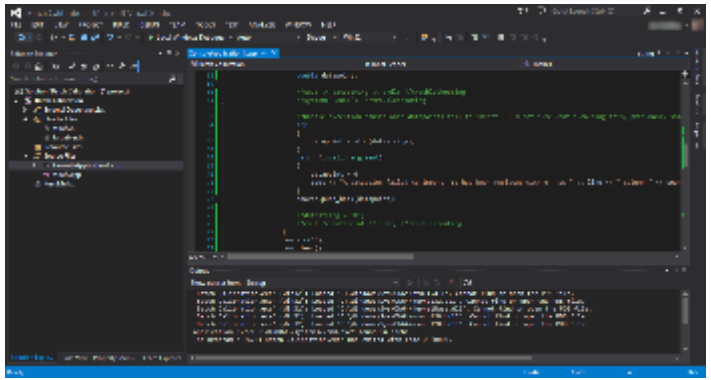
Multiple means of extending and customizing your system

CiCode scripting



- Cicode is a **built-in and well-documented scripting language** requiring no previous programming experience to use.
- Cicode allows you to access all real time data within Power SCADA.

CtAPI



- CtAPI is a **set of API's intended for programmers** to create applications extending Power SCADA using industry standard programming languages (C, C#, etc.)
- Requires programming experience.

Efficiency and Compliance Applications

Visualize energy usage, power demand and make actionable cost savings decisions

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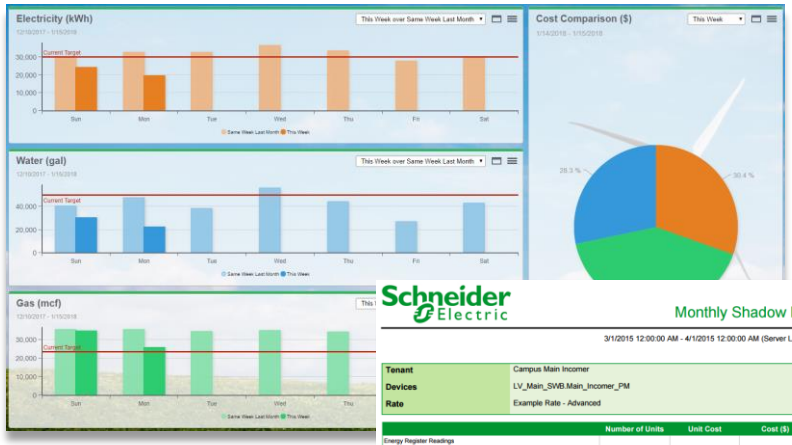
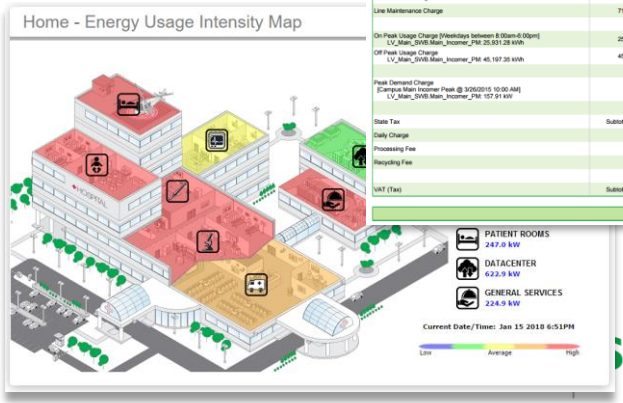
Maximize Energy Efficiency

Much more than your typical SCADA Historian

Via **Advanced Reporting and Dashboards** module:

- **Provide energy transparency** on where and how much energy and other utilities (WAGES) are generated, distributed and consumed.
- **Set energy reduction targets** and **adjust operations** for continuous efficiency improvements.
- **Showcase energy performance** to a broad group of stakeholders via Energy Kiosk displays.
- **Create accountability** by allocating costs to departments or processes
- **Avoid Utility penalties and billing discrepancies** due to peak demand, power factor and errors in utility bills





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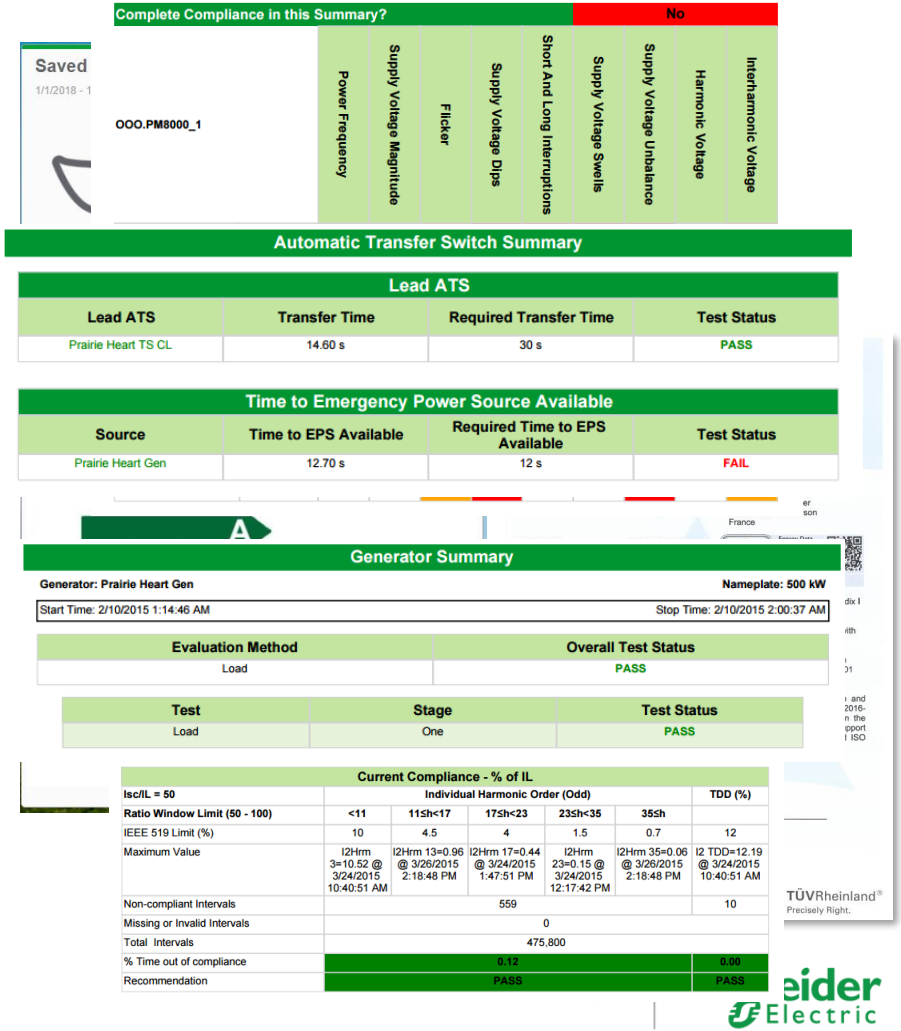
Simplify Regulatory Compliance

Standards relevant to your operation

Via **Advanced Reporting and Dashboards** module:

- Monitoring and reporting tools for **energy efficiency and green building standards** (ISO 50001, ISO 50002, ISO 50006, SEP, LEED, NABERS, etc)
- Ensure **power quality compliance** with standards to avoid unexpected downtime (EN50160, IEEE519, ITIC, etc)
- Ensure regulatory **compliance with backup power system testing** in healthcare facilities (NFPA110 and others)



Complete Compliance in this Summary?	No								
	Power Frequency	Supply Voltage Magnitude	Flicker	Supply Voltage Dips	Short And Long Interruptions	Supply Voltage Swells	Supply Voltage Unbalance	Harmonic Voltage	Interharmonic Voltage
OOO.PM8000_1									

Automatic Transfer Switch Summary

Lead ATS

Lead ATS	Transfer Time	Required Transfer Time	Test Status
Prairie Heart TS CL	14.60 s	30 s	PASS

Time to Emergency Power Source Available

Source	Time to EPS Available	Required Time to EPS Available	Test Status
Prairie Heart Gen	12.70 s	12 s	FAIL

Generator Summary

Generator: Prairie Heart Gen — Nameplate: 500 kW

Start Time: 2/10/2015 1:14:46 AM — Stop Time: 2/10/2015 2:00:37 AM

Evaluation Method	Overall Test Status
Load	PASS

Test	Stage	Test Status
Load	One	PASS

Current Compliance - % of IL

Isc/IL = 50	Individual Harmonic Order (Odd)					TDD (%)
Ratio Window Limit (50 - 100)	<11	11≤h<17	17≤h<23	23≤h<35	35≤h	
IEEE 519 Limit (%)	10	4.5	4	1.5	0.7	12
Maximum Value	I2Hrm 3=10.52 @ 3/24/2015 10:40:51 AM	I2Hrm 13=0.96 @ 3/26/2015 2:18:48 PM	I2Hrm 17=0.44 @ 3/24/2015 1:47:51 PM	I2Hrm 23=0.15 @ 3/24/2015 12:17:42 PM	I2Hrm 35=0.06 @ 3/26/2015 2:18:48 PM	I2 TDD=12.19 @ 3/24/2015 10:40:51 AM
Non-compliant Intervals	559					10
Missing or Invalid Intervals	0					
Total Intervals	475,800					
% Time out of compliance	0.12					0.00
Recommendation	PASS					PASS

Safety Applications

Protecting people and assets

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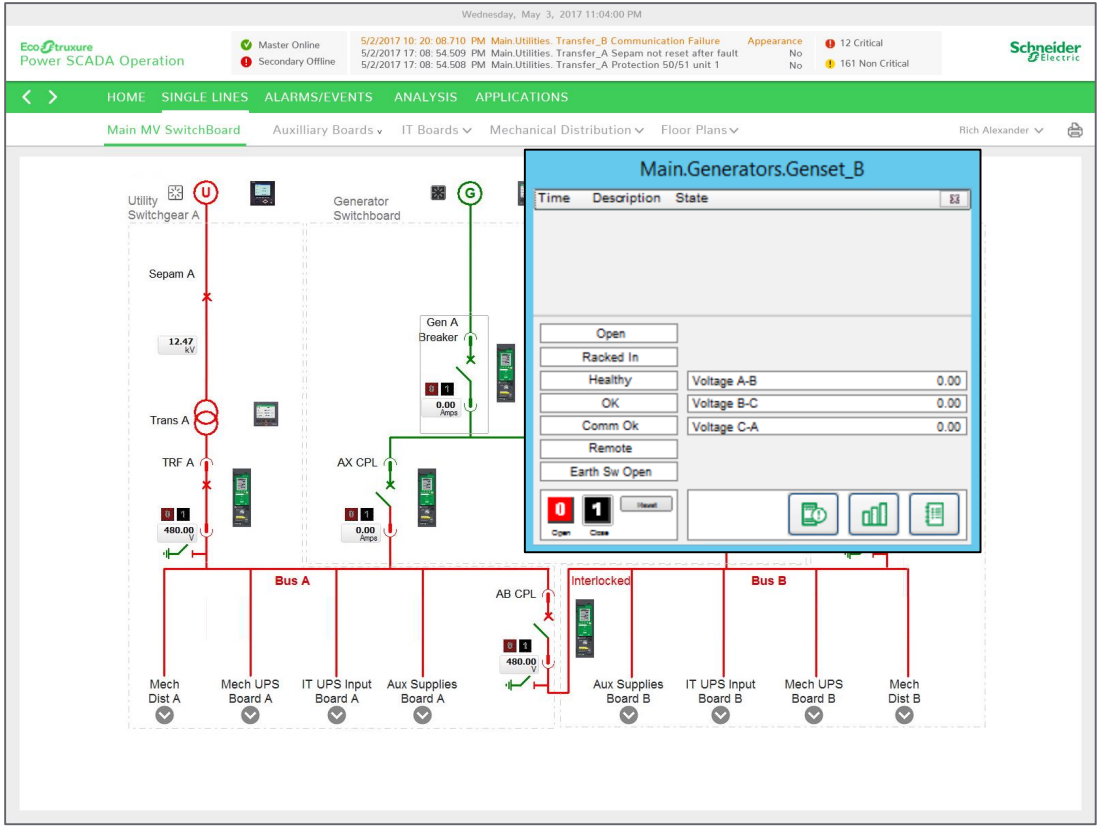
Manually Control Loads

Open/close breakers remotely



Control breakers in real time using interactive Power graphics.

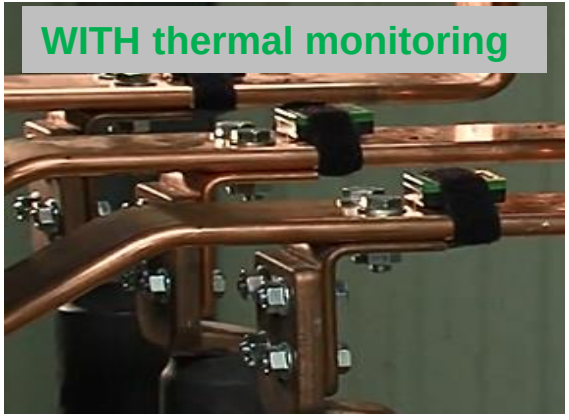
Operate breakers remotely from a safe distance from energized equipment to **minimize potential arc-flash risk**.

Continuous Thermal Monitoring

Thermal Monitoring available August 2018

22% of fires in a facility are due to electrical failures

WITH thermal monitoring



WITHOUT thermal monitoring

As busbar joints degrade, they can overheat and cause a fire risk.

Avoid electrical fires by **detecting and alarming on abnormal temperature** rise in electrical distribution equipment.

24/7 continuous monitoring in MV and LV equipment to provide early detection of abnormal temperature rises.

Reduce total cost of ownership by 60% throughout the lifecycle by reducing periodic thermography.

Wireless, self-powered sensors (no batteries) can be deployed anywhere, including in areas that are difficult to see with a thermal camera

Reduce recurring manual thermal imaging costs

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Reliability Applications

Real-time monitoring of your electrical distribution systems

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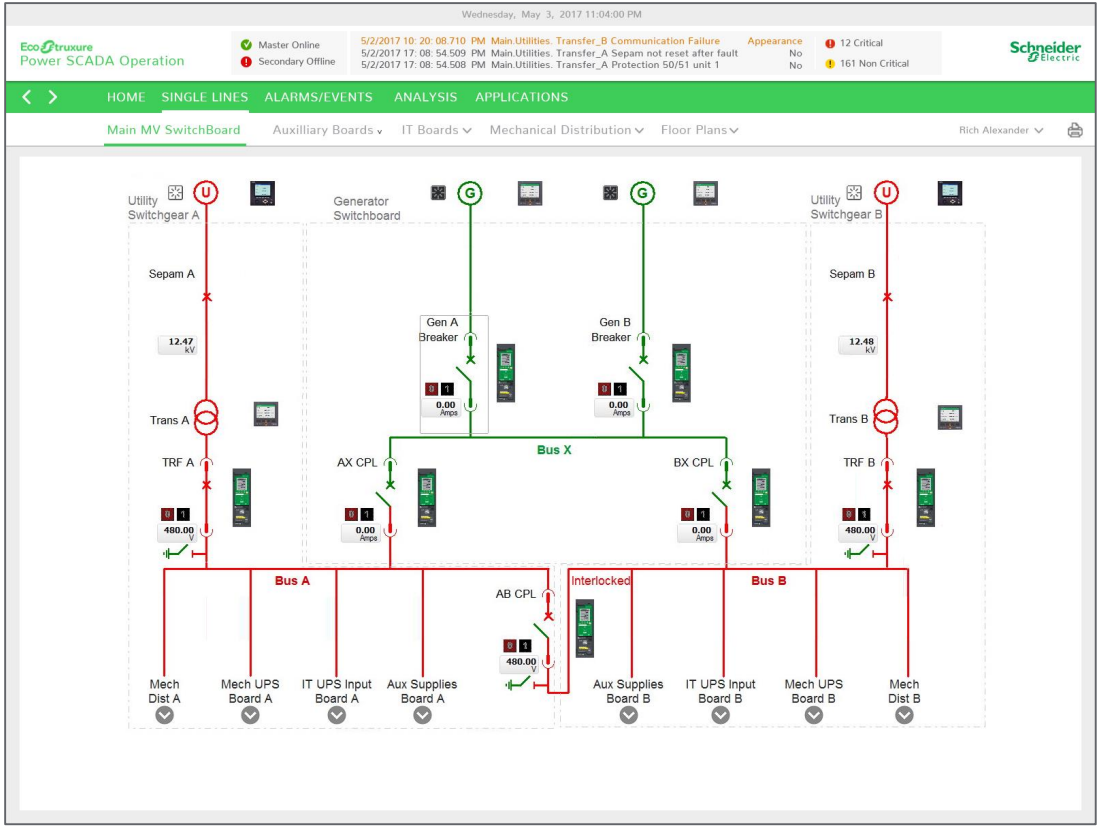
Real-time Situational Awareness

Animated one-line to visualize electrical system status



Quickly **understand the state of your power system**

Determine which parts of your electric network are energized and from what sources.

See in real time when **loads are shifted** as part of control schemes using PLC's, relays, etc.

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Power Availability Applications: Power Events Analysis

Avoid disruption of business by maximizing uptime of electrical distribution

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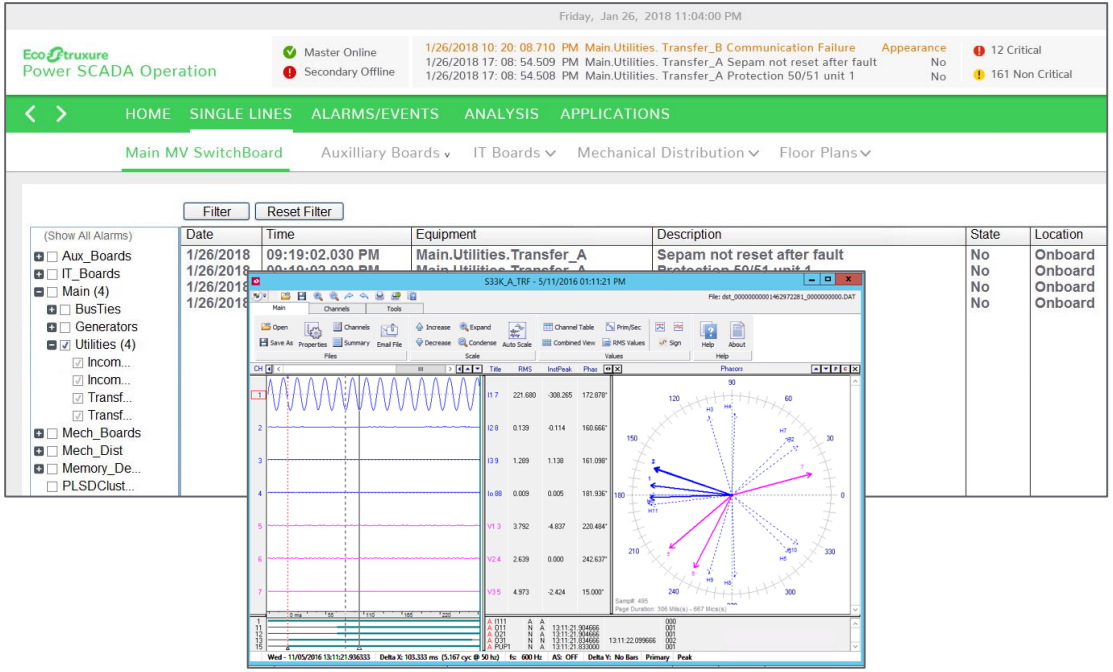
Power Events Analysis

Help determine root cause and get back to normal quickly



Identify exact **sequence of power events across system**

View electrical waveforms associated with specific events for deeper analysis

Re-establish normal operations quickly and safely once root cause is determined

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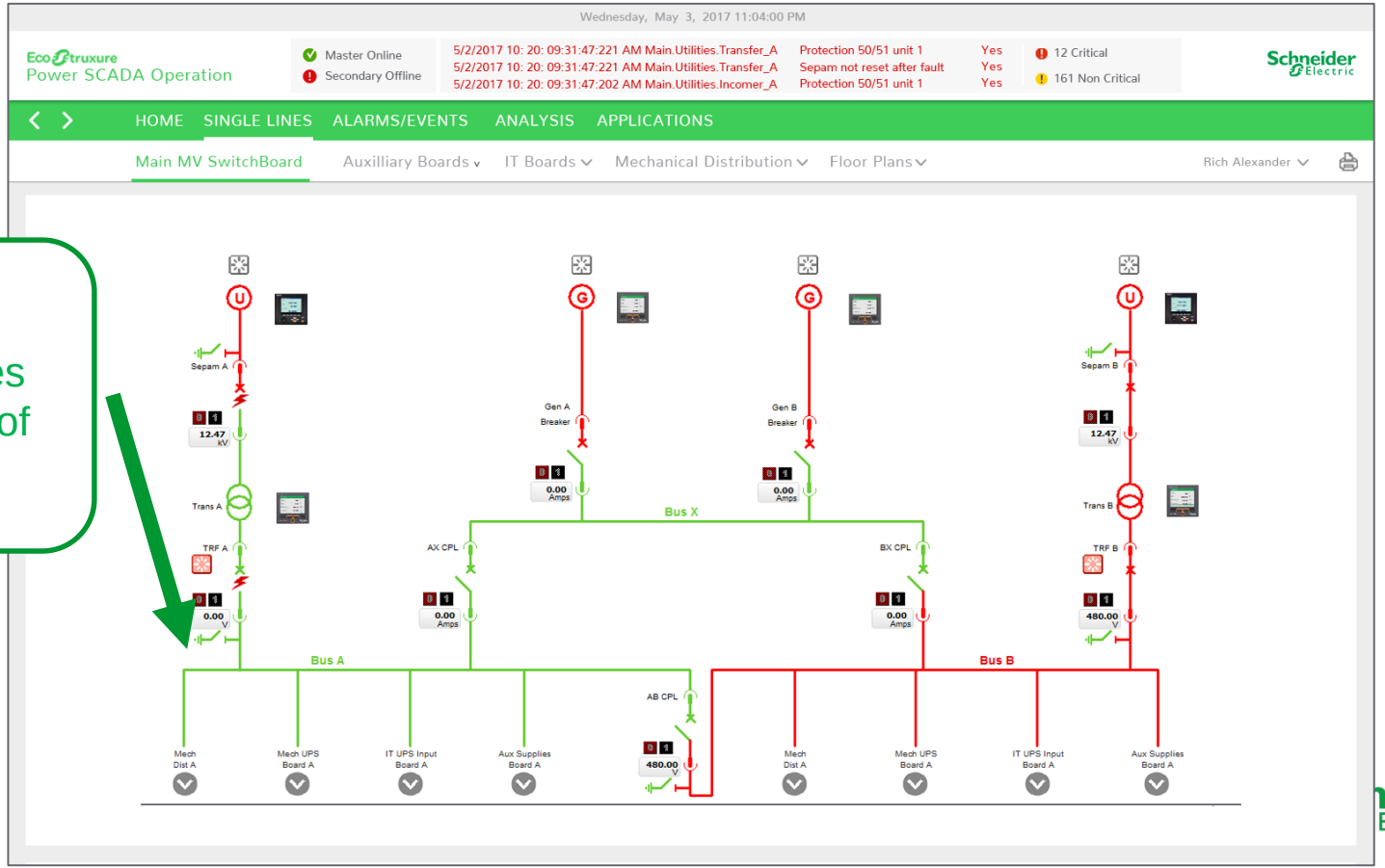
Power Availability – in practice with the Power SCADA system

Sequence of Events Example

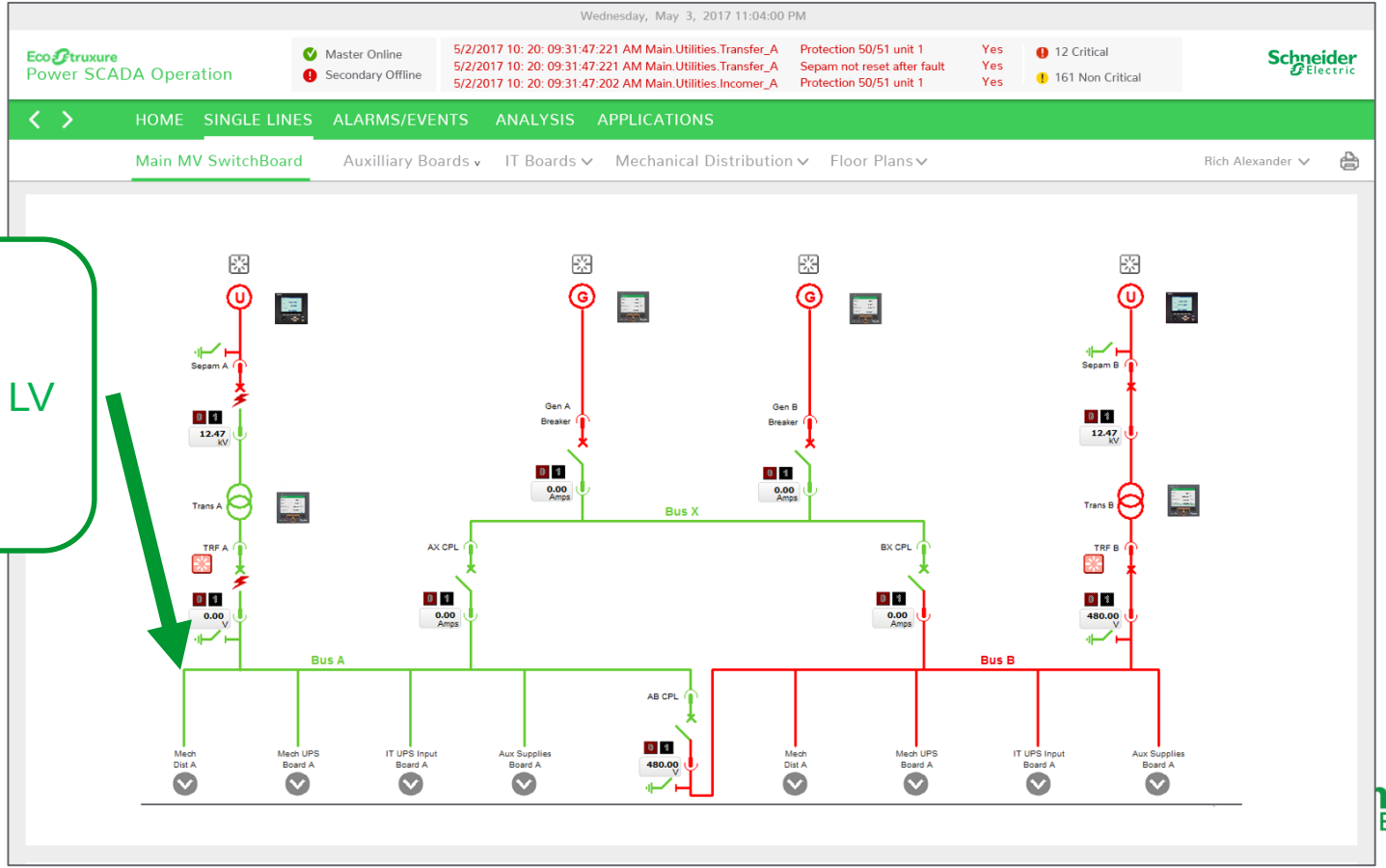
The facility suddenly loses power to half of the network



Power Availability – in practice with the Power SCADA system

Sequence of Events Example

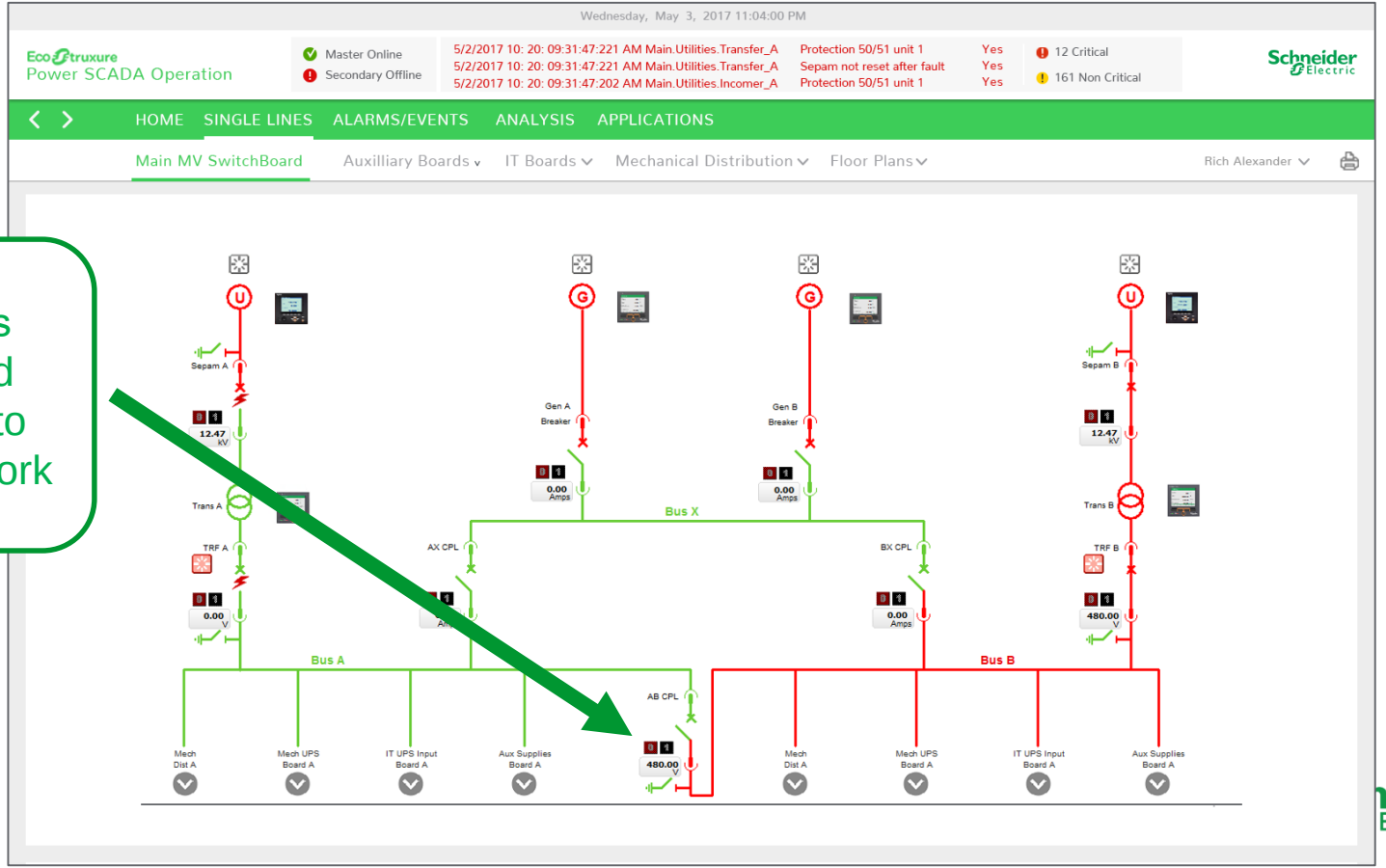
If the fault occurred in the LV panel…



Power Availability – in practice with the Power SCADA system

Sequence of Events Example

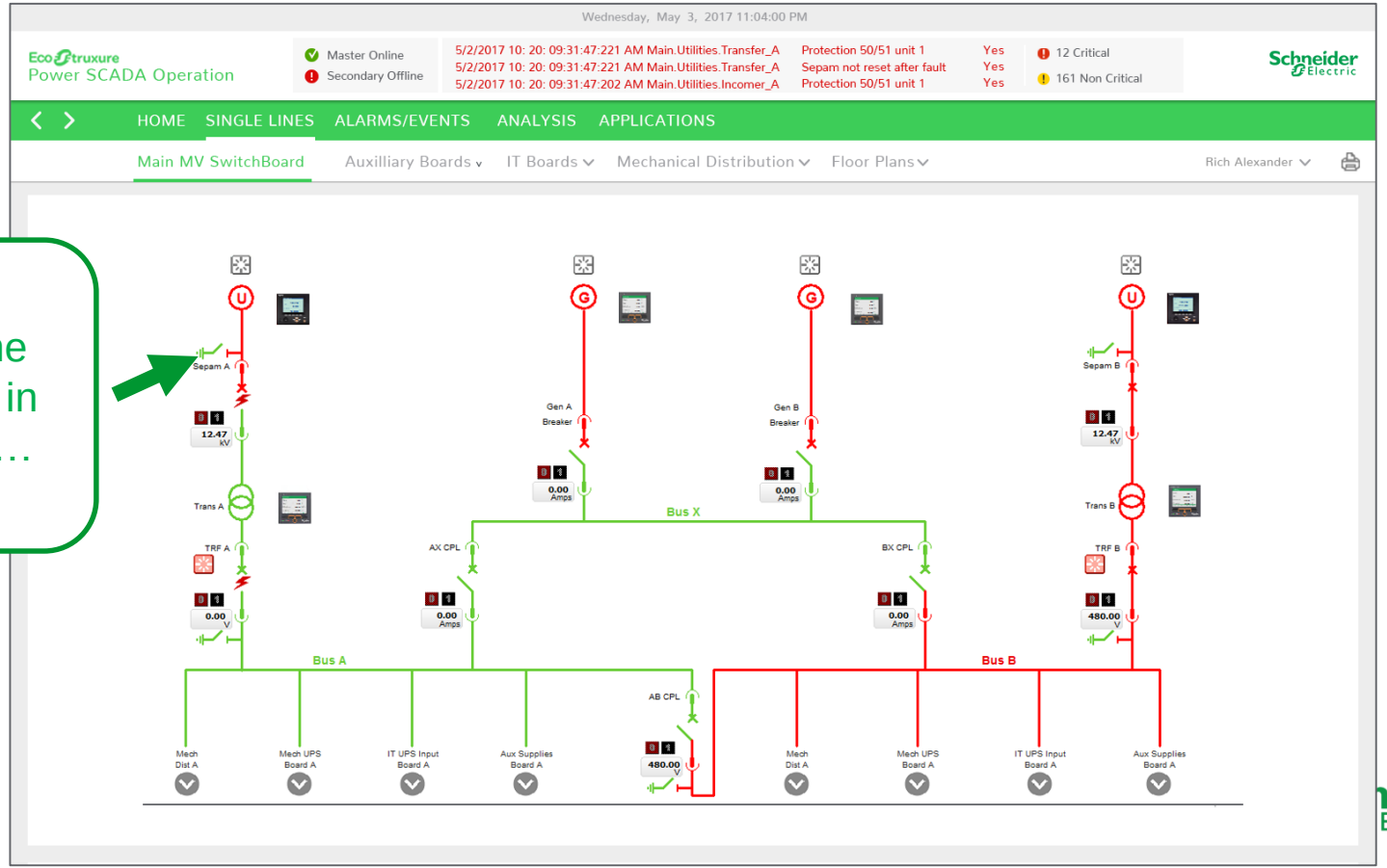
…closing this breaker could cause a loss to the entire network



Power Availability – in practice with the Power SCADA system

Sequence of Events Example

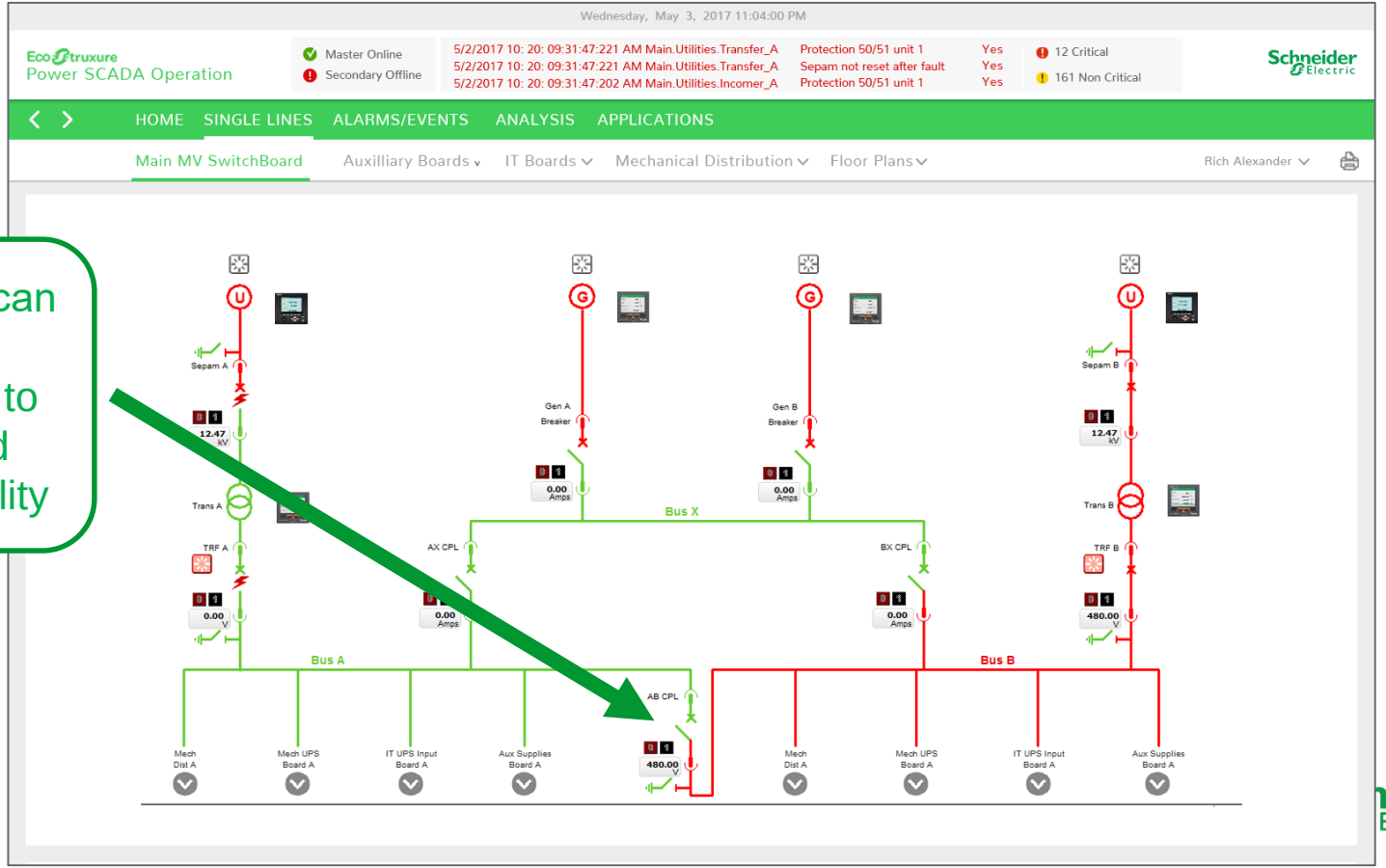
However, if the fault occurred in the MV panel…



Power Availability – in practice with the Power SCADA system

Sequence of Events Example

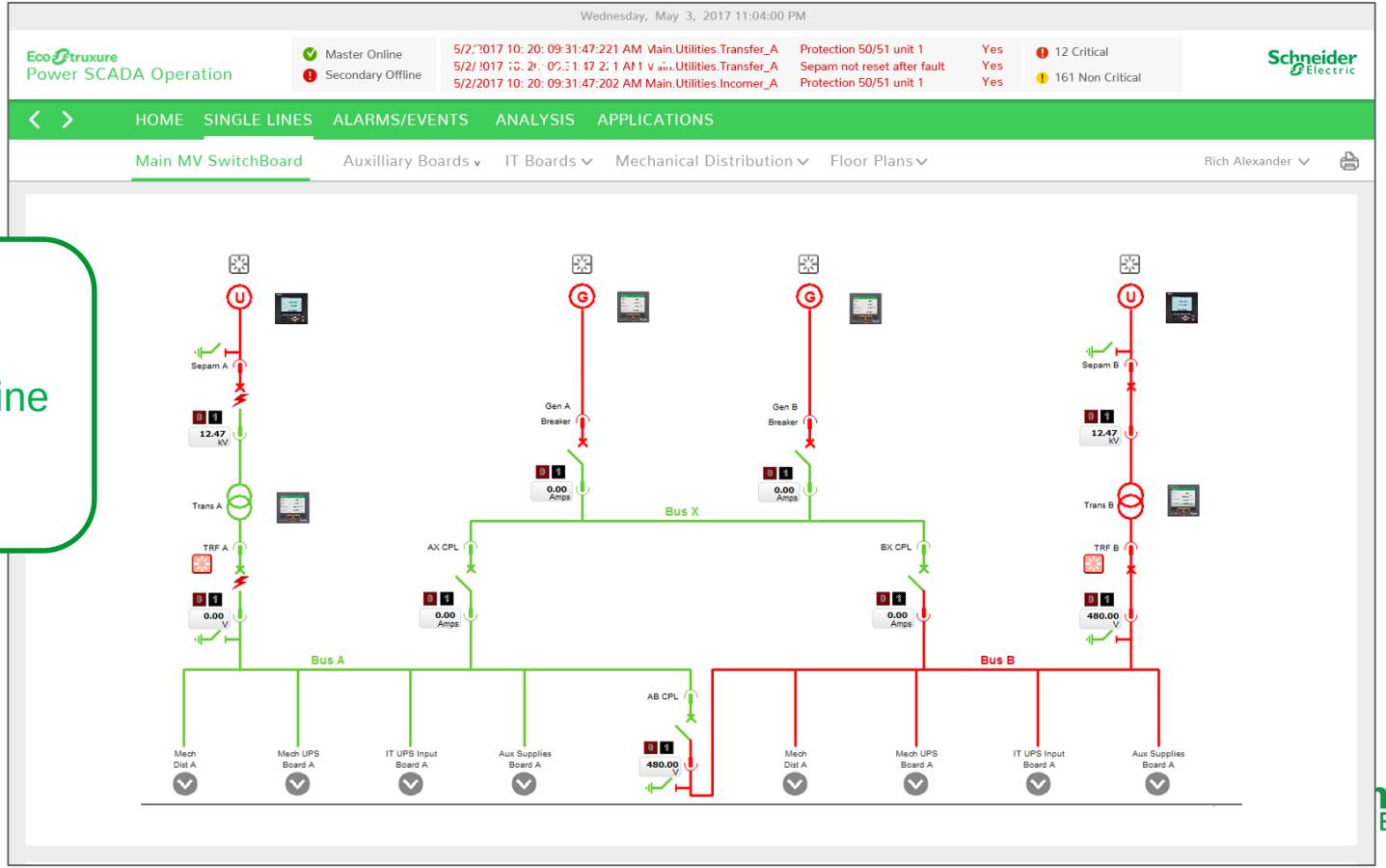
…this breaker can be closed to restore power to de-energized portions of facility



Power Availability – in practice with the Power SCADA system

Sequence of Events Example

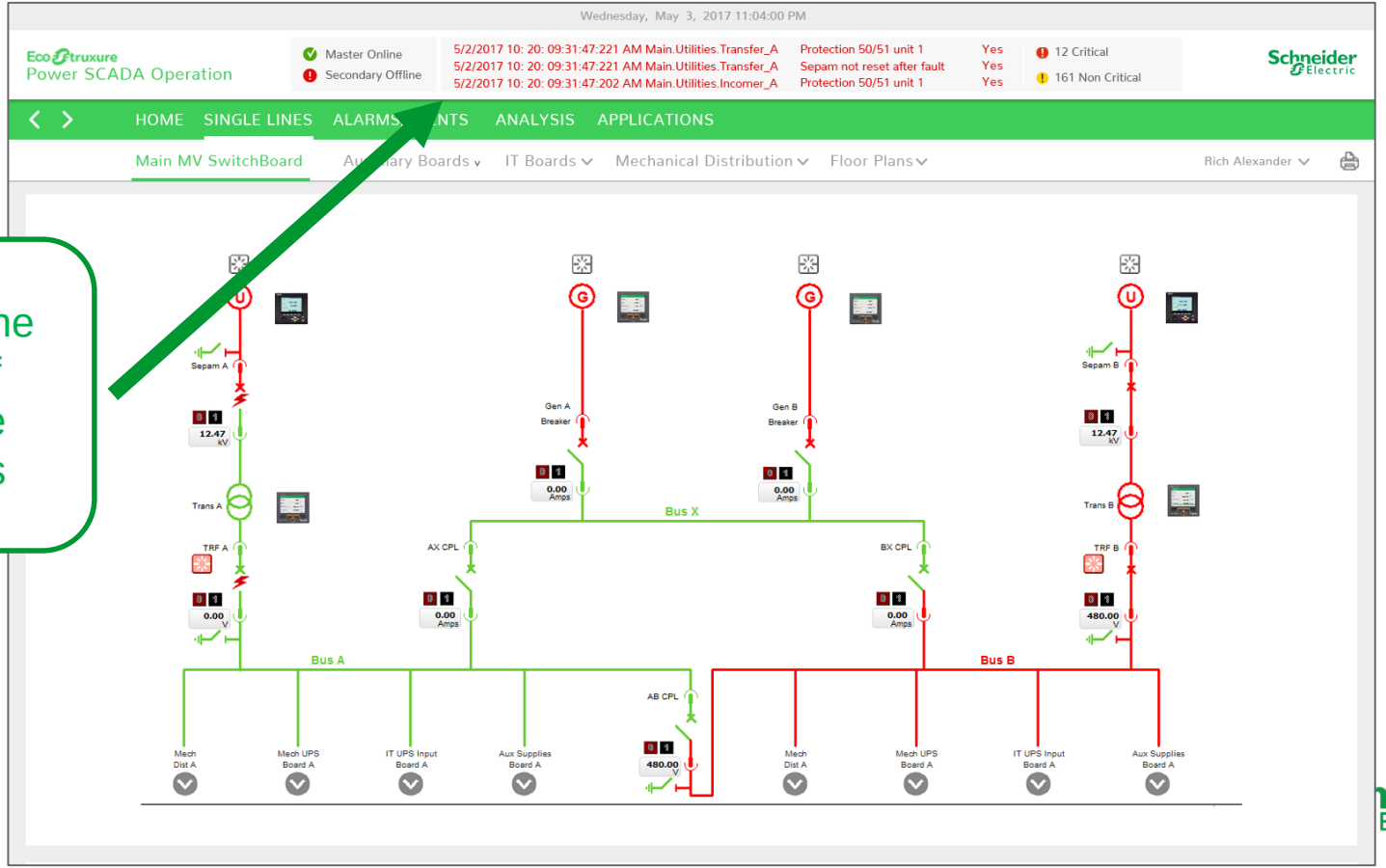
How can we quickly determine what to do?



Power Availability – in practice with the Power SCADA system

Sequence of Events Example

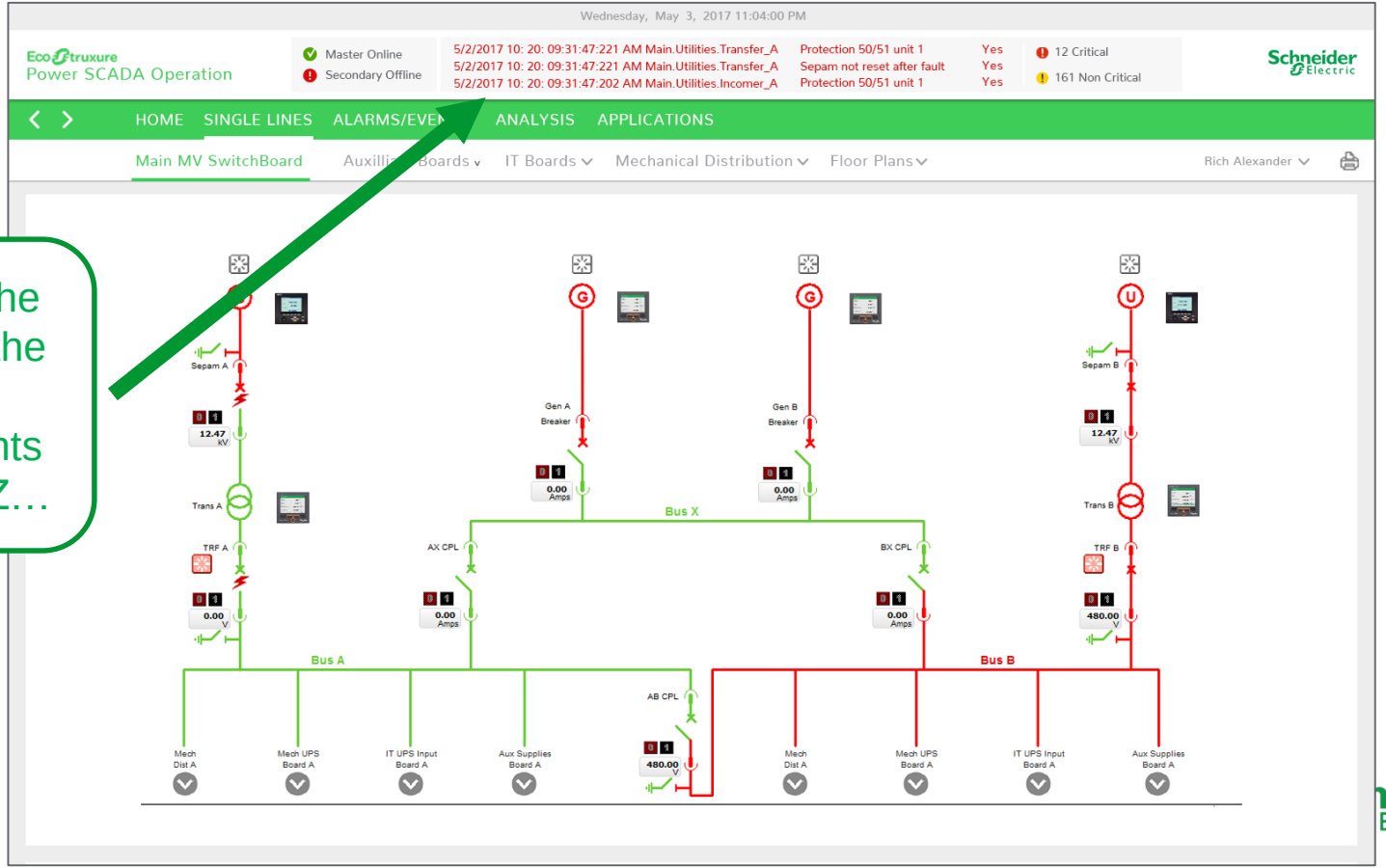
By checking the sequence of events in the alarm details



Power Availability – in practice with the Power SCADA system

Sequence of Events Example

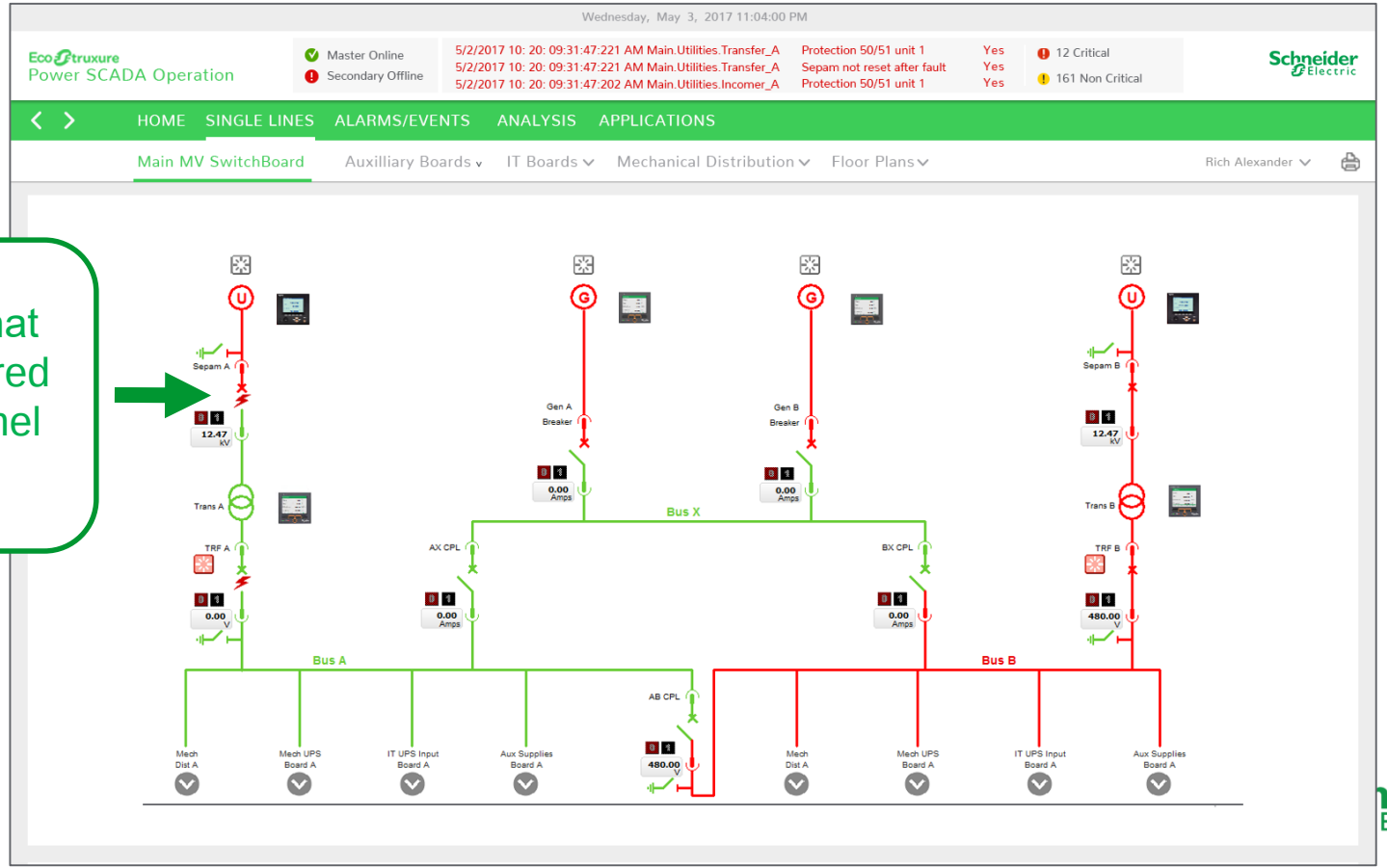
We see from the ION9000 that the Sepam was tripped moments before the MTZ…



Power Availability – in practice with the Power SCADA system

Sequence of Events Example

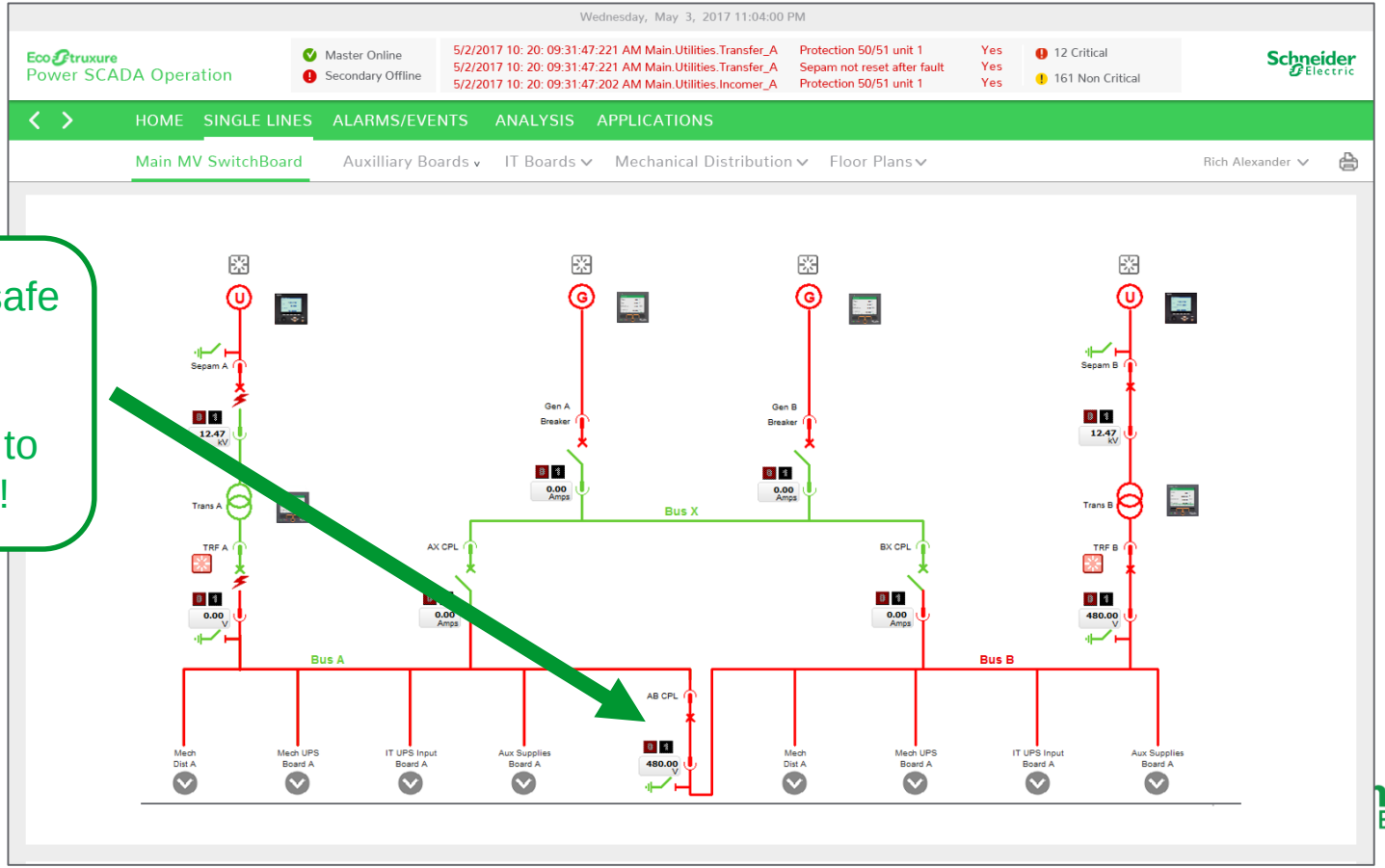
…indicating that the fault occurred on the MV panel first



Power Availability – in practice with the Power SCADA system

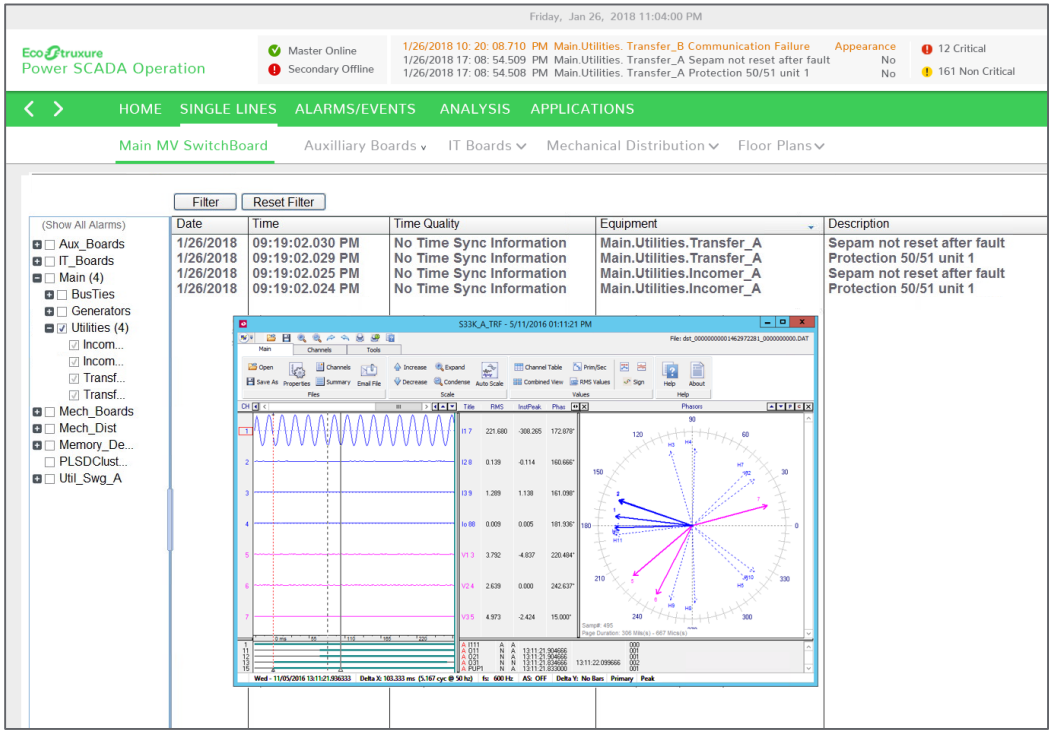
Sequence of Events Example

Therefore it is safe to close the breaker and restore power to entire facility!



Sequence of Events Functionality

Fully-featured waveform viewer to analyze electrical events



Perform deeper Sequences of Events analysis by displaying and analyzing waveforms generated as a result of associated alarms

Analyze the harmonics that are impacting your Power Quality and affecting large equipment

Display Phasor or circular diagram to view individual V, I and Harmonics channels

Supports ION waveforms along with IEEE Std. C37.111 (1991, 1999, and 2013 **COMTRADE formats**)

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Compliance: Cyber Resiliency Deep Dive

Enable compliance with IT security requirements

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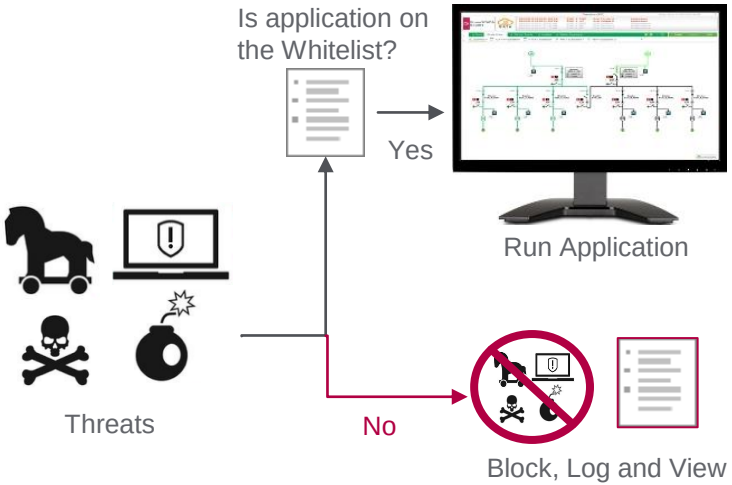
Secure at Server Level

Technology:
Wi-Fi Attacks
Ethernet Attacks
USB Attacks

Secure Development Lifecycle (SDL) Industry standard process (based on Microsoft model and IEC 62443)

Security-Related Feature Development Driven by standards alignment (IEC 62443, etc)

Dealing with potential “Zero Day” cyber-attacks



Even air-gapped systems *(not connected to Internet)* are susceptible to attack!

Application Whitelisting via McAfee Application Control provides **protection against "Zero Day" attacks** and advanced persistent threats.

Application Whitelisting **proactively blocks unauthorized executables** on PSO Server that are not part of 'whitelist' such as executables, java apps, Active X controls, scripts, etc.

PSO validated with McAfee Whitelisting application.

Microgrid Solutions & Energy Management Solutions

September 2019

Life Is On Schneider Electric

Distributed Energy Ressources (DER)

What is a Microgrid?

Optimize your electrical bill & sustainability footprint

Hybrid system : Grid + local generation/storage + load management

Grid-tied

Manage blackouts while optimizing your electrical bill & sustainability footprint

Hybrid system : Grid + local generation/storage + load management

Island-able

“Power on” with efficient and future proof power systems

Hybrid system : Diesel/Gas &/or renewable generation + storage + load management

Off-grid

Our Microgrid markets

Buildings | Large sites | Utilities & Districts | Access to Energy

Schneider Electric EcoStruxure Microgrid Solutions

Open | Scalable | Secure | Global | On-Premise & Cloud

EcoStruxure™

End-to-End Cybersecurity

Life Cycle Management

- Apps, Analytics & Services
- Edge Control
- Connected Products

Microgrid

EcoStruxure™ Microgrid Advisor		Forecast and Optimize when to consume, produce, Store, or Sell Energy
EcoStruxure™ Microgrid Operation		Ensure system stability whatever the system configuration

Villaya Emergency

Battery Energy Storage

Energy Control Center

Smart switchgear, power meters, solar inverters …

Energy Consulting

- Demand expertise : analysis of present and future energy needs, energy efficiency
- Supply expertise : analysis of present and alternative energy supply
- Financial, environmental, TCO analysis
- Regulation, standards and country codes

Power System Engineering

- Technical & economical sizing
- Technical studies : Load flow, voltage plan, protection studies
- Dynamic stabilities

EcoStruxure™ Microgrid Advisor

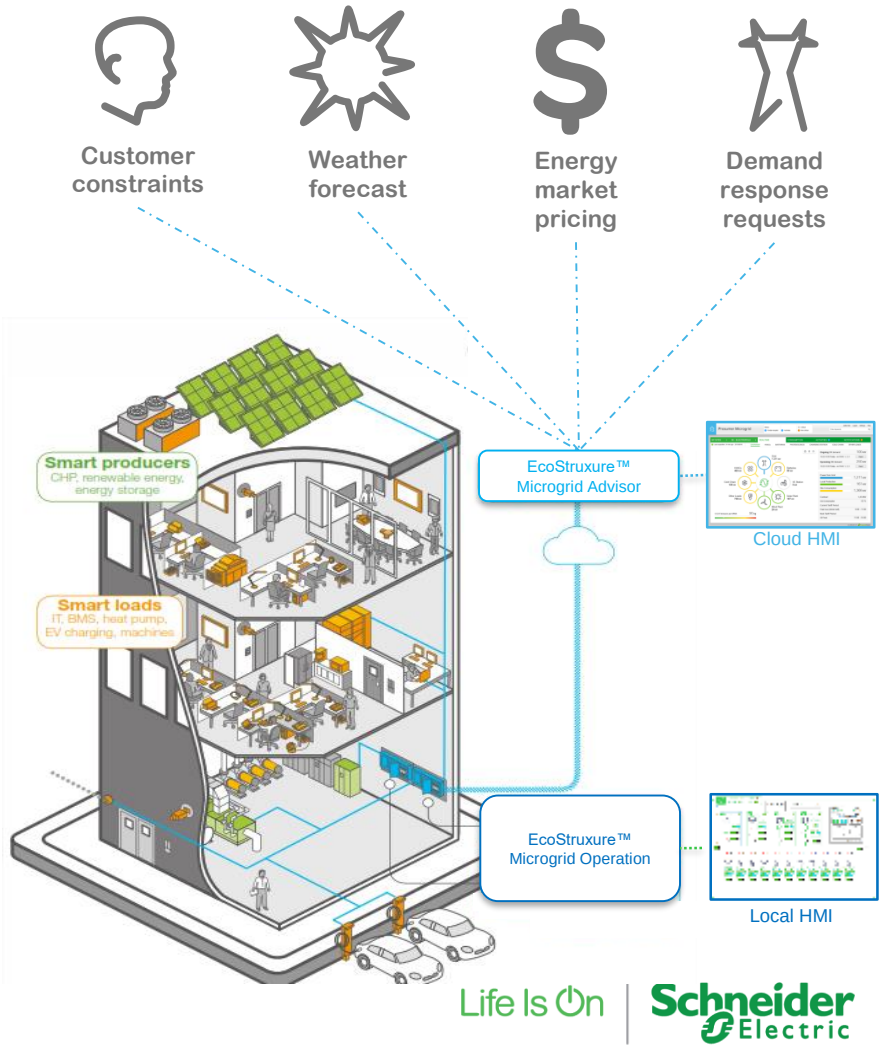
Forecast and optimize

when to

consume, produce, store, or sell energy

EcoStruxure™ Microgrid Operation

Manage island mode and optimize DER in real time

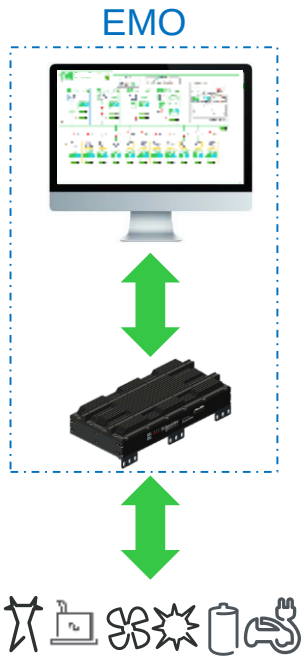


Demonstration EcoStruxure Microgrid Operation (**EMO**)

Zoom on EMO: EcoStruxure™ Microgrid Operation

Manage island mode and optimize DER in real time (s)

- **Industrial computer** with a **local HMI** embedding **advanced control algorithms**, leveraging years of experience in critical facilities
- Able to manage up to **100% renewable in off grid mode** depending on the DER available
- **DER agnostic**
- Extensive library of algorithms for **optimized execution and commissioning cycles**, easier operation and maintenance
- **Dedicated HMI** (EcoStruxure Power SCADA Operation), or integration with third party SCADA system
- **Cyber security** compliance with IEC62443-4-2 and IEC/ISA 62443-3-3
- **Communication protocol** available: Modbus TCP IP, IEC 61850, DNP3, IEC 101, IEC 104
- **Connection with EMS** (Schneider Electric, third party) **or ADMS** (Schneider Electric, third party)



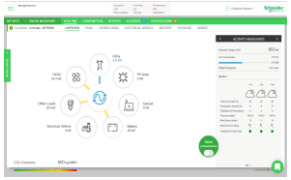
Use cases / DER		
Ensure microgrid stability in all grid situations	**Grid connection management**	Automatically manages connection / disconnection from the grid
Manage DER in island mode	**Sharing strategy**	Maximize renewables consumption within the microgrid / per type of DER
	Load sharing	Ensure the stability for the voltage and frequency by balancing the production and consumption in real time
	Load shedding	Cut-off non-priority loads when the production can not reach the consumption
Ensure microgrid safety in island mode	**Protection relay and earthing scheme management**	Manage the protection relays and if needed the global system protection when islanded
Grid services in grid connected mode	**No export limit**	Manage the level of authorized energy export back to the grid following a utility signal / third party / a threshold

Demonstration EcoStruxure Microgrid **Advisor** (EMA)

Zoom on EMA: EcoStruxure™ Microgrid Advisor

Forecasting and economic dispatch of Distributed Energy Resources

- **Software as a Service (SaaS)** Business Model - continuous updates for customers
- **Predictive and automatic management** of DER (hours, days) – 24/7/365
- **Intuitive and easy to use user interface**
- **Connection with third party platform** (web services)



Use cases / DER	
Remote monitoring & forecasting	Monitoring Power / Energy and other KPI for each DER using a web access
Tariff Management	Control DER (consume/produce/store energy) according to variable electricity tariff rate
Demand Charge reduction	Control DER (consume/produce/store energy) for reducing site consumption peak
Self consumption	Control energy storage and PV system for maximizing the energy consumption from PV system
Demand Response	Control DER for participating in DR mechanisms
Off grid mode preparation	Control DER for anticipating on future off grid events
No export	Control DER for avoiding exporting energy to the grid

Architectures

Grid connected microgrid

Microgrid EMS

In charge of the economic optimization of your site

Cloud

Cloud HMI

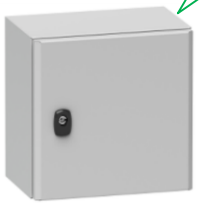
EcoStruxure Microgrid Advisor

Weather forecast

Electricity tariff rate

Demand Response

Site



DER Box

Modbus IP

Utility Meter	PV	Genset	EV charging station	ESS	BMS	CHP	Other loads
	XX kW	XX kW	Number of EV charging stations XX kW	XX kW XX kWh		XX kW	

HVAC

XX kW

Islandable microgrid

Microgrid EMS

Microgrid PMS

In charge of the economic optimization of your site

Cloud

Cloud HMI

EcoStruxure Microgrid Advisor

Weather forecast

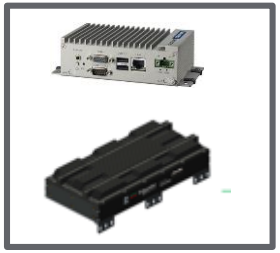
Electricity tariff rate

Demand Response

Site

DER Box

Modbus Table



Control Cabinet

In charge of the stability and reliability of your site

Local SCADA

EcoStruxure Microgrid Operation

Modbus IP / IEC 61850

Utility Meter	PV	Genset	EV charging station	ESS	BMS	CHP	Other loads
	XX kW	XX kW	Number of EV charging stations XX kW	XX kW XX kWh		XX kW	

HVAC

XX kW

Islandable/off grid microgrid

Microgrid PMS

Cloud

Site

In charge of the stability and reliability of your site

Local SCADA

EcoStruxure Microgrid Operation

Modbus IP / IEC 61850

- Utility Meter
- PV — XX kW
- Genset — XX kW
- EV charging station — Number of EV charging stations XX kW
- ESS — XX kW XX kWh
- BMS
  - HVAC — XX kW
- CHP — XX kW
- Other loads

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