The future of industry electrification
Condition monitoring for switchgear
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Distribution Automation
Electrification business

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Short introduction
Current market and transition

Current Market
• Focus on switchgear, breakers and relays
• Minimum life of 30 years for primary equipment and 15 years for electronic equipment
• Robust with low failure rates
• Higher consequence in case of failure

ABB Ability™
ABB offers more with digital solutions:
- Sensing equipment on board
- Software based solutions
- Communication between different layers and tools

Electrical distribution digitalization: an ABB Ability™
Distribution Automation Solution

Typical Power network

Medium Voltage Substation
- Transformer protection
- Incomer line protection
- ARC protection
- Local control
- Measurement

Energy and Power management
- MV& LV Substation remote control
- Transformer/ Tap changer control
- Process control
- Monitoring
- Analyzing
- Logic control (automatism)

Low Voltage Substation
- Earth fault protection
- Motor protection
- Transfer system
- ARC protection
- Local control
- Measurement

ABB Zenon ZEE600 Power Management SW

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Distribution Automation Solution

Typical Power network

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ABB Zenon ZEE600 Power Management SW

Utility

Medium voltage switchgear condition monitoring

Condition monitoring

Low voltage switchgear condition monitoring

Water treatment
Capacitor Banks
Wastewater

Drives & Controller

Air condition
Packaging line
Doors
Air condition

Solar
Generator

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Why is condition monitoring required?
Asset health management
Find the optimum balance

Effective asset management requires investment planning. The owners need to be aware of:

- Assets condition
- Risk level
- Failures consequences
- Life cycle status
- Retrofit investments

Optimal maintenance strategy
Asset health management
Maintenance strategies

- Proactive, predictive
  - 5) Predictive
  - 4) Condition-based
  - 3) Usage-based
  - 2) Time-based
  - 1) Run to failure

Value and savings at fingertips with advanced maintenance strategies
Smart asset management
Experience intelligence

Why should I embrace ABB Ability™?

• **Reduce total cost of ownership:**
  – Optimization of maintenance schedule and increase work force efficiency

• **Maximize Uptime:**
  – Avoid unplanned outages which directly effect revenue generation

• **Improve safety:**
  – Reducing catastrophic failures which impact human and asset life

![Diagram showing ABB Ability features: Reduce total cost of ownership, Maximize uptime, Improve safety, Condition monitoring, Remote diagnostics, Predictive analytics.](image-url)
Reduce total cost of ownership
Optimizing maintenance

100%
Unplanned labor cost doubles
Plan maintenance activities based on real time data diagnostic and prediction

30%
Decrease the duration of the time required for maintenance activities

End user value

<table>
<thead>
<tr>
<th>Asset type</th>
<th>Maintenance type</th>
<th>Frequency of action</th>
<th>Preventive / per asset</th>
<th>Condition / per asset</th>
</tr>
</thead>
<tbody>
<tr>
<td>Circuit breaker</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Visual/Basic</td>
<td>2 years</td>
<td>2 h</td>
<td>0 h</td>
<td></td>
</tr>
<tr>
<td>Advance</td>
<td>5 years</td>
<td>2 h</td>
<td>1.4 h</td>
<td></td>
</tr>
<tr>
<td>Switchgear</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Visual</td>
<td>0.5 years</td>
<td>0.5 h</td>
<td>0 h</td>
<td></td>
</tr>
<tr>
<td>Basic</td>
<td>5 years</td>
<td>0.75 h</td>
<td>0 h</td>
<td></td>
</tr>
<tr>
<td>Advance</td>
<td>10 years</td>
<td>2.5 h</td>
<td>1.75 h</td>
<td></td>
</tr>
</tbody>
</table>

Opex cost reduction
$336 per annum
$168 per annum
Maximize uptime

Avoid unexpected failures

Before failure happen

- Digitalization informing before the system fails
- Know-how about the current asset
- Avoid possible failures help reduce production and asset loss

$1.2M PER HOUR*
AVERAGE DOWNTIME COSTS FOR AN AUTOMOTIVE INDUSTRY

$740k PER OUTAGE*
AVERAGE DOWNTIME COSTS FOR DATA CENTERS

$4.4M PER DAY*
120,500 BARRELS OF OIL LOST PER DAY OIL & GAS SEGMENT

$150M PER OUTAGE
AIRLINE LOST A SWITCHGEAR WITH 3.7% STOCK DROP IN 2 DAYS IN 2016

$100k PER PANEL
STEEL WORKS LOSS PER YEAR PER PANEL

$20k PER PANEL
ANNUAL LOSS IN SEMI-CONDUCTOR PRODUCTION
Improve safety
Avoid unexpected failures

**Operate more safely**
Keep your personnel out of the arc flash zone

Personnel must enter arc flash zone. 4000 injuries occur in the US each year.

**Vs.**
Remote communications enabled, data can be safely transmitted to a remote location.

~300
80%

**ANNUAL DEATHS IN US ALONE ARE CAUSED BY ENERGIZED ELECTRICAL EQUIPMENT**

**OF ALL ELECTRICAL ACCIDENTS ARE CAUSED BY ARC FLASH INCIDENTS**

$1M$ to $15M$

**POTENTIAL COST OF ONE ARC FLASH INCIDENT**

- **19,000 °C** (35,000°F) Hotter than you can imagine
  - Arc Flash temperatures are hotter than the sun.

- **1,100km/h** (700 mph) Projectile-producing pressure
  - Arc flash can throw workers across a room. Metal and equipment become shrapnel.

- **+2,000 burns** More than one way to burn you
  - Each year 2,000+ people seek treatment for serious Arc flash burns.

- **3 meters** (10 feet) Too close for comfort
  - Arc flash can reach out 3 meters to take a life. Serious-Injury zone is even larger.

- **140 dB** An assault on your senses
  - Light and sound bursts can cause vision and hearing loss.
Why temperature monitoring in electrical assemblies
Are the better methods?

Electrical failure – and how to detect it

Common failure in electrical equipment and assemblies are caused by bad joints. But how to detect bad joints early?

- Current measurement  
- Power measurement  
- Temperature measurement

Bad joints need to be detected early before any damage occurs. It can be detected best by temperature monitoring although this will add costs (i.e. by traditional infrared sensing by maintenance personnel or fixed installed monitoring equipment).
Temperature online monitoring
Actual and future situation?

A temperature increase under constant load conditions is the earliest sign of a bad electrical connection in a switchgear. Traditional methods bear certain risks:

- Switchgear operators need to monitor switchgear using Infrared measurement devices which only provides a snapshot view of the temperature condition
- Monitoring needs to be done on life switchgear, for safety high level PPE is required
- Some areas of the switchgear are not accessible under live condition

With 24/7 online temperature monitoring:

- Switchgear operator can monitor the temperatures from a safe and remote location
- The detailed location and the severity (temperature alarm) is available
- Critical areas are monitored (i.e. inside of outgoing modules, incoming cable termination of ACB)
- No need to go to switch room for regular temperature monitoring reduces operational costs

NOTHING

Yearly or 5-year checkups

Online monitoring
WHICH TECHNOLOGY TO CHOOSE?

Zigbee / wired / SAW ?

Technology ?

Temp resistance ?

Local processing?

Lifetime ?

Primary current dependant for self powering ?

On premises / Cloud ?
Temperature online monitoring
Main technologies in the market

**Infrared**
- Safe due to touchless sensors
- Sensors do not require power (works also on powered off switchgear)
- Sensor lifetime 40 years
- Sensor provides differential temperature for most accurate temperature prediction (same as cameras)
- Installation requires mechanical brackets, holders to run cables away from busbars
- Investment cost same or slightly higher compared to other
- Life time cost lower than Wireless, Fibre optic
- BIL (voltage) resistance 545 kV

**ABB SAW**
- Sensor touches the busbar
- Replacement requires shutdown of switchgear
- Sensor does not require battery, and not power current.
- Sensor lifetime 40 years.
- No maintenance required.
- Installation relatively simple – needs antenna placed close by
- Temperature resistance permanently up to 150°C
- PD monitoring and Breaker monitoring without additional hardware
- BIL (voltage) resistance 545 kV
Perceived benefits
Costs and savings balance

Availability
Reliability
Predictability
Electrification ecosystem
A digital world

ABB Ability™ platforms

1. **MyRemoteCare**: the cloud based condition monitoring dashboard
2. **MySiteCare**: all existing MV switchgear can be digitally enabled
3. **SWICOM**: all new MV switchgear are digitally enabled
4. **MNS Digital** LV switchgear
5. **EDCS**: electrification performances can be further expanded
Distribution Automation Solution

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Energy and Power management
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- Analyzing
- Logic control (automatism)

ABB Zenon ZEE600
Power Management SW

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Condition monitoring for MV

Wireless temperature sensors
SWICOM

Switchgear monitoring

- On premises solution
- Circuit breaker monitoring retrieving data from the relays:
  - Opening and closing times estimation and analytics
  - Operation, trip counting etc.
  - Contact wearing etc.
- Health indication and diagnosis on the touch HMI and mobile App
- Extension to ABB cloud possible
Advanced switchgear monitoring

- Temperature sensors across the panels
- Covering failure modes in busbar, circuit breaker and cables compartments
- Flexible installation
- IEC 61850 not requirement for this specific purpose
- Other sensors also possible e.g. ambient temperature and humidity
SWICOM

Scenario overview

Features

- Dedicated and secure private network
- State-of-the-art cyber security
- One way communication without control capability (segregated in the ZEE600 system)
- Warning and alarms delivered to operators, directly, through ZEE600 or both
- Immediate support from ABB if authorized by customers
- Automated reports as per customer wish
- Possible integration through the local network or downloading the data from the Cloud
- Redundant data availability
- Extended condition monitoring data analysis from ABB Ability Condition Monitoring cloud data

Benefit: ROI (Payback) generally from 7 months up to 2 years + increased power supply reliability
MyRemoteCare
Assets health and performance management

Local monitoring → 3G mobile network → Azure platform → Private channel → Remote monitoring

User → Azure platform → ABB

Link: https://myremotecare.abb.com/Equipments/Detail?equipmentId=211
MyRemoteCare
Assets health and performance management
MyRemoteCare
Assets health and performance management
MyRemoteCare
Assets health and performance management
Condition monitoring
Temperature monitoring applications

Arc flash hazards

- Connection faults
- Insulators degradation
- Overload
- Aging
- Oxidation

Avoid unwanted outages
Condition monitoring

Temperature monitoring applications

1. Cable terminations temperature monitoring on GIS (main busbar are also applicable when outside the gas tank)
2. Circuit breaker fixed contacts temperature monitoring on AIS (cables and main busbar are also applicable)
Condition monitoring for LV
Distribution Automation Solution

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ABB Zenon ZEE600
Power Management SW

- Condition monitoring
- Water treatment
- Capacitor Banks
- Wastewater
- Drives & Controller
- Process Electrification
- Air conditioning
- Packaging line
- Doors
- Air conditioning
From LVS Digital to ABB Ability™
Real-time on-premise solution with integrated data connectivity and optimized reporting

- Switchgear with smart devices and Modbus communication interface
- LVS Digital (i.e. MNS Digital / MNS iS / NeoGear) device family, provides the backbone to collect data and make them available
- LVS Digital connects to the ABB Ability on-premise CMES and cloud platform

- Data available on premise
  - Real time data display
  - Condition monitoring
  - Alarm and event display
  - Condition reporting

- Cloud based solution
  - Determining future conditions
  - Data gathering from additional sources
  - Includes data beyond electrical values
  - Condition becomes predictive
## From LVS Digital to ABB Ability™
Scalable solutions for all customer switchgear application

### LVS Digitalization

<table>
<thead>
<tr>
<th>Smart Devices Integration</th>
<th>Condition Monitoring</th>
<th>Data Analytics</th>
<th>Option for Cloud Integration</th>
</tr>
</thead>
</table>

**Scalable, modular, flexible**
- Across MCCs, EDs
- Standard switchgear
- Open platform
- Extendable
- Customizable
- Replaceable

**ABB Ability™ On-premise solution**
- Integrated condition monitoring functions
- Full thermal condition tracking
- Historical event log
- Energy and condition reporting
- On site fault finding
- Knowledge Base

**Asset management**
- On-premises data analytics
- Predictive maintenance support
- Asset health supervision

**ABB Ability™ Cloud solution**
- Common platform not limited to LV installations
- Enhanced data analytics with more available data
- Enhanced asset health supervision and fleet management
- Remote diagnostics and support
Step 1: Connected switchgear, sensors

Switchgear network with process and electrical control connection

- Connected switchgear and sensors
- July 16, 2020 (*)
- Profinet for Motor Starter (UMC/M10x) and ACB (Emax2) supported as these are the devices usually connected to process control system

Switchgear network with process and electrical control connection

- Serial Interface: Modbus, Profinet, Modbus TCP, Profinet (*)
- Digital Gateway
- Modbus TCP ring network
- IEC61850
- Modbus TCP, i.e. COM600 or SSC600

Electrical Control

Process Control

MControl

TMS Modules

ACB and MConnect

MNS iS

MNS iS

MNS / NeoGear

Power meter

VSD and Softstarter

Up to 4 UMC100 per MTQ22

TMS Modules

MTQ22

EM01

RTU to TCP

M10x-M w/ TMS Module

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Step 2: Adding condition monitoring on the Edge

Make the switchgear deliver values

- ACB
- MCCB
- Power meter
- VSD and Softstarter
- Up to 4 UMC100 per MTQ22
- TMS Modules
- M10x-M w/ TMS Module

IEC61850

Modbus TCP ring network

Digital Gateway

CMES

CMES Edge device connects to 512 devices

TMS Module

MConnect M10x-M w/ TMS Module

IEC61850

MNS/NeoGear

MNS iS

ABB Ability™

CMES

VSD and Softstarter

Power meter

MCCB

ACB

MNS iS

MNS iS network

MLink

MControl

ACB and MConnect

RTU to TCP EM01

Proprietary

Modbus TCP ring network
Step 3: Cloud connectivity
Unlock Industry 4.0

- ABB Ability™
- MyRemoteCare or other cloud application
- CMES Edge device connects to 512 devices
- Digital Gateway
- Modbus TCP ring network
- IEC61850
- Modbus TCP ring network
- ACB, ACB, MCCB, Power meter, VSD and Softstarter, Up to 4 UMC100 per MTQ22, TMS Modules, M10x-M w/ TMS Module
- Proprietary MNS iS network
- MNS iS
- MNS/NeoGear
- MNS iS network
- MControl
- ACB and MConnect

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The temperature supervision in the CMES includes the supervision of absolute temperature threshold values specified by the switchgear.

In addition, specific optional maintenance algorithms correlate the temperature and the current for dynamic adaptation of the sensitivity and to secure early failure detection.

Screen grab from condition monitoring indicating temperature warning.
ABB Ability™ CMES
Your dashboard for predictive maintenance

SWGR health condition
Switchgear overview including:
- Total number of item
- General temperature status
- Mechanical components
- Time related trend

SWGR Single line diagram
Single line showing
- Feeder name
- Feeder status
- Single devices status
- Main electrical parameters

Event list
Detailed list including per each event
- Description
- Possible cause
- Suggested actions

Temperature monitoring
Single monitoring point:
- Position inside the switchgear
- Traffic light status
ABB Ability™ CMES
Condition Monitoring for electrical systems

Features and Functions

- **Switchgear 'black box'** data collector; fully embedded solution
- No PLC, no programming required
- Web based full graphical user interface, secure access, password protected
- Online log for alarm, trip and status information
- **Switchgear overview and single line diagram** for diagnosis purpose
- **Condition and Energy consumption report** to optimize the assets
- **Thermal condition of switchgear**
- Assessments i.e. **maintenance date calculation**
- Option for remote monitoring or assistance and cloud services for predictive maintenance
ABB Ability™ CMES - Condition Monitoring for electrical systems
On-premise monitoring, analysis and reporting

ABB Ability™ CMES is the switchgear ‘black box’ monitoring solution that does

Monitor
- Collect the data from every device (with communication interface)
- Monitor and supervise the complete electrical system
- Prioritize information to get right action in time

Analyze
- Connect data and analyze to
  - Separate normal from abnormal condition
  - Enable fast fault finding
  - Present only needed information

Report
- Report creation tool for
  - Switchgear and connected load condition (one click information for maintenance planning)
  - Energy management reporting consumption and changes versus previous (quickly identify high energy consumers)

Predict
- Online 24/7 data analysis of devices such as motor starter, circuit breaker, switchgear modules, etc. to identify maintenance needs and time
  - Contact greasing
  - Device maintenance
  - Operation checks, etc.
LVS Digital and ABB Ability™
Delivers benefits in all industries and application

**One platform**

The connected switchgear solution can be used on all switchgears in all applications:
- Motor control center
- Energy distribution
- Critical power

for new and retrofit application, to maximize customers advantage:
- Simplicity and standardization
- Reduced spare parts
- Just one product training needed
- Interchangeability

Maximized usability with the same solution on all the applications
DIAGNOSTIC

- Calculated Power Loss: 96.74 W
- Health Score: 100%
- Mechanical Score: 100%
- Number of devices in critical condition: 0
- Number of devices in good condition: 7
- Number of devices in medium condition: 0
- Number of devices in offline condition: 0
- Total number of devices: 7
### Measurement

<table>
<thead>
<tr>
<th>Metric</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase L1 Current Percent</td>
<td>0 %</td>
</tr>
<tr>
<td>Phase L2 Current Percent</td>
<td>0 %</td>
</tr>
<tr>
<td>Phase L3 Current Percent</td>
<td>0 %</td>
</tr>
<tr>
<td>Average of Phase Currents (%)</td>
<td>0 %</td>
</tr>
<tr>
<td>Current Phase L1</td>
<td>0 A</td>
</tr>
<tr>
<td>Current Phase L2</td>
<td>0 A</td>
</tr>
<tr>
<td>Current Phase L3</td>
<td>0 A</td>
</tr>
<tr>
<td>Average of Phase Currents</td>
<td>0 A</td>
</tr>
</tbody>
</table>

### Diagnostic

<table>
<thead>
<tr>
<th>Metric</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Running Time</td>
<td>256 h</td>
</tr>
<tr>
<td>Stopped Time</td>
<td>0 h</td>
</tr>
<tr>
<td>Actual Startup Time</td>
<td>3.60 s</td>
</tr>
<tr>
<td>Max Current At Startup</td>
<td>31 %</td>
</tr>
<tr>
<td>Number Of Starts</td>
<td>56</td>
</tr>
<tr>
<td>Number Of Trips</td>
<td>9</td>
</tr>
<tr>
<td>Number of Emergency Starts</td>
<td>3</td>
</tr>
<tr>
<td>Thermal Capacity</td>
<td>64 %</td>
</tr>
</tbody>
</table>
Distribution Automation Solution

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ABB Zenon ZEE600
Power Management SW

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"Based on zenon Energy Edition SCADA and ABB Ability™ Operations Data Management zenon, the ABB Ability Electrification Monitoring and Control for distribution networks ZEE600 advantageously inherits all their features and versatility in visualization, data communication and control.

ABB ZEE600 seamlessly integrates ABB’s electrification products and applications to deliver the next generation on-premise digitalization solutions for state-of-the-art electrification systems."
ABB ZEE600 - A propelling agent for Digital Solutions

Versatility at work

Why ABB ZEE600?

- Versatile across multiple segments:
  - Utilities (Power generation, Sub-transmission, Distribution, Renewables...)
  - Industries (F&B, Oil & Gas, Chemicals, Metals, Electronics & Semi-conductors...)
  - Commercial and Industrial buildings (Data Centers, Hospitals...)
  - Transportation infrastructure (Railways, e-mobility, airports...)
- Easy, wide-range, seamless device & system integration
- Fast deployment using libraries
- Well accepted & proven
ABB ZEE600 – Coverage
Operational facets

A 360° view

Handles several essential facets of substation and electrical process monitoring, control and data management.

– Process awareness
– Process control
– Process monitoring
– Cyber security
– Connectivity to downstream and upstream devices or systems
– ABB electrification libraries
ABB Zenon Electrification Edition - concept

Scalable solutions according your production capacity and power need
ABB ZEE600 – Application perspective
ABB Zenon Electrification Edition ZEE600

An OPEN architecture

- Multiple and open communication protocols
  - Modbus
  - PROFINET
  - ProFibBus
  - IEC61850
  - DNP3
  - LonWorks
  - Bacnet
  - Etc..

- Integration of
  - HV and MV SWG’s
  - MCC LV panels
  - Transformers
  - Motors
  - UPS
  - Alarms

- Asset management
  - Integration of EDCS/MNS Digital/SWICOM condition monitoring
Solution Scalability

- The ZEE600 solution can run in anything which has a screen, including tablets, iPad, iPhones, laptops, industrial computers.

- The ZEE600 is dedicated to connect all platforms and devices through 1 comprehensive system.

- The ZEE600 can represent the data from ABB Ability or other clouds systems, including condition monitoring.
ABB ZEE600 – Application example (MV Swg. condition monitoring integration, SWICOM)

For all segments

- On premise condition monitoring for
  - circuit breakers (open, close times, operation trip count, contact wear, remaining life etc.)
  - switchgear (temperature, partial discharge)
- SWICOM integration to IEC 61850 network with
  - Relion protection relays
  - ABB ZEE600

Contributes to cost of ownership, operational continuity, safety
ABB ZEE600 – Application example (LV Swg. condition monitoring integration, CMES)

For all segments

Contributes to cost of ownership, operational continuity, safety

- On premise condition monitoring in switchgear:
  - Idling of equipment
  - Mechanical operations
  - Power contact temperatures
  - Circuit breaker supervision
  - Time based trends

- Integration based on
  - Modbus TCP
  - Web server
### ABB Zenon Electrification Edition - benefits

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Open architecture</strong></td>
<td><strong>Energy monitoring and analysis</strong></td>
<td><strong>Condition monitoring integration</strong></td>
<td><strong>Backup protection &amp; Safety</strong></td>
<td><strong>Optimization</strong></td>
</tr>
<tr>
<td>Core system supported by 200 integrators globally</td>
<td>Verify and monitor the power consumption</td>
<td>Integration of local and cloud-based condition monitoring information</td>
<td>Arc flash protection and monitoring integration</td>
<td>Load-shedding, disconnecting non-priority loads to avoid Utility penalties</td>
</tr>
<tr>
<td>More than 100 protocols available</td>
<td>Identify savings during peak hours</td>
<td>Integrate alarming and organize maintenance schedules</td>
<td>Future integration of partial discharges monitoring</td>
<td>Peak-shaving, optimize the power consumption for energy savings</td>
</tr>
<tr>
<td>Suitable for power and process integration</td>
<td>Identify power quality improvements</td>
<td>Asset management, add notes about devices, components</td>
<td>Loop control and ring reconfiguration &lt;1s in case of a cable or transformer failure</td>
<td>Power Control, synchronize and control generators to coincide energy supply and demand forecasting</td>
</tr>
<tr>
<td>Suitable for IEC and ANSI architectures</td>
<td>Events analysis with the process recorder</td>
<td>Look for devices and take corrective actions over the system</td>
<td>Backup protection with SSC600 Smart Substation Control</td>
<td>Plant Power Management with Energy Storage, Generators and Microgrids application</td>
</tr>
<tr>
<td>Integration with 3rd party components</td>
<td>Virtual metering by zones and departments</td>
<td>Remote fault-analysis and support</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Multiple locations compatibility</td>
<td>Coincide demand report, savings with Utility</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Value proposition
- Collects, analyzes, visualizes and manages data
- Provides valuable process insights for better decisions
- Minimizes downtime
- Optimizes energy efficiency
- Fast, dependable, agile automation
- Maximum data security and powerful reporting
- Easy and seamless integration
- Global service and support

Customer benefits
- Turns data into information
  - Communication protocols
  - Key component in Industrial IoT, cloud interface capabilities
- Securing information integrity
  - Integrated data and cyber security management
- Creating insight for better business decisions
  - Certified load/energy management system module, reporting
- Low total cost of ownership
  - Extensive life cycle
  - Simple and cost-effective extensions
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