Analytics & Advisory Services

Presenter: Dave Savage – Senior Director, Digital Power Services

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Internal

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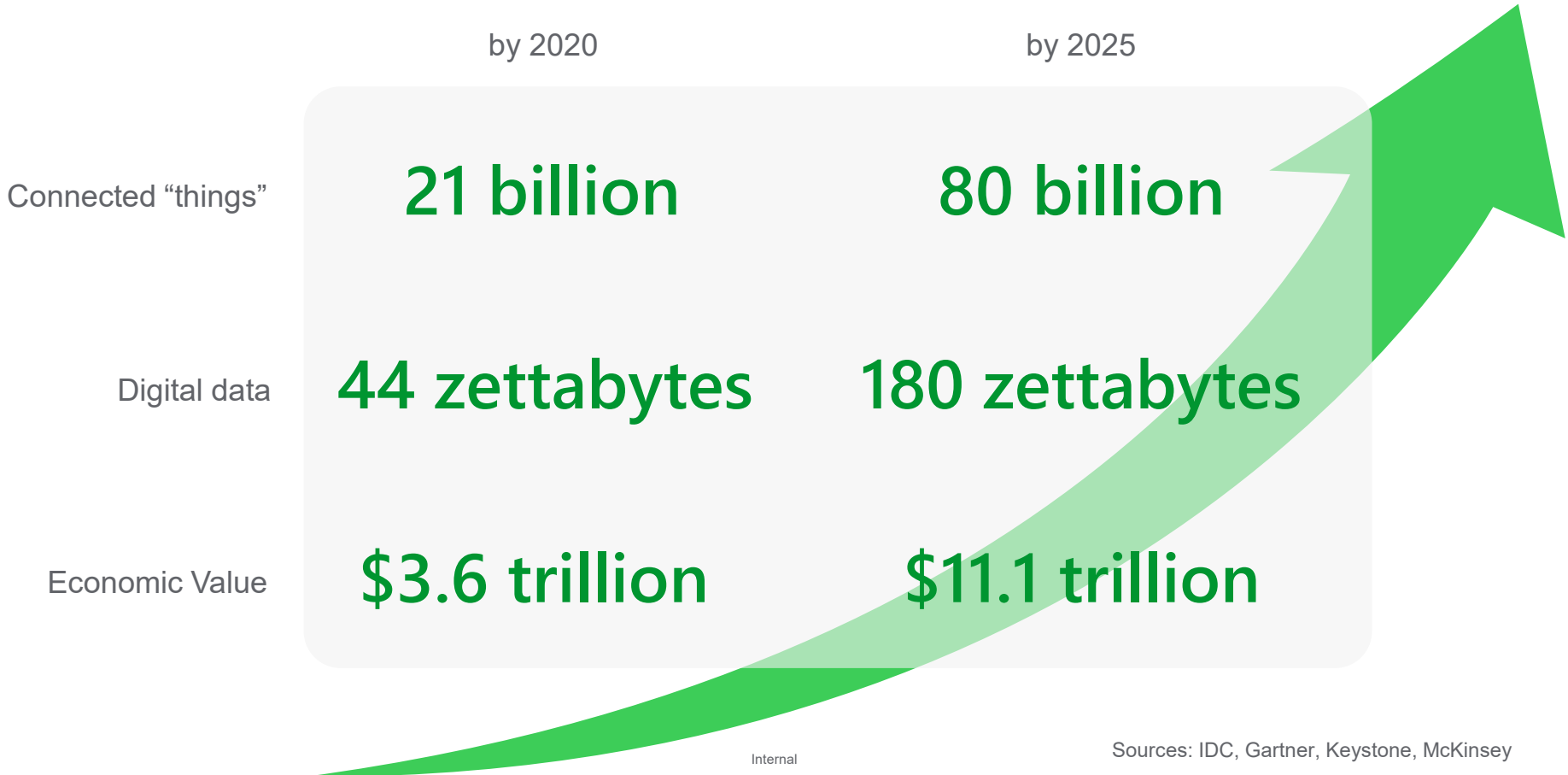
Bigger Data

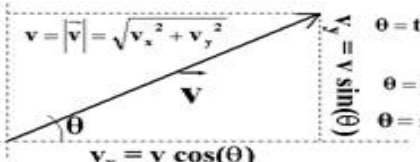


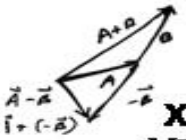
Sources: IDC, Gartner, Keystone, McKinsey

Data Science and Advanced Analytics

$$\Delta x = x_f - x_i \qquad \Delta v = v_f - v_i$$

$$\vec{v} = \frac{\Delta \vec{r}}{\Delta t} \qquad \vec{a} = \frac{\Delta \vec{v}}{\Delta t}$$





$$\omega = \frac{\Delta\theta}{\Delta t} \qquad \alpha = \frac{\Delta\omega}{\Delta t}$$

$$v = v_o + at$$
$$x = x_o + v_o t + at^2/2$$
$$v^2 - v_o^2 = 2a(x - x_o)$$
$$\bar{v} = \frac{v_f + v_i}{2} \qquad \Delta x = \bar{v}\,\Delta t$$

$x \to x, y \quad x_o \to x_o, y_o$

$v \to v_x, v_y \quad v_o \to v_{ox}, v_{oy}$

$a \to a_x, a_y$

$$x = r\theta \qquad v = \omega r \qquad a = \alpha r$$

$$\omega = 2\pi f \qquad f = \frac{1}{T}$$

$$\omega = \omega_o + \alpha t$$

$$I = \sum_i^{all} m_i r_i^2 \qquad \theta = \theta_o + \omega_o t + \frac{1}{2}\alpha t^2$$

$$\omega^2 - \omega_o^2 = 2\alpha(\theta - \theta_o)$$

$$L = r_\perp p = m v r_\perp \qquad \tau = r_\perp F = r F_\perp$$

$$L = I\omega \qquad \tau = \frac{\Delta L}{\Delta t} \qquad \tau = I\alpha$$

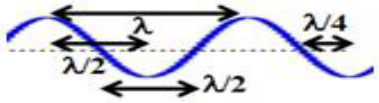
$$\frac{1}{2} I\omega^2$$

$$\sum_i^{all} \vec{F}_i = 0 \qquad \sum_i^{all} \vec{\tau}_i = 0$$

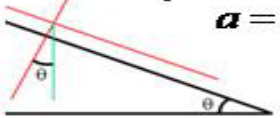
$$v = \sqrt{\frac{T}{\rho}}$$

$$\mu N \qquad a = \frac{v^2}{R}$$

$$v = \lambda f$$



$$\vec{F}_{tot} = m\,\vec{a}$$



$$E = K + U \qquad \Delta Q = (\text{quant.})\, C_{cond}\, \Delta T$$

$$\Delta S \geq 0$$

$$W = F\, d_{\parallel} = F_{\parallel}\, d$$

$$E_i = E_f \qquad \Delta Q_{into} = \Delta W_{by} + \Delta E$$

$$\Delta Q = 1\,\Delta(\text{quant.}) \qquad PV = nRT$$

$$W_{tot} = \Delta(KE) \qquad \frac{1}{2} m v^2 \qquad \frac{RT}{2}\Big|_{deg.\ freedom} \qquad C_P = C_V + R$$

$$e = \frac{\Delta W}{\Delta Q} \qquad e = 1 - \frac{T_L}{T_H} \qquad P = \frac{F}{A}$$

$$\Delta U = -W_{if}$$

$$\frac{1}{2} k x^2 \qquad \omega = \sqrt{\frac{k}{m}}$$

$x = A\cos(\omega t) = \{or\}\ A\sin(\omega t)$

$v = A\omega\sin(\omega t) = \{or\}\ A\omega\cos(\omega t)$

$a = -A\omega^2\cos(\omega t) = \{or\}\ -A\omega^2\sin(\omega t)$

$$M = \rho V \qquad P_1 = P_2$$

$$\Delta P = \rho g\, \Delta h$$

$$B = \rho_{liq} V_{disp} g$$

$$p = m\,v$$

$$\vec{P}_{init} = \vec{P}_{final}$$

$$\left(\sum_i^{all} m_j \vec{v}_j\right) = \left(\sum_i^{all} m_j \vec{v}_j\right)$$

$$\frac{GM_e}{R_e} = gR_e \qquad \frac{GMm}{r^2}$$

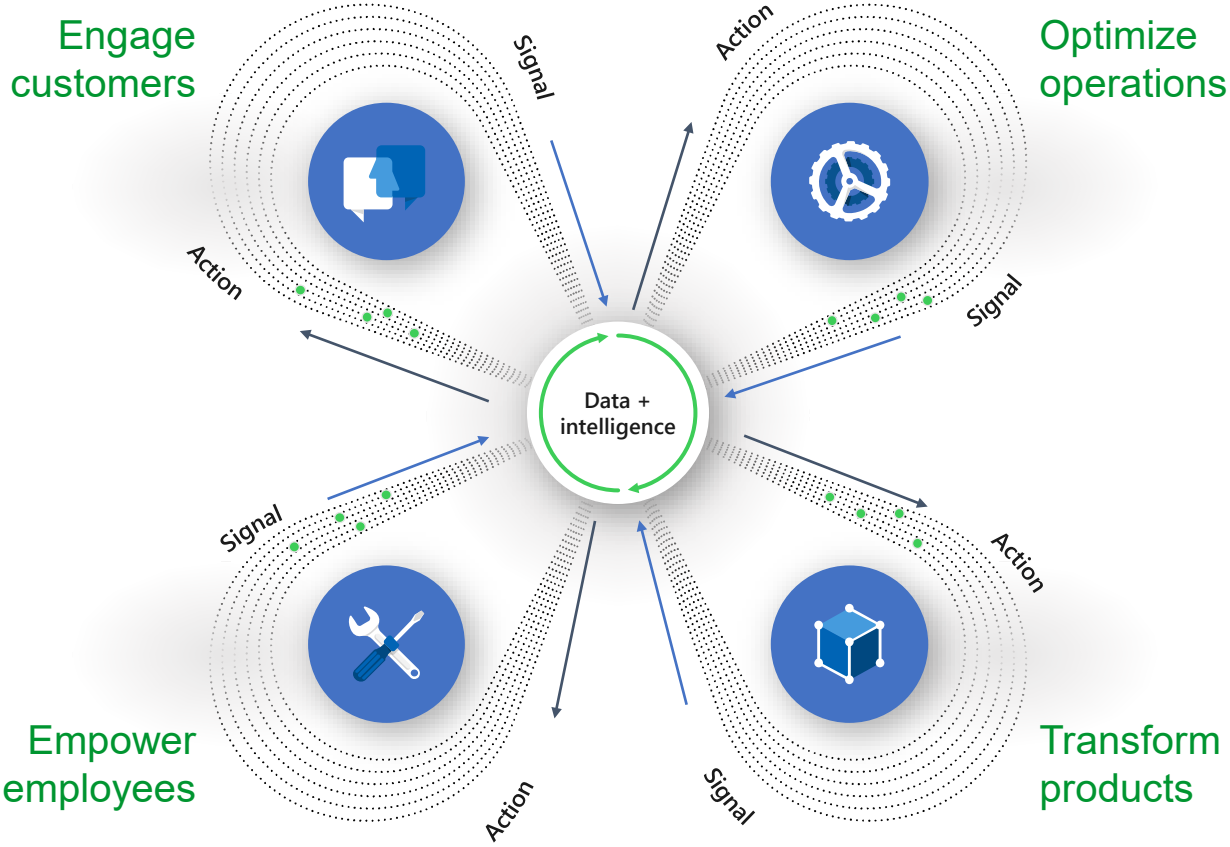
$M_e = 5.97(10)^{24}$ Kg

$R_e = 6.37(10)^6$ m

$$-\frac{GMm}{r}$$

$$A_1 v_1 = A_2 v_2$$

$$P + \frac{1}{2}\rho v^2 = \text{const.}$$



Analytics

help customers succeed

- Technology
- People
- Process

A transformational shift is happening in our industry

Services DNA is changing with Analytics

Drivers like Energy Efficiency and Carbon reduction, shifting manpower; data quality and reliability; deeper insight into electrical networks, have been the catalyst for evolution.

Simultaneously, the industry is experiencing a parallel convergence of IT (information technology; used for data-centric computing) and OT (operational technology; systems used to monitor events, processes and devices) that is affecting how our customers develop and manage their maintenance strategies.

Changes in our Industry

- Experienced workforce retiring
- Covid has introduced new ways of working leveraging technology for remote access
- Service provider **to include analytics provider**
- Your Maintenance has evolved from reactive to preventive to planned preventive maintenance **into condition-based**
- **Analytics** are becoming mainstream and are widely used**… deliver greater value with digital based insights and expertise**

Your Challenges

- Reducing downtime, mitigate electrical and fire risks in aging infrastructures
- Coping with staff shortages and lack of qualified people
- Digitizing operations with increasingly tight budgets and competing priorities
- Addressing the rising cost of Energy

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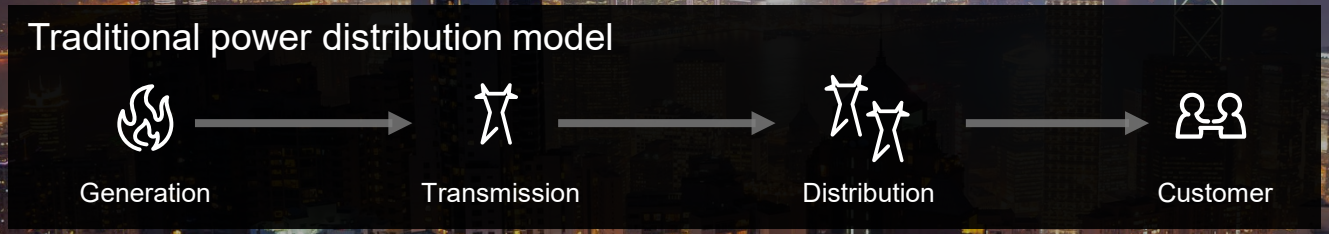
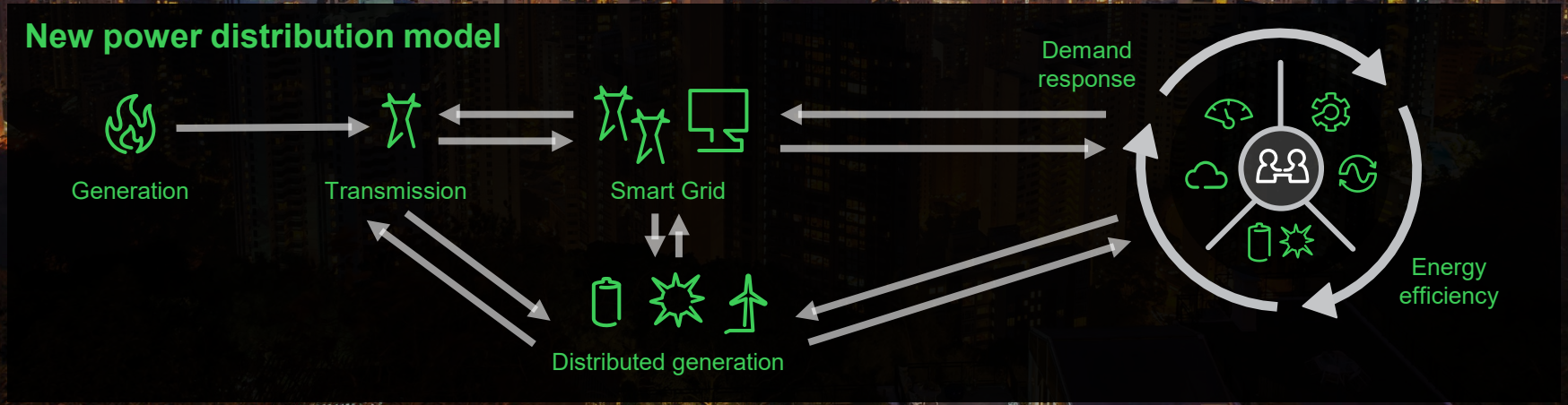
Your Power Distribution is Evolving





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CONNECT

Connect everything from shop floor to top floor

COLLECT

Capture critical data at every level, from sensor to cloud

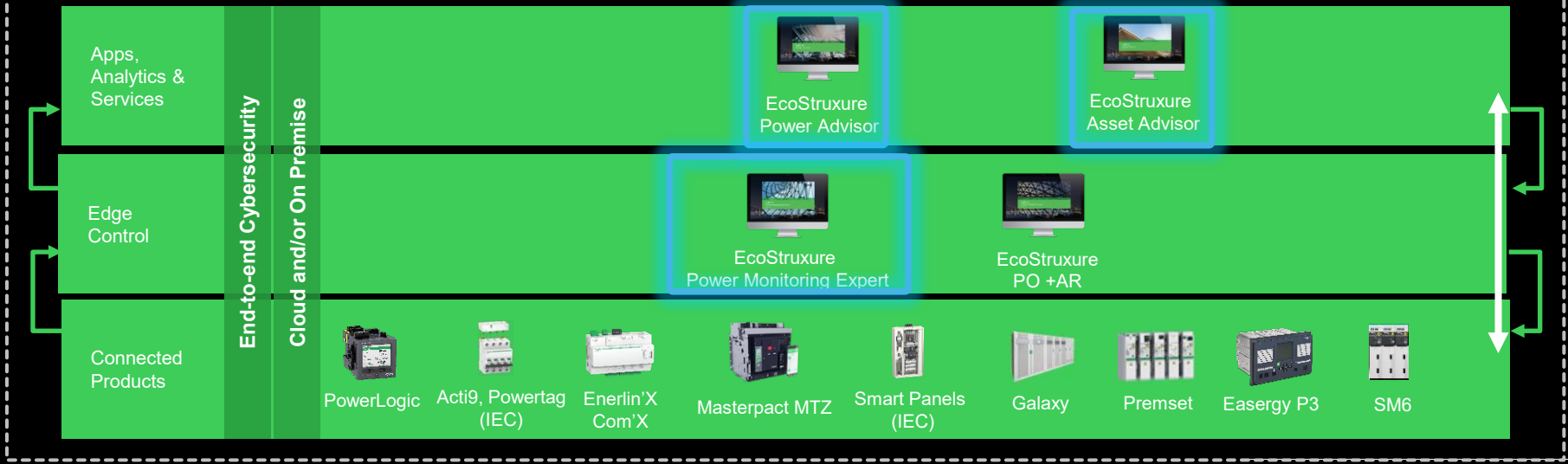
ANALYZE

Convert data into meaningful insights

TAKE ACTION

Drive action through real-time information and business logic

EcoStruxure™ Power Architecture: Open | Scalable | Flexible | Secure | Future-ready



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Data Quality is imperative, critical decisions matter

Power Monitoring Expert helps you make all the right moves

Make informed decisions to maintain power reliability and a safe installation

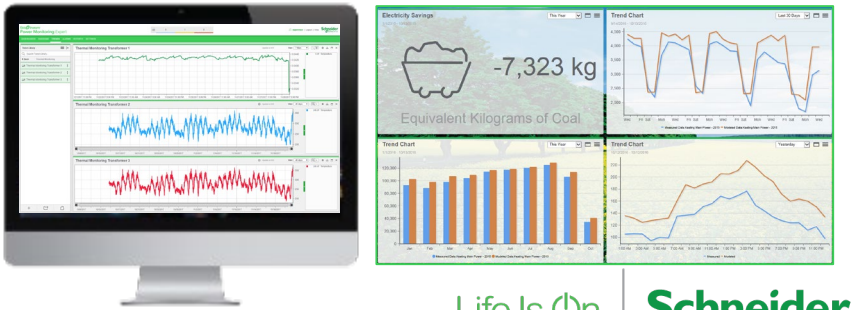
- Run power events analysis thanks to default/rich data integration for connected devices (e.g., Masterpact MTZ circuit breaker, ION9000, PM8000, AccuSine), events time-sequence, location, and power quality waveform analysis.
- Track your facility's power quality performance and compliance against standards

Run an efficient and compliant facility

PME and all PS devices are a Certified Energy Data Management System in accordance with ISO 50001, ISO 50002 and ISO 50006

- Collect and analyze energy performance data of your facility
- Provide appropriate data for your energy audit
- Enable you to implement action plans to improve performance based on review of energy audit

ISO 50001
ENERGY MANAGEMENT



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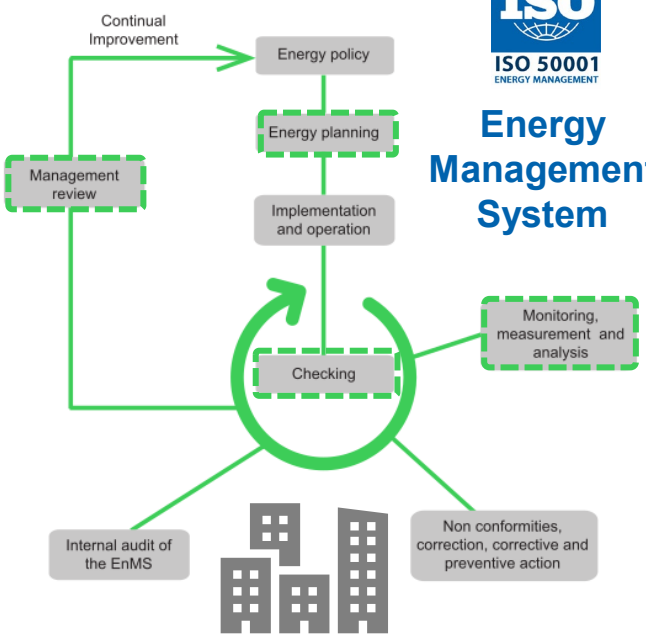
Energy Management is simple with PME and all PS devices

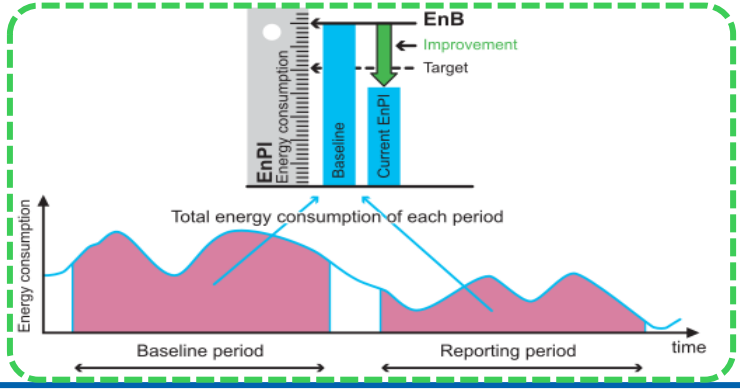


ISO 50001
ENERGY MANAGEMENT

Energy Management System

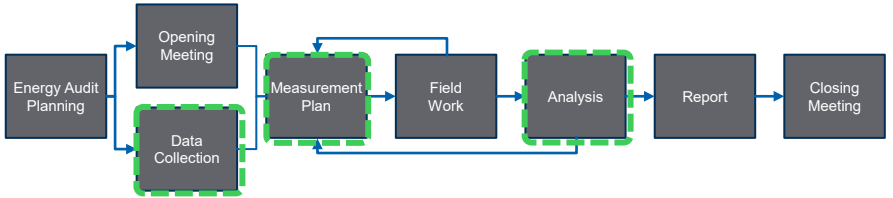
ISO 50006

Measuring Energy Performance



ISO 50002

Energy Audit



- Energy Data Collection
- Energy Monitoring
- Energy Alarms
- Pareto Charts
- Sankey Charts
- Energy Heat Maps
- Energy Modeling
- Energy KPI Gadget
- Energy Calendar Report

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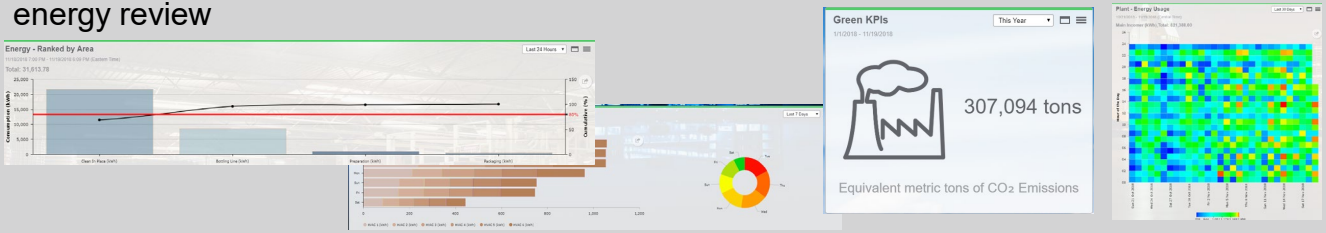
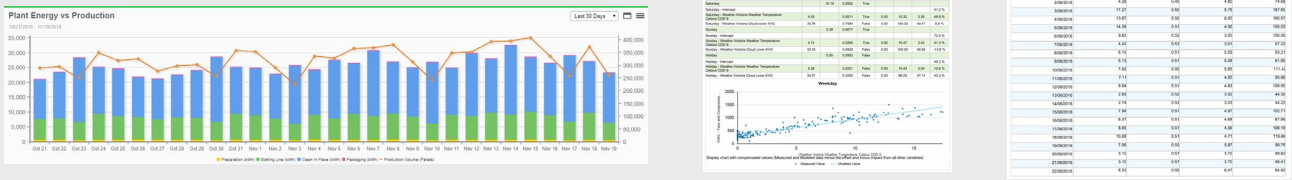
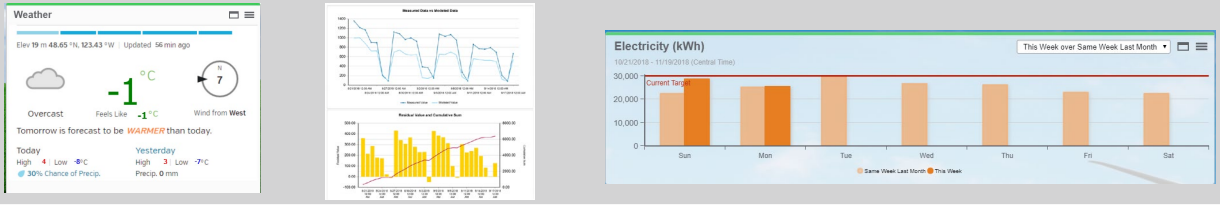
Energy Management is simple with PME and all PS devices

ISO Requirements	Samples of how we make it simple to comply
ISO 50001 • Energy review ISO 50002 • Analysis of current energy performance	We analyze energy consumption data, and identify area of significant use for you to develop energy review 
ISO 50001 • Energy baselines (EnBs) • Energy performance indicators (EnPIs) ISO 50006 • Identifying energy performance indicators	Energy modeling helps you to understand energy consumption characteristics to establish EnBs and EnPIs 
ISO 50001 • Monitoring, measurement and analysis	We monitor and measure the key characteristics that determine your energy performance 

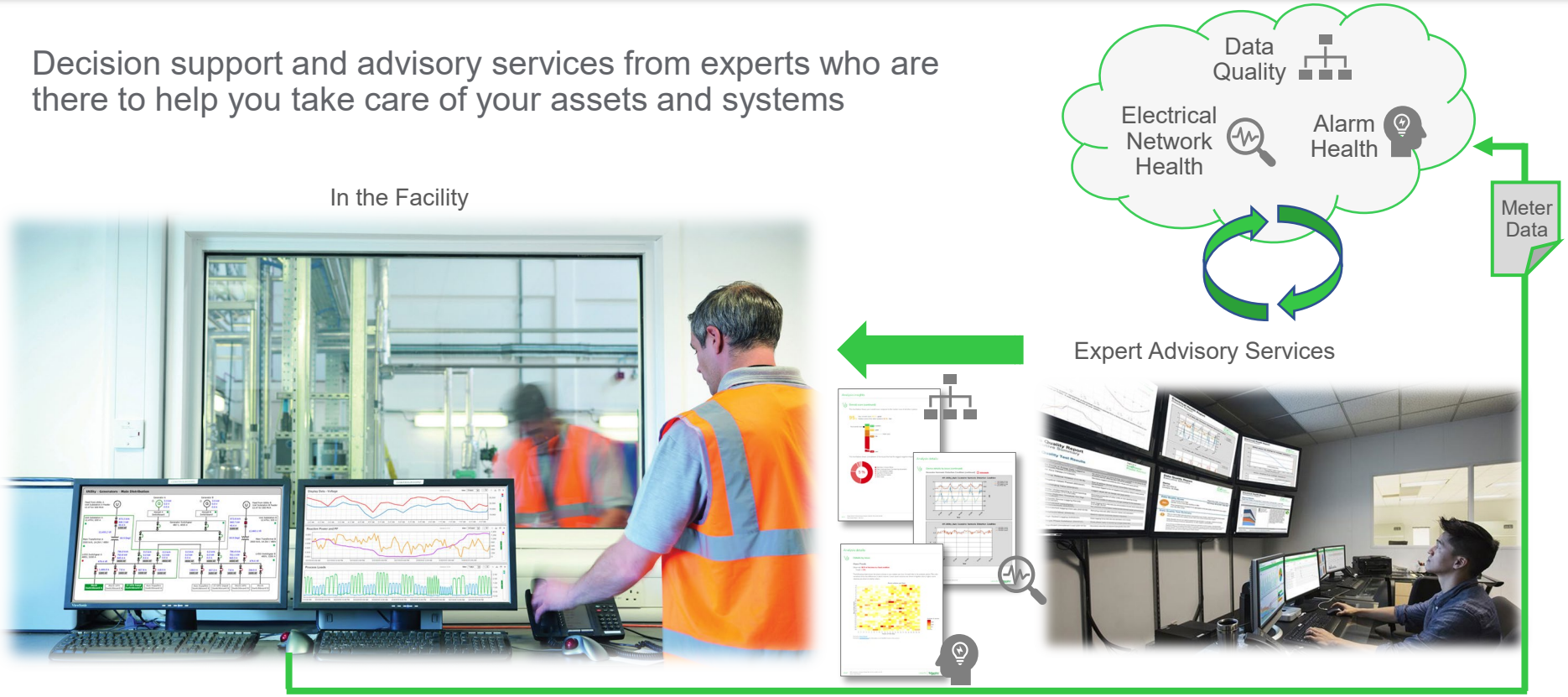
EcoStruxure™ Service Plans

	Prime		Ultra	
Corresponding Part Numbers:	DSPPRIME	DSPPRIMEOS	DSPULTRA	DSPULTRAOS
Support				
Basic product support (phone and email; 8am-8pm EST)	✓	✓	✓	✓
Direct access to advanced support & priority case escalation	✓	✓	✓	✓
Remote access troubleshooting	✓	✓	✓	✓
24/7 support	✓	✓	✓	✓
Software Assurance*	✓	✓	✓	✓
Maintenance				
Diagnostic Xpert - Server Monitoring	✓	✓	✓	✓
Diagnostic Xpert - Device Monitoring			✓	✓
Dedicated Senior Engineer			✓	✓
On-site preventative, condition based maintenance**		2 days/year		4 days/year
Reliability/Improvement				
Power Advisor system & network analysis	Semi-annual	Semi-annual	Quarterly	Quarterly
Expert design and customization eServices (remote)	Discounted	Discounted	Discounted	Discounted
Self-Help Web Portal	✓	✓	✓	✓
On-Demand Online Training Classes	✓	✓	✓	✓
Power Management University Training Classes	Discounted	Discounted	Discounted	Discounted

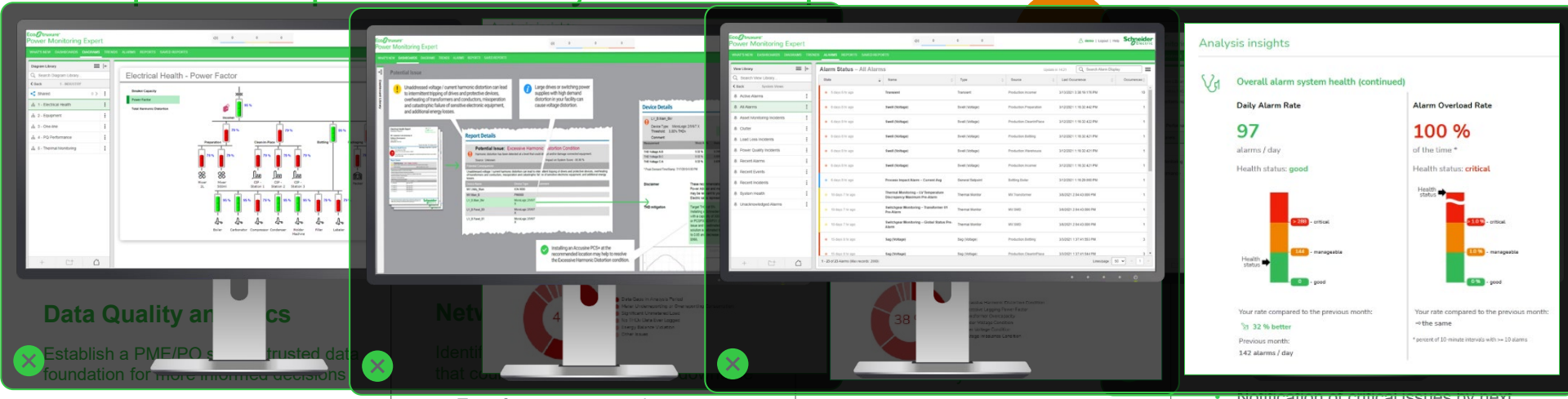
*Upgrade labour not included
**Exceptional travel may result in additional charges

EcoStruxure Service Plans with Power Advisor technology

Decision support and advisory services from experts who are there to help you take care of your assets and systems



The power of powerful analytics with expert advice



Data Quality an cs

Establish a PME/PO s trusted data foundation for more informed decisions

- All zeros or unchanging values
- Data spike
- Data gaps in analysis period
- Conflicting communication settings
- Wrong meter settings
- Energy balance violation
- Unmetered area
- Firmware mismatch

Netv

Identif that co

- Transformer over capacity
- Voltage harmonics
- Excessive lagging PF
- Voltage imbalance
- Under/over voltage

- Categorize alarms as per ISA 18.2: nuisance, stale and fload alarms
- Assess excessive alarm conditions

New

- Notification of critical issues by next business day with expert guidance on corrective actions
- Check software services are running
- Check PME system log errors
- Check Window service errors
- Detect low system memory, excessive CPU usage
- Detect low disk space
- Detect devices not communicating

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Focus on: Power Advisor Alarm Health

Gain insights, maximize operator effectiveness, reduce risk

Measure Alarm Health KPIs

Average Alarm Rate KPI

Peak Periods KPI

Detect Nuisance Alarms and Provide Recommendations

Chattering / Fleeting Alarms

Stale Alarms

Alarm Floods

Frequent Alarms

- Identify hidden patterns that can help address root cause of alarms (e.g., nuisance breaker trips)
- Repair and tune alarm settings to minimize false positives under real operating conditions
- Adjust alarm priorities and ensure alarms are truly necessary to drive action

Internal

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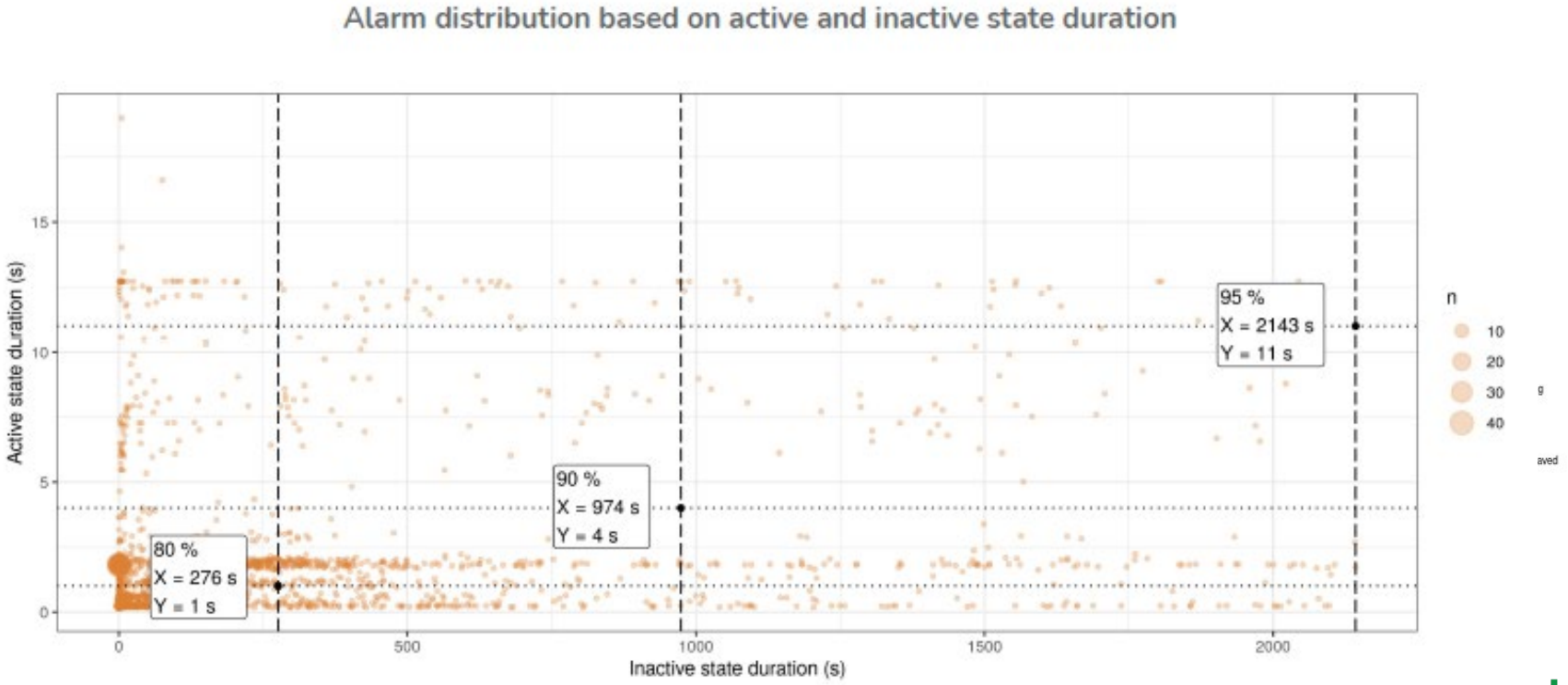
Focus on: Power Advisor Alarm Health

Many Indicators based on the performance measures defined in the ANSI/ISA-18.2-2009/IEC 62682 Management of Alarm Systems for the Process Industries (ISA-18.2/IEC 62682) standard



Go back to Alarm Floods.
Go back to identified issues for information on all identified issues in this analysis.

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Other Analytics

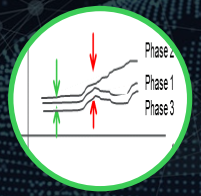
Assets under Management

- OIL TRANSFORMERS
- DRY TRANSFORMERS
- MV PANNELS & BREAKERS
- LV PANNELS & BREAKERS
- VSD
- Industrial UPS
- ROTATING EQUIPMENT*

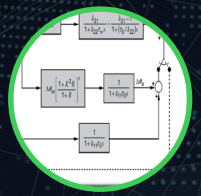
Sources of Data

- Direct Connect
  - MV/LV protection relays / trip units
  - Variable speed drives
- Predictive Technology
  - Temperature / humidity / environmental
  - DGA / partial discharge
  - MCSA…
- Edge Control
  - SCADA / PME …

Analytics + Expertise

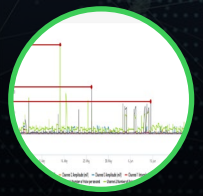


Asset monitoring via intelligence embed into IED, and simple calculations on measurements (threshold crossing, rule of thumb) including thermal monitoring



Analytics for Condition assessment via KPIs for wear, ageing, thermal modelling… defined by Product Development team or Int'l Standards.

Data-driven Condition assessment via advanced statistical treatment (machine learning) to compare next values with estimated or predicted values



Predictive technology via specialized sensors and controllers: Dissolved Gas Analyzers, Vibration, Partial Discharge, MCSA…

Threshold crossing

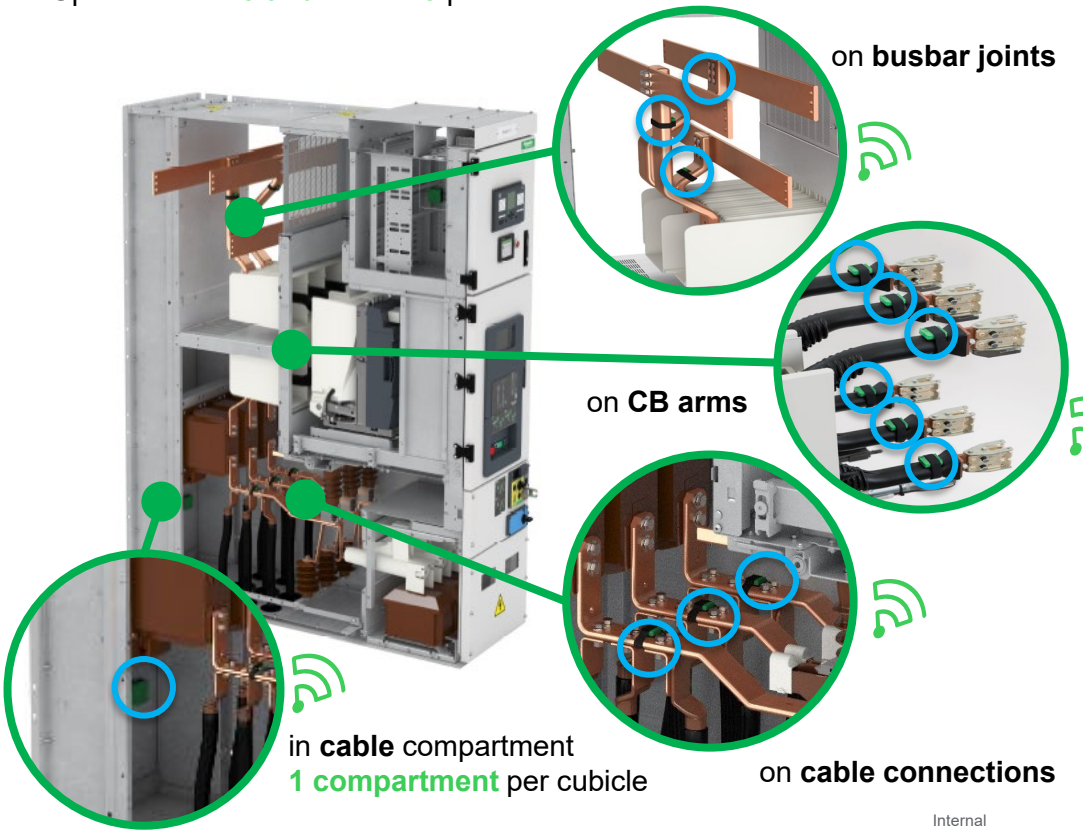
Ongoing impact analysis

Deep, predictive analytics with machine learning

Thermal monitoring

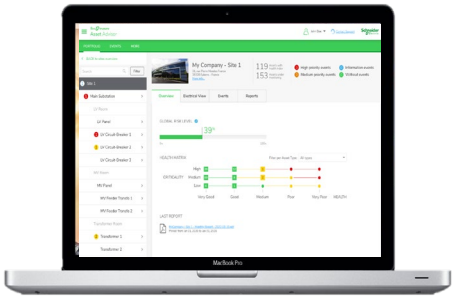
Installation performed by certified service engineers

Up to **12 TH110 and 2 CL110** per MV cubicle



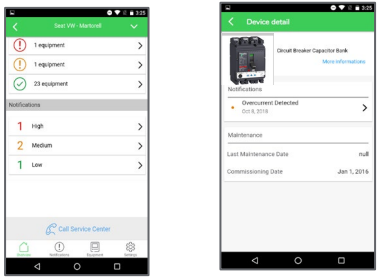
Up to **13 TH110 (and 6 CL110)** per distribution transformer

EcoStruxure Asset Advisor for ED - Digital platform



Web dashboard

- Accessible from PC or tablet
- Multi-user rights and access
- 24/7 asset health status monitoring, alarms, alerts, notifications
- Historical data, patterns, trends, events
- Recommendations depending on issue
- Asset performance Analytics (predictive)
- Condition based recommendations (predictive)



Mobile App

- Mobile App that gives remote access to features of the web dashboard
- 24/7 Access from mobile phone to monitor asset health status
- Alerts and alarms are forwarded directly to the mobile app

Reports

- Self-service automated reports on energy consumption and asset condition
- Customized reports with insights from our experts (predictive)
- Available on the platform and delivered by e-mail

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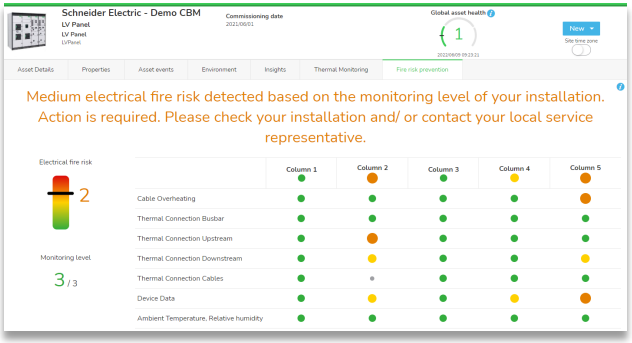
Powerful analytics to manage and improve the performance of your assets

1. Asset Health index

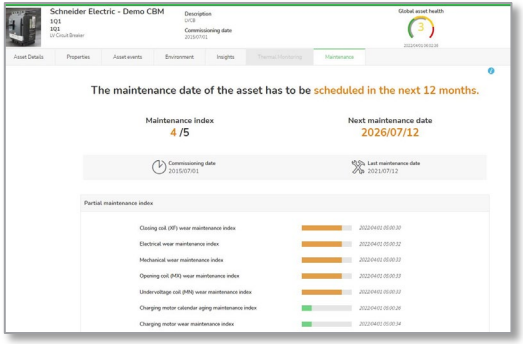
Monitor health status of your assets

2. Fire Prevention index



Mitigate the electrical fire risk in your installation

3. Maintenance index



Move from calendar to condition-based maintenance

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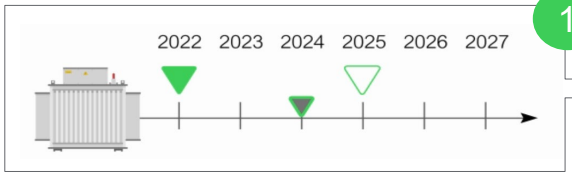
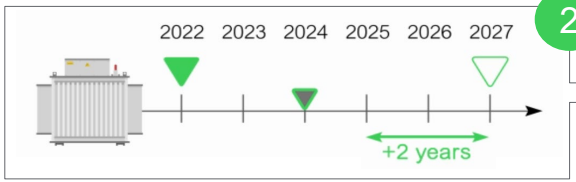
Condition-Based Maintenance to enhance your maintenance strategy



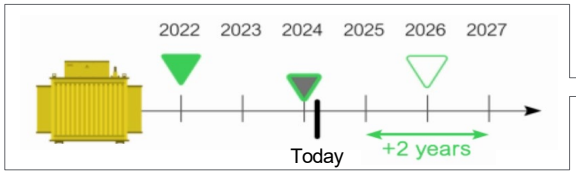
1 **No EcoStruxure Service Plan**

Calendar-Based maintenance activities



2 **With EcoStruxure Service Plan**

Maintenance cycle extension **by up to 2 years** compared to a traditional maintenance contract.



In case of high maintenance index of the asset, an **expert calls you for further investigation.**

Depending on the maintenance index value, the expert shall **propose to re-schedule the next maintenance date** in order to prevent failures and avoid downtime.

Manufacturer maintenance
Intermediate maintenance

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Overheating of Cable connection

Event managed by CSH - Bharath Kumar and Satyajit Gosh

EVENT

- Temperature rise in Phase-C cable connection point of 11kV incomer VCB feeder.

CAUSE

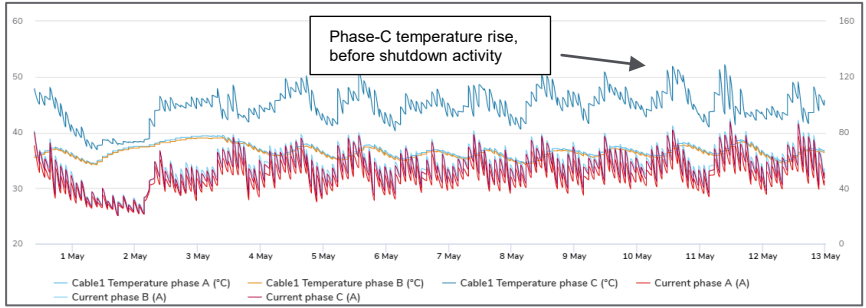
- This event is due to lose connection at Phase C cable point

RECOMMENDATION

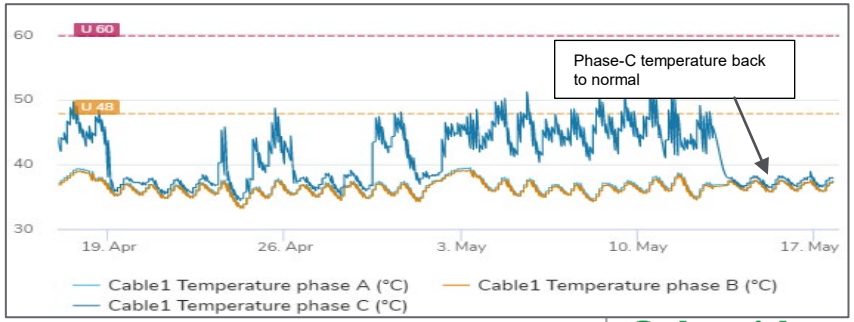
- Recommended to check the tightness of Phase C connection point by taking shut down

Action

- Customer took the shut down on May 13th, 2021, observed loose connection at Phase-C and tightened the cable connection point. Now the temperature of Phase-C is normal.



Shut down	Current Phase A	Current Phase B	Current Phase C	Temperature phase A	Temperature phase B	Temperature phase C
Before	69.11	79.85	77.75	37.1	36.8	51.2
After	63.5	75.63	72.22	36.7	36.5	**37.2**



POTENTIAL IMPACT and RESULTS

Safety: Equipment derating prevention, reduced fire risk.

OPEX: Production downtime savings.

Efficiency: Targeted and direct maintenance where required. Updated calculated age and condition of the asset with associated risk.

Transformer's Fire & Critical Factory Shutdown avoided
with Predictive CSH & EAA ED in a Food & Beverage connected Customer

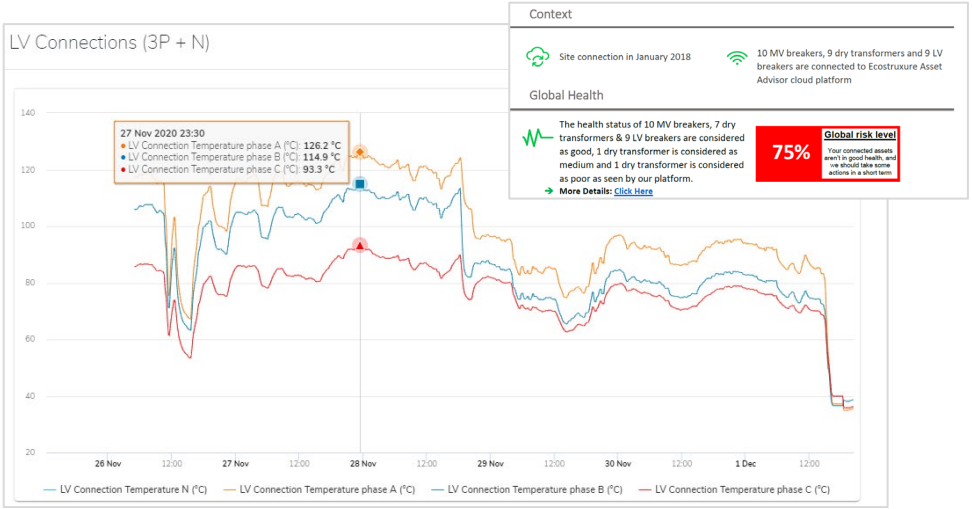
Critical site connected to **EAA Predictive since 2018** :

- 9 LV Breaker
- 10 MV Breakers
- 9 Dry Transformers

Production capa. : **800k€/day** = 33k€/h

Nov. 2020 : Detection by the Predictive CSH of an overheating on a Dry Transformer

126°C (260°F) detected on LV connection Phase A
after the provisioning of new TH110 thermal sensors



Internal

Transformer's Fire & Critical Factory Shutdown avoided
with Predictive CSH & EAA ED in a Food & Beverage connected Customer

1 Event detected, but 2 on going Failures

Loose Cable Connection

Root cause of the overheating :
Presence of oxydes in the screw thread, jeopardizing the torque tightening

Presence of Partial Discharges

« Buzzing sound » = Corona effect detected during the remote assistance of the Predictive CSH agent (over the phone)

Permanent **Added Value**
of the **Ecostruxure Asset Advisor for Electrical Distribution platform**

combined with

the Expertise of the Connected Services Hub Agents

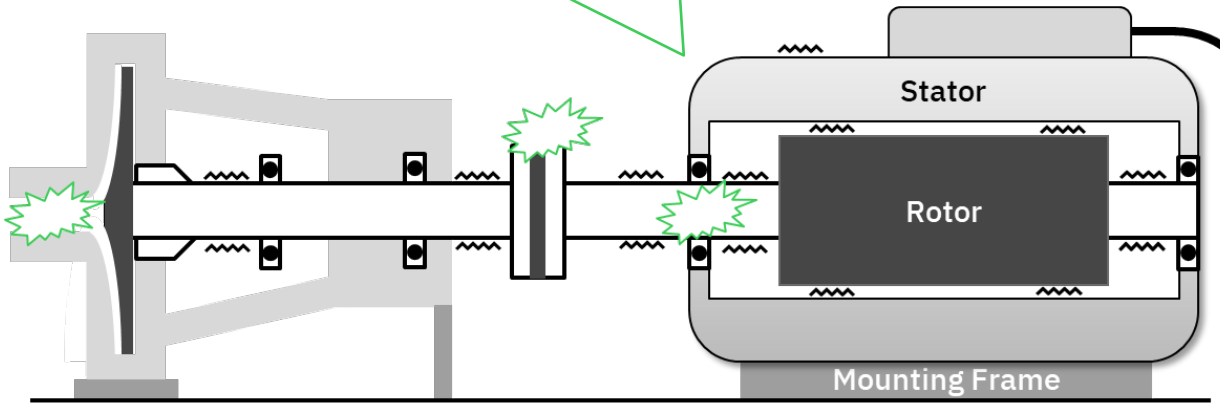
=

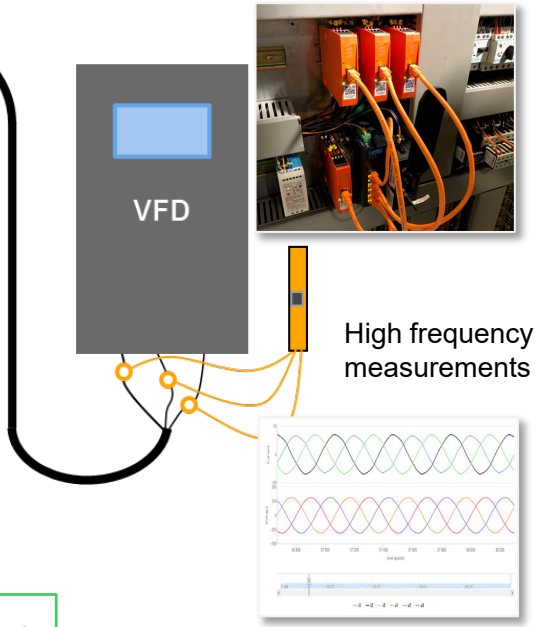
Early anticipation of 2 costly shutdowns

Internal

Motor Current Signal Analytics (MCSA) can detect mechanical and electrical failures that occur throughout the drivetrain.

Vibrations from the complete drivetrain influence the airgap between stator and rotor.



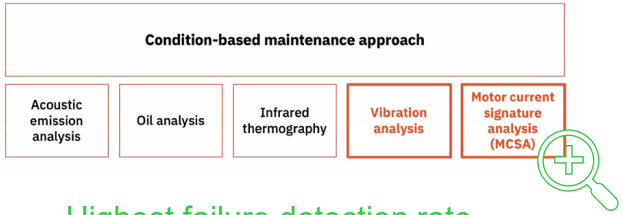


Cavitation *Alignment error* *Bearing damage*

Failure mechanisms show up in their own specific way on the frequency spectrum.

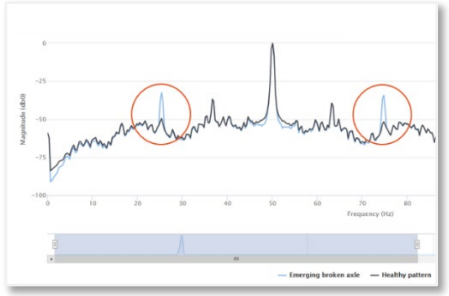
Internal

Motor Current Signature Analysis for rotating assets



MCSA is best substitute for most established technology, Vibration. Why?

Highest failure detection rate



Among other advantages, MCSA has significantly higher failure detection rate than substitutes (e.g. vibration sensors)

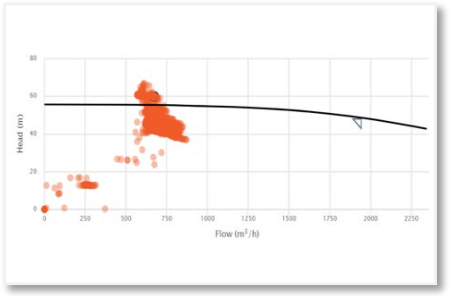
>9/10 failures detected, very few false positives

Works in harsh Environments

Systems sensors - unlike any other sensor technology - do not need to be installed on the asset; inside safe MCC instead. No sensors enter an ATEX zone

Easier to install and scalability

Identify Mechanical & Electrical issues



System informs about power factor, energy consumption and also analyse harmonics anomalies.

This is enabling energy savings and performance optimization insights

Internal

EcoStruxure Asset Advisor for ED – What do we Connect

Apps/Analytics & Services

EcoStruxure Asset Advisor for ED services

Route to cloud connection

Power Monitoring Expert (PME)

Power SCADA Operation (PSO)

Com'X Gatewa

EPAS Gateway

Connected Product

MV Smart Panel

Protection Relay

Sepam or Micom or Easergy P3/P5

Power Meter: PM5000 - PM8000

MV Drives ATV6000

Sologate w TH110 / CL110

Main LV Panel

eIFE

MTZ / NT / NW Air circuit breaker with Micrologic X,P,H

IFE GW

IFM

NSX/NS MCCB Molded Case Circuit B. Micrologic 5.x E

Heat Tag

Earth Leakage Vigilohm ('21)

Softstarter TesysT

LV Drives ATV60x/90x ATV 61/71

LV AC motors[1] & applications: Pumps, Fans…

LV Final Distribution Smart Panel

IP Communication Backbone

Transformers

Thermal Relay

NT935 or equiv.

eDMCR or equiv.

Oil temp. through relay from DGPT2 /Buchholz

Oil trafo options: DGA; PD device

UPS and other back up systems

Gutor UPS G.BMS

MTZ

Soft starter

Air circuit breaker

Preventive scope

(1) Specific set up: CT sensors and dedicated Gateway

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QUESTION & ANSWER
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Internal