

F&B DIGITAL EXPERT DAY, 2020-04-28

Uncover the hidden potential of your plant

Digitalization of electrical assets and associated benefits

ABB

Luca Cavalli

20 years serving industrial customers

Luca Cavalli is Head of Asset Management digital solutions for ABB's Electrification business.

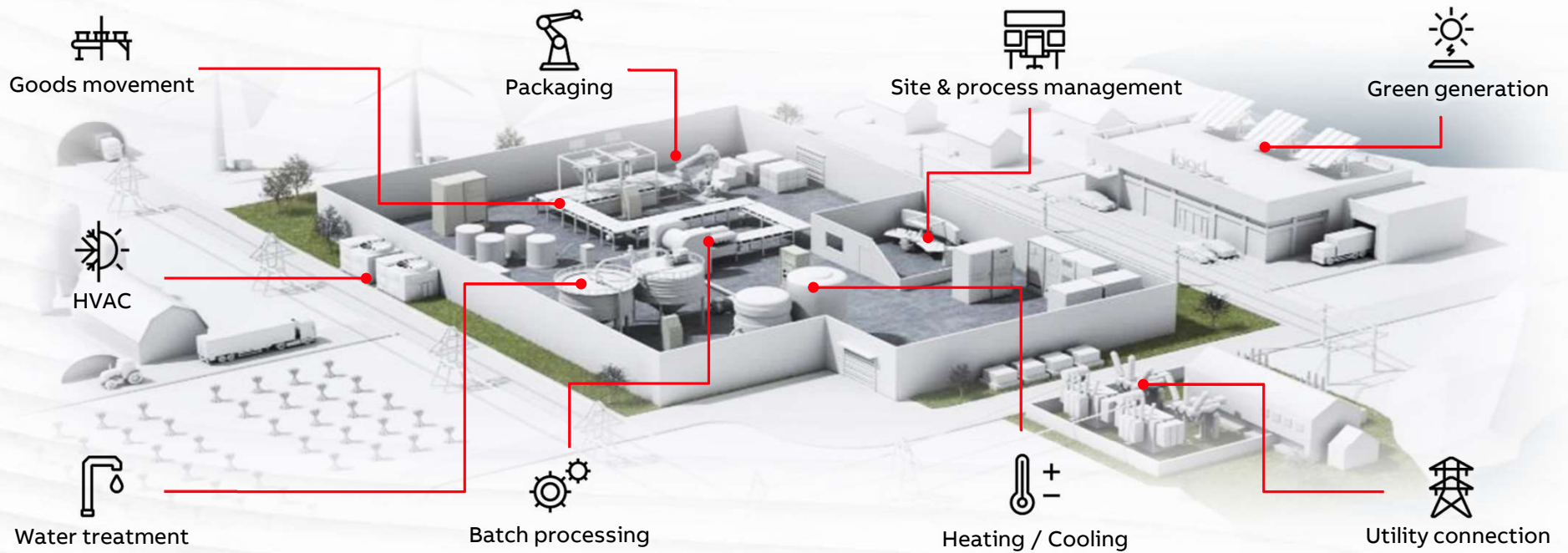
Luca joined ABB in 2012, as a Product Manager for smart asset management in Medium Voltage Service, where he launched one of the first IoT cloud global applications for Electrification, and created the basis for the future portfolio, from sensors to predictive analytics.

From 2008-2012, Luca was involved in the industrial automation market, launching one of the first remote service cloud-based solutions for PLCs. Prior to that, he was the Electrical and Automation Manager at a machine builder (industrial and marine cranes).

Cavalli holds an M.Sc Software and Automation Engineering degree at Polytechnic of Milan, Italy.



Food & Beverage



Food & Beverage with ABB Ability™

Safe, smart and sustainable food and beverage



Safety



Production continuity
& energy management



Asset performance
& optimization



Scalability, flexibility
& sustainability

Uncover the hidden potential of plants: digital

“Start small, think big. Don’t worry about too many things at once.”

Steve Jobs

Start simple and scale

- Faster to learn and use
- More efficient
- Fewer mistakes
- Effective
- Modularity

“You are never too old to set another goal or to dream a new dream.”

C.S. Lewis

Installed base

- Digital is plug’n’play
- Exploit more from existing assets
- Easily enhance capabilities without retrofit/replacement
- “Extract” digital data from non-digital assets

“We are all now connected by the Internet, like neurons in a giant brain.”

Stephen Hawking

Internet of Things

- Enable communication and connectivity
- User can access content wherever, whenever
- Safety first! Remote monitoring instead of access hazard areas

Safety

People and equipment protection

Fast acting and coordinated arc protection systems applicable on MV and LV systems, and on new and existing switchgear, to increase safety and minimize downtime.

MV and LV certified switchgears against internal electrical arc faults.

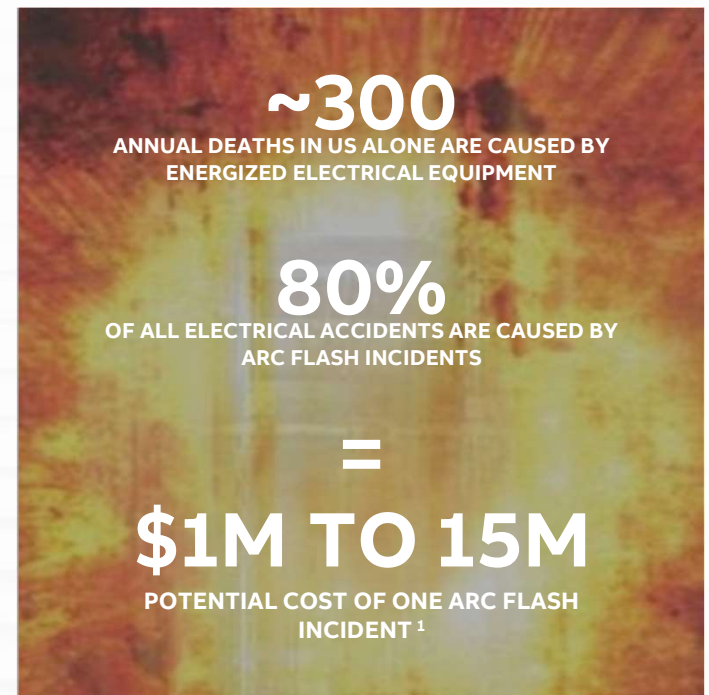
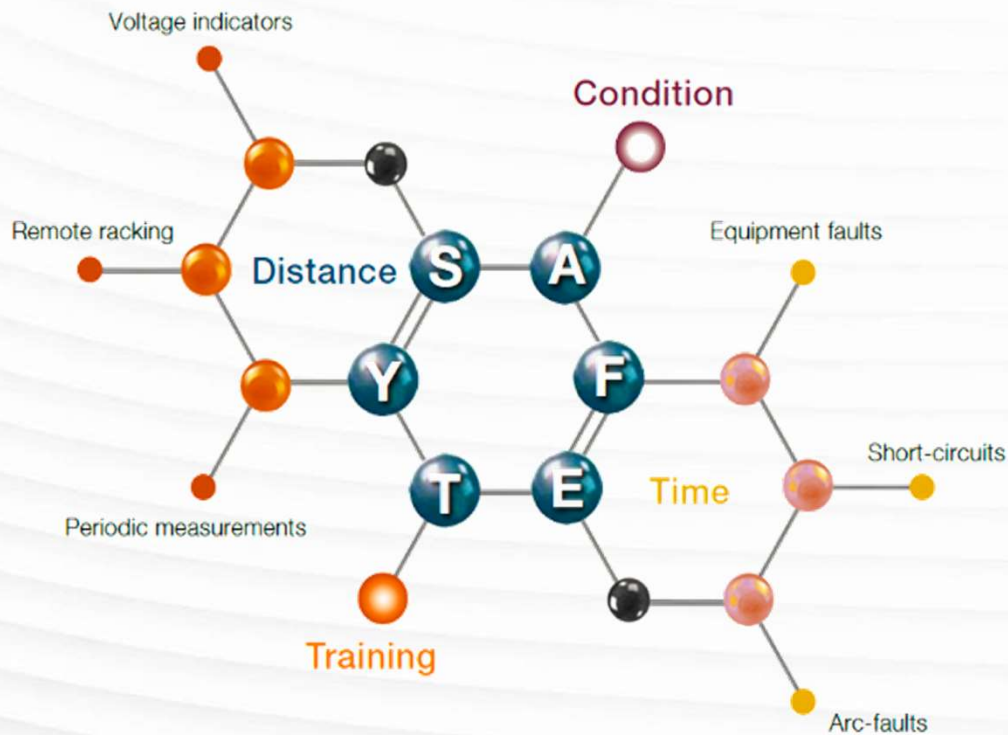
Digital asset

Self-monitored digital communication bus and devices.

Personnel not exposed to high-voltage with sensor technology during testing.



Failures on electrical equipment



1) A 1999 Electric Power Research Institute (EPRI) study pegged total direct and indirect costs of an arc flash incident

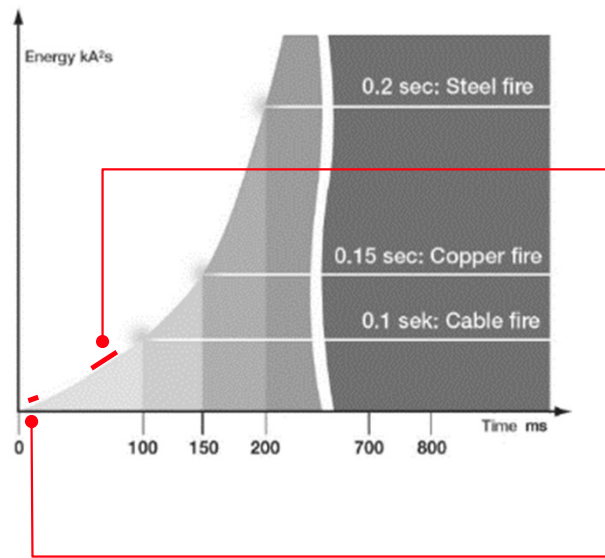
Active people and equipment protection

Why?

The occurrence of an arc fault is the most serious fault within a power system. The destructive impacts of an arc flash event can lead to severe injuries of the operating personnel, to costly equipment damages and long outages.

How?

ABB digital solution detects the intense light of an arc flash, with fiber optic sensors (loop or radial schema), comparing with overcurrent condition, sending a trip signal in less than 2.5ms. The arc extinction is achieved by means of innovative and dedicated switch or by circuit breakers.



MV arc detection and extinction

REA solution and Relion® relays with arc protection offer fast arc-fault detection and extinction in **60-80ms**.

LV arc detection and extinction

TVOC 2 offer fast arc-fault detection and extinction in **60-80ms**.



UFES Ultra-Fast Earthing Switch

Offers best arc-fault detection and extinction in **less than 4ms**. It includes primary switching elements. It can be used **up to 40.5kV and 100kA**, and easily extended for both MV and LV with other arc detecting devices (REA, TVOC, etc).

Production continuity and energy management

Energy management

Energy monitoring and reporting to evaluate and compare consumption.
Full control of energy flow, integrating utility, renewables and production.

Power quality and stability

Integrated capacitor banks for power factor correction.
Modular and combined Uninterruptible Power Supply solution.

Power availability and restoration

Load-shedding and peak-shaving to keep up the running of critical loads and avoid extra-costs.
Automatic transfer switch ensuring power supply.
Full power management for critical processes.



Energy management

Why?

It is nowadays crucial to keep the energy consumptions under control and achieve relevant savings, running a sustainable business.

How?

Energy management is the process of monitoring, controlling, and conserving energy in a plant. It includes activities like: metering, collecting and monitoring aggregated and detailed data, comparison reporting by time period, amid loads, production lines, and different sites.

Let's find opportunities to save energy, track improvements, replicate best practices and innovative solutions.



Energy analysis and efficiency

Full **awareness** of consumption, of every production or facility area. Configurable logical **groups** to aggregate the equipment. Allows easy costs allocation. **Multi-site** analysis. Energy **peaks** monitoring and alerts. **Power factor** and harmonics analysis. Moreover, **power forecast** enables further optimization.

Energy control and plant integration

Electrical Control System, for real time monitoring and control of energy flows. **Scalable** from a single substation to a complete plant and more. **Integrating** all the data sources, with more than 300 communication protocols and IT/OT convergence.

Energy metering

Energy consumption is a relevant portion of production and facility costs. Existing digital protection devices as well as easy-to-retrofit and plug digital meters enables site consumption monitoring, up to every single load.

Avoid penalties

100%

Decrease in penalties for overcome contractual power

Energy savings

20%

Less energy consumed by facility equipment

A journey from monitoring to forecasting



Baseline and comparisons

- Create a baseline monitoring plant, production lines, and loads
- Compare period over period and each product lines (cost allocation)



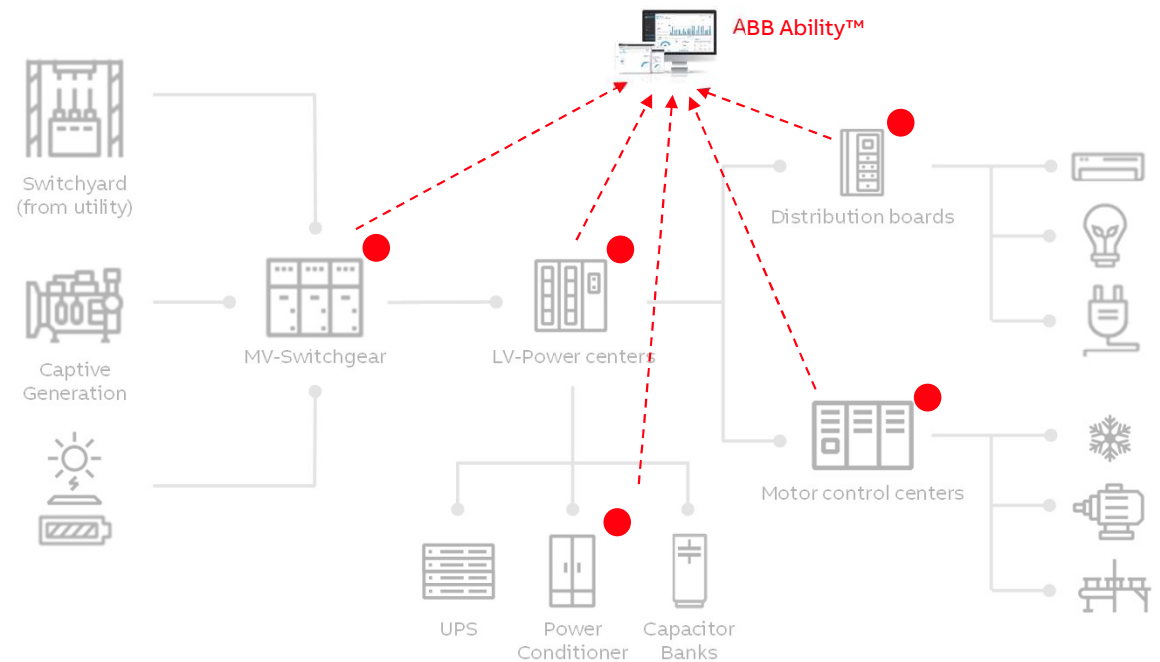
Optimization and adjustments

- Continuous improvement to achieve energy efficiency targets
- Relevant KPIs and automatic report for energy audit

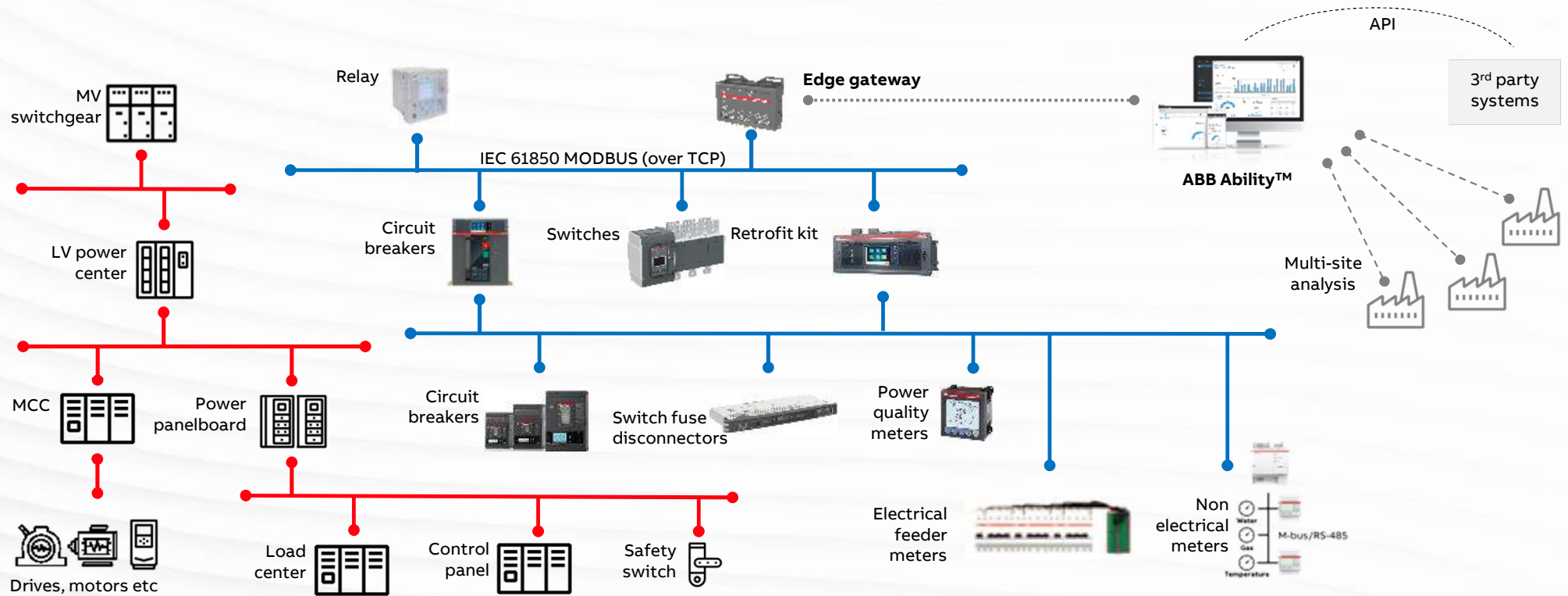


Forecast

- Predict the energy consumptions to achieve higher efficiency and productivity in the long term
- Decrease your effort by forecasting the energy consumption



Electrical and digital architecture



ROI: case of a small F&B plant

Energy management on existing LV switchgear and sub-distribution

Information about energy bill

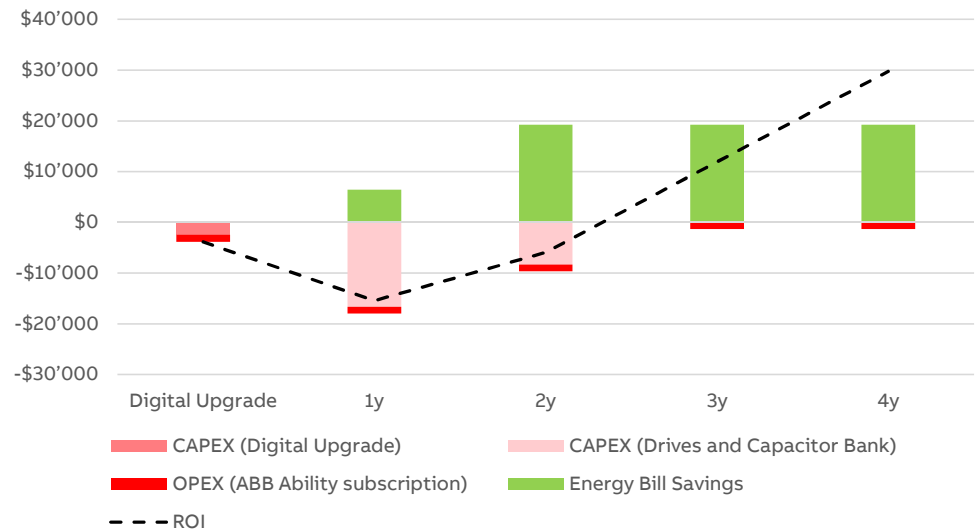
- Contractual power installed = 400 kW
- Avg energy consumption = 133 MWh / month
- Avg energy bill = \$32 k / month (\$384k / year)
- Avg energy price = \$0.24 / kWh
- No energy management system installed

Information about ABB standard devices installed (20 devices)

- 2 main breakers (Emax 2)
- 8 breakers (XT2, XT4)
- 1 control unit with 96 sensors (CMS-700)
- 9 power meters (M4M)

Information on digital investment

- Digital equipment (gateway and connectivity modules) + commissioning = \$2,5 k
- Replacements of drives and installation of capacitor bank = \$15 k
- Yearly standard subscription for ABB Ability Energy Management = \$ 660 /y
- Yearly premium intelligent alert on cost control for ABB Ability EM = \$ 690 /y



ROI = 2,2y from digitalization (1,2y from modernization)

Energy savings = \$19 k / Year

Largest Swiss rice mill monitors energy distribution digitally



Plant

La Riseria part of Migros group, largest rice mill in Switzerland



Customer needs

Customer is renewing its production facility pursuing a sustainability program. They want to monitor energy consumption of every load in the facility.



Digital offering

Emax 2, Tmax, CMS-700, Ability™ EDCS

“

We are currently gaining experience with the energy consumption measurement of ABB Ability™ EDCS and can thus analyze the consumption in the existing plant [...] I can see, in a very detailed way and with graphic visualization, where and how much electrical energy is consumed throughout the entire plant.

”

Stefano Aimi, CTO/COO



Italian water company reduces operational costs



Plant

Consorzio di Bonifica Veronese, wine yard, Italy



Customer needs

Remote monitoring of water pumping stations.

Optimization of personnel's tasks and costs, and downtime prevention.

Removal of power quality penalties.



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Digital offering

ABB Ability™ energy and asset management solution, Emax 2

“

The availability of data made us eligible for energy efficiency certificates worth €24,000, without the time and expense of independent external auditing. We will deploy this solution across dozens more water distribution facilities and estimate we can reduce operational costs by around 30%.

”

Riccardo Tosi, COO



Optimization of production and costs



Plant

Hermes International food factory
Croatia



Customer needs

Improvement in reliability and efficiency of the production process and optimization of production and costs. Control of power peaks.



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Solution offering

ABB Ability™ Electrical Distribution Control System (EDCS), Ekip UP digital units, including gas and water meters and temperature measures.

“

In addition to limiting peaks in the power, we have better control over the consumption of energy sources. The system also triggers an alarm for temperatures in cooling chambers in the warehouse, a factor that highly influences the quality of raw materials and final products.

”

Martin Brezovec, COO



Power quality and stability

Why?

A poor power factor can increase the costs of energy and utility penalties. And electrical network disturbances, like **sag and swell** events, can impact the automation systems causing costly production interruptions.

How?

ABB can offer a broad portfolio of solutions to maximize the power quality and stability. In particular the reactive power and harmonics can be optimized with capacitor banks and filters. And the power stability is maximized with UPS (Uninterruptible Power Supply) as well as with AVC (Active Voltage Conditioner), which removes immediately the disturbances.

1

Power and voltage conditioner

Keep the line voltage in a given range, eliminating sag and swell, with a very high energy efficiency, small footprint and low maintenance, since it does not require batteries.



ABB PCS100 family provides active Voltage Conditioner for voltage regulation and sag correction in commercial and industrial applications.

2

UPS

Provides backup electrical power for a period of time to critical equipment in the event of brownouts or total power failure. It requires a battery storage.



ABB UPS portfolio covers applications from LV single-phase and three-phase, up to MV, and from few KVA up to 50+ MVA, with standalone installations.

3

Capacitor banks

Helps factories to reduce costs of reactive power. Typically associated with an automatic system to correct the power factor.



ABB MNS platform offers LV solution from power distribution to motor control centers, and in the same cubicles it can embed modular plug-in UPS and capacitor banks, saving costs and footprint.

Moreover ABB offers solutions to efficiently control MV capacitor banks.

Power stability success case



Plant

Fonterra's Takanini facility, milk production, New Zealand.

22B liters/year, 6.4 bottles/sec, 40MW plant



Customer needs

Avoid power disturbances that cause 6-8 production interruptions per year. At every event the product lines requires sterilization and costs more than 28 hours.



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Digital offering

PCS100 AVC-40

“

After commissioning, the solution eliminated voltage disturbances and unwanted downtiming of the production lines, letting us achieve savings of about USD 500k/year.

”



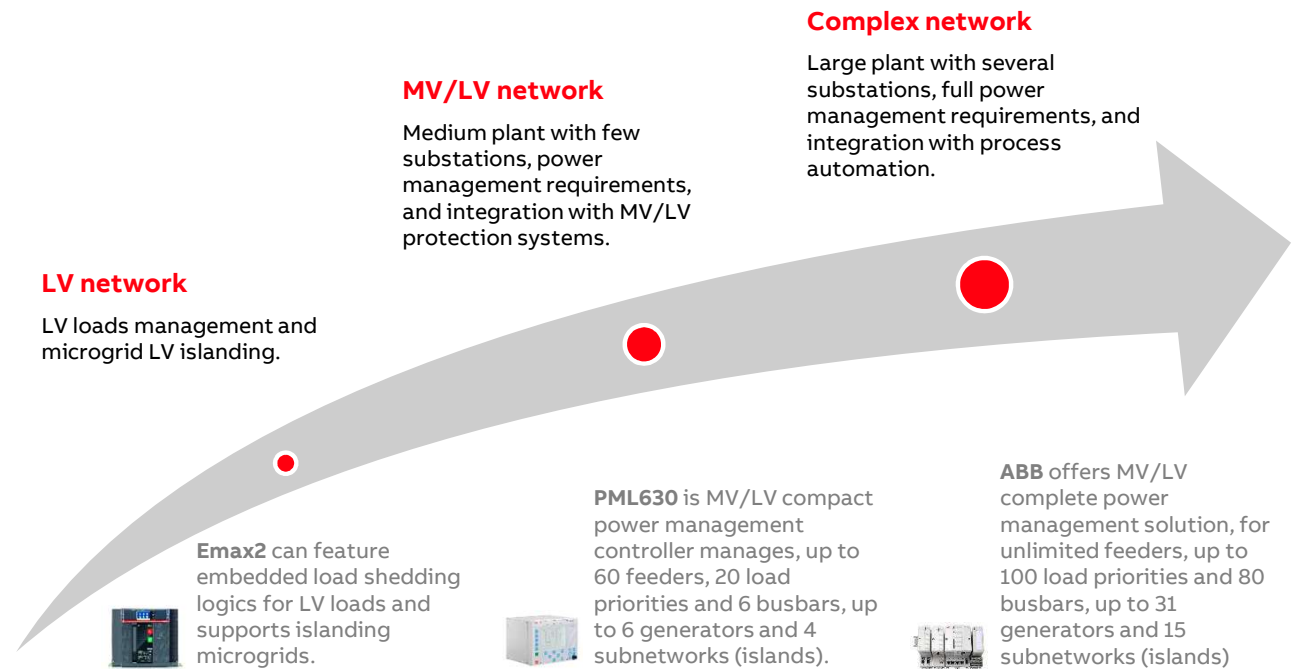
Power availability

Why?

Power management solutions guarantee power availability and therefore process continuity of critical loads and production lines. It avoids extra energy costs (e.g. utility fines) due to peaks consumption. Moreover, prevents damages to motors and captive local generation sizing can be optimized.

How?

Power management solution includes functions like **load-shedding**, **peak-shaving**, **load restoration**, **load sharing** and generators control. Depending on requirements it can be enabled at LV and/or MV level, and it scales from one substation up to several substations. The real-time functionality and easy integration is guaranteed by IEC 61850.



Power restoration

Why?

Most plants have connection to the medium and low voltage grid to supply all production areas. A power loss on main incomers (e.g. utility failure) or internal (fault in the plant grid) can disrupt the production.

How?

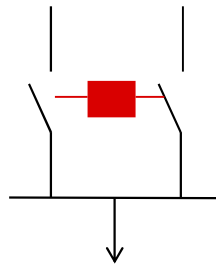
Automatic power restoration digital solution systems can manage different scenarios of fault, maximizing production continuity. A fault and restoration on main feeders can be managed with automatic transfer systems, while a fault on the distribution grid (e.g. a ring topology) can be resolved by Loop Control solution.

Automatic transfer switch (ATS) from one power source to another, is ensuring power supply to process, in case of voltage failures.

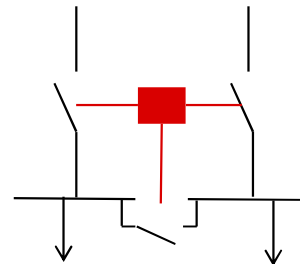
On medium voltage by means of **Relion® relays** manage synchronized ATS, guaranteeing **200-300ms** restore time.

On low voltage ATS functionality can be configured into **Emax** and **Ekip UP** trip units.

High Speed Transfer System (HSTS) is suitable for sensitive production processes requiring transfer time <100ms. **SUE3000**, can restore voltage in **30ms**, offering uninterrupted operations.



Example: Busbar with two feeders



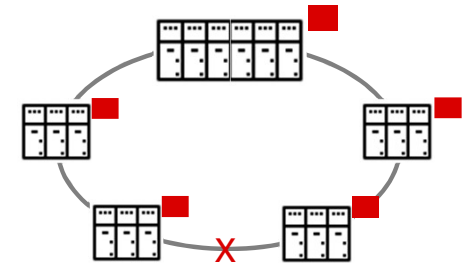
Example: Busbars with two feeders and bus-coupler breaker

Automatic ring re-configuration enables automatic and quick power restoration in an MV ring, when a fault happens.

The solution is based on **LC1000 Loop Control**, able to restore a fault in less than **0,5 sec.**

It is made of Relion® components to implement FDIR (Fault Detection, Isolation and Restoration), communicating on IEC 61850.

It can be applied to switchgears with switch-disconnectors or, for higher performances, with circuit breakers.



Example: on fault, the fault is isolated opening the relevant branch, and supplying the rest of the ring.

Peak-shaving success case



Plant

Glencane Bionergia, sugar and ethanol production with electrical cogeneration, Sao Paulo, Brazil



Customer needs

Reliable and secure power supply through minimized downtime for ethanol, sugar production and electricity cogeneration.
Level the power consumption avoiding penalties, and supervision of the whole MV and LV electrical system



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Digital offering

UniGear ZS1, Relion 615, RIO600, PML630, COM600S

The compact power management solution does real time power leveling, so the plant no longer exceeds the contacted amount, thus avoiding utility penalties. Fast return on investment in about 7 months.



Asset performance and optimization

Condition monitoring

Sensors to detect possible failure causes.
Switchgear condition monitoring to support troubleshooting and drive service activities.

Predictive maintenance

Site and multi-site asset health analysis to predict and notify potential faults, minimizing maintenance, while increasing safety and asset lifetime.

Cyber asset management

Electronic devices inventory, configurations traceability, security firmware updates notification, plant data and documentation back-up.



Predictive maintenance

Preventive maintenance (time-based)

It assumes that the probability of equipment failure increases with use, which is not often the case (usually there is a random pattern ¹). Every asset has a maintenance plan, based on manufacturer instructions or experience.

Predictive maintenance

It is based on condition monitoring data to predict failure. Maintenance when (date) and where (asset) required. It can go also further by combining multiple variables with analytics to predict failure with a higher degree of confidence and fewer false positives.

¹ Source NASA and US Navy: 18% of failures are age related, and 82% have a random pattern. So, preventive maintenance (PM) provides a benefit for just 18% of assets.

Equipment	Maintenance	Frequency	Time/ asset	Predictive
MV circuit breaker	Visual/Basic	2 years	2 h	0 h
	Advanced	5 years	2 h	1.4 h
MV switchgear	Visual	0.5 years	0.5 h	0 h
	Basic	5 years	0.75 h	0 h
	Advanced	10 years	2.5 h	1.75 h
			USD 336 /y	USD 168 /y
Low Voltage Motor	Basic	1 year	1 h	0.25 h
	Advanced	1 year	4 h	0 h
			USD 250 /y	USD 113 /y

Example based on ABB experience

100%

PREDICTION AVOID
HIGH COSTLY
UNPLANNED LABOR

30%

DECREASE
MAINTENANCE TIME

=

40%

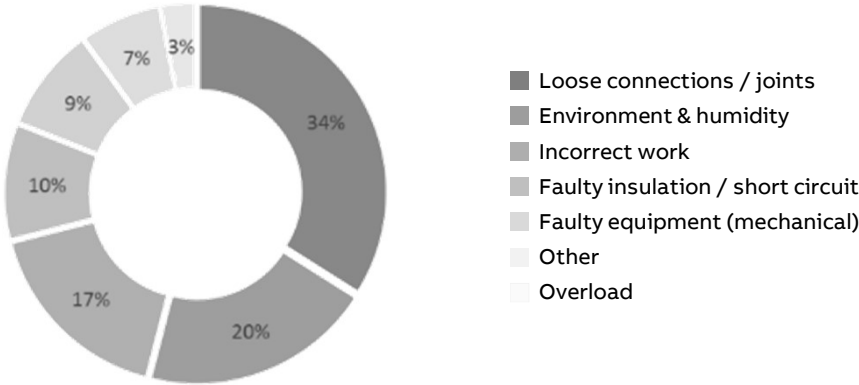
OPEX COST
REDUCTION

Monitoring main electrical failure causes

An efficient and effective condition monitoring solution focuses on most important **failure causes**.

Sensors and other data sources support the monitoring of potential failure causes, substituting the usual manual time-based inspection and maintenance.

A **diagnostic** algorithm typically is required to highlight an abnormal condition (e.g. a temperature over a threshold), which could lead to a potential failure.



Manual (corrective or time based)	Automatic (condition monitoring)
Temperature power parts inspection (require shutdown)	Continuous joints temperature monitoring (detect loose connections)
Environment assessment (might require shutdown)	Continuous environmental monitoring (temperature, humidity, etc)
Insulation inspection and tests (might require shutdown)	Continuous partial discharge monitoring (detect insulation degradation)
Circuit Breaker Periodical tests (requires shutdown)	Continuous electro-mechanical operations monitoring with protection relays

MV condition monitoring SWICOM

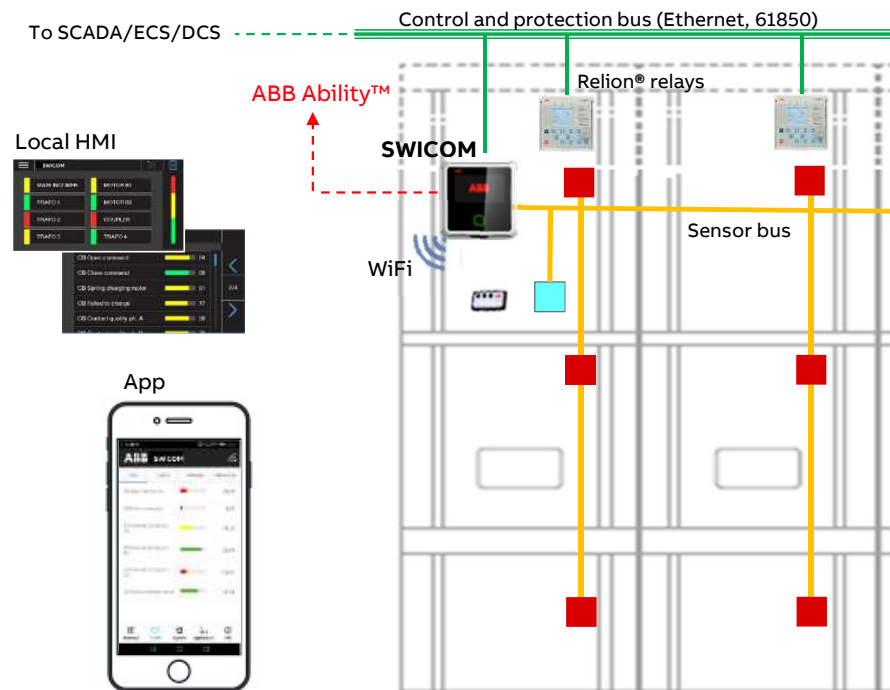
Switchgear COndition Monitoring reads data from:

- **Relion® protection relays** offer breaker monitoring function, such as operations timing, trips information and accumulated energy (I^2t)
- **Environmental sensor** measures temperature and humidity of switchgear room, so important to track long term external source of failures
- **Partial Discharge sensor**⁽¹⁾ offers a non-invasive detection of a potential insulation problem in the switchgear, which can lead to catastrophic failures.
- Primary parts **temperature sensors** helps in finding potential problems early in advance, especially about loose joints

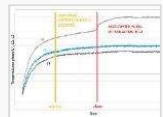
Local color touch HMI, wifi, smartphone App

It includes an IEC61850 channel to the control and protection devices, to collect operations data, and connect to SCADA/ECS.

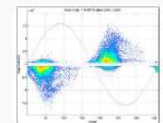
Easy to install on new and existing switchgears (also on non-ABB equipment). Up to 24 panels.



Temperature sensors



Environmental sensor and Partial discharge sensor



CMES: LV MCC/PC condition monitoring

Complex production processes, like sugar, ingredients, brewery, requires specific features in their power centers (PCCs) and motor control centers (MCCs).

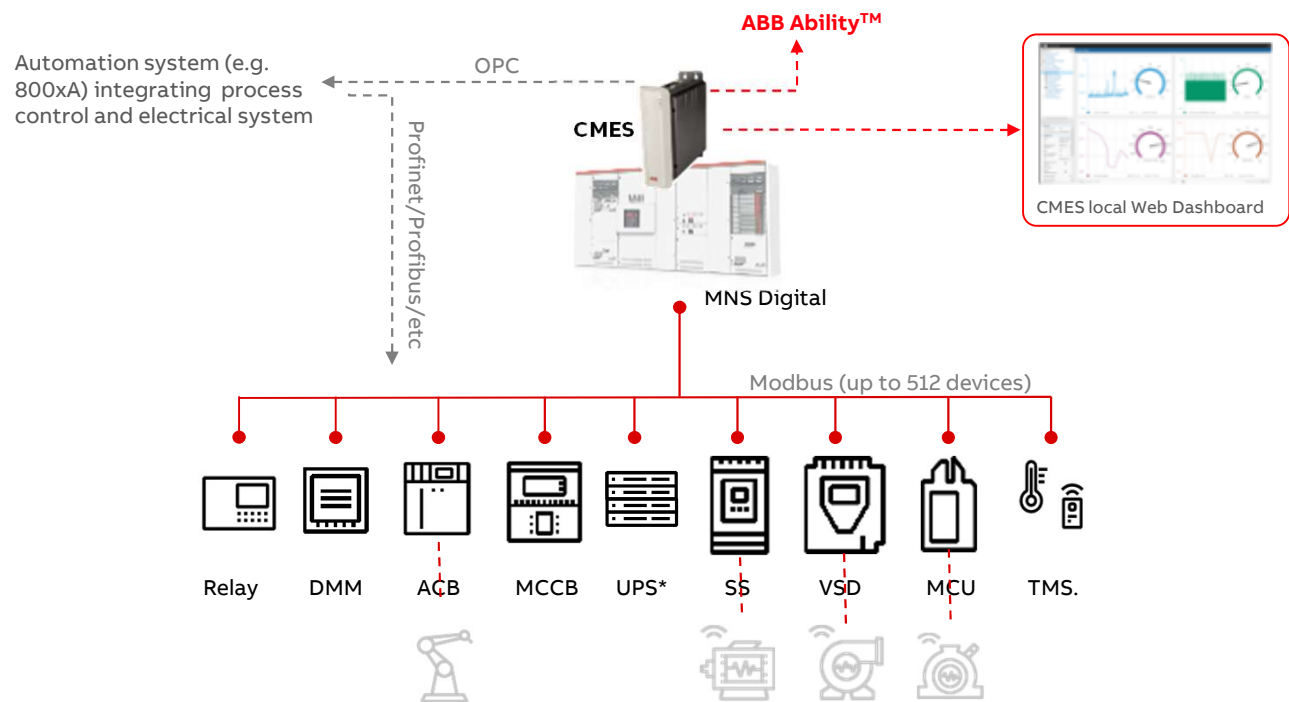
Such switchgears are made of **hundreds of digital components** (breakers, soft starters, motor controllers, etc), that need to be considered in a condition monitoring system.

Condition analysis and **troubleshooting** support shall consider the switchgear and the connected loads (e.g. motors)

It requires an **integration** with the automation system (e.g. a DCS) which is also controlling the electrical system.

CMES: Condition Monitoring for Electrical Systems

©ABB



DMM: Digital Multi-meters
ACB: Air circuit breakers (Emax2, Emax/Ekip UP)
MCCB: Molded case circuit breakers (with Ekip)

UPS: uninterruptible power supply *Scheduled
SS: Soft Starter
VSD: Variable speed drivers

MCU: Motor control unit (UMC100.3, M10x, MControl)
TMS: Temperature Monitoring System

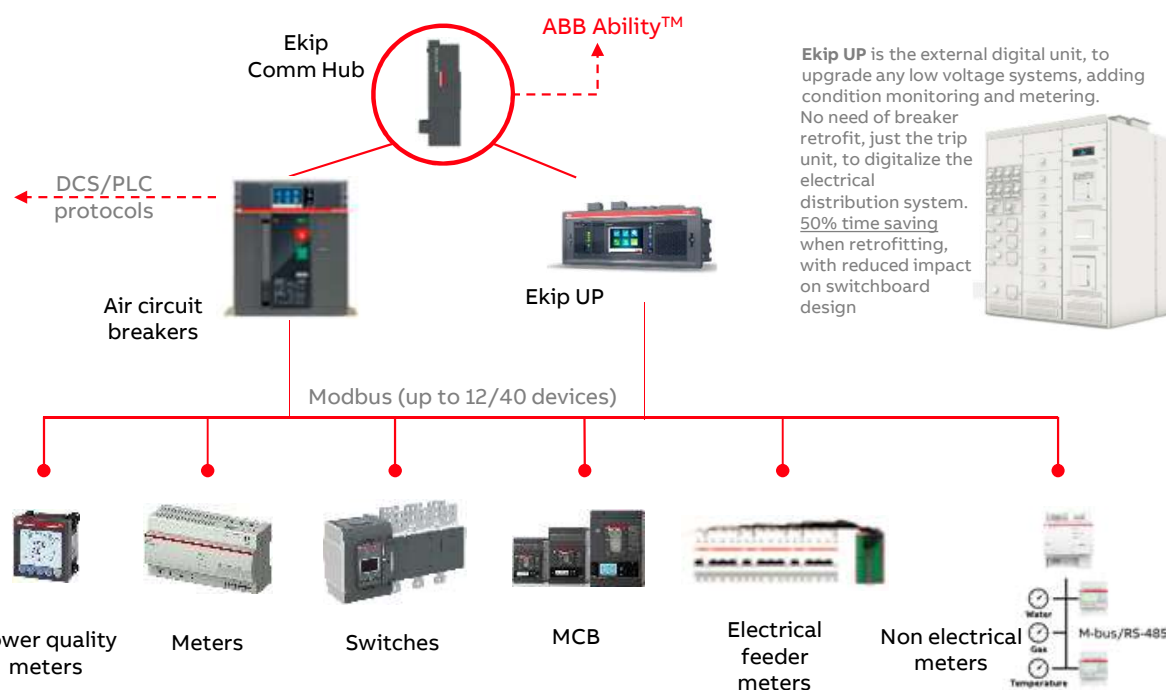
Ekip: LV condition monitoring

Industries, buildings and facilities have huge amounts of low voltage switchboards, to control and protect any kind of load: from lighting to condition/cooling, from motors to industrial machines.

New digital devices allows:

- Advanced **protection** (current, voltage, power and frequency protections) and control (load shedding, ATS, synchro reclosing)
- Condition **monitoring** (contact wear, operations, trips, trips/events log)
- Communication **protocols** (Modbus, Profibus, Profinet, Ethernet IP, IEC 61850)
- **Metering** (voltage, current, frequency, power factor, peak factor, etc)
- Datalogger and **network analyzer**

Note: in the last ten years, more than 350M circuit breakers have been installed worldwide without advanced features for monitoring [ABB]



Predictive maintenance journey

Here is a typical journey of a user using ABB Ability™ asset management solution:

- 1) Remote supervision of the facilities (multi-site): owner or service provider can take action everywhere, anytime
- 2) ABB Ability™ enables a digital twin of the electrical system. Ease of use: interactive images through tags & markers.
- 3) Asset health overview with alerts management to react quickly, reduce downtime and plan maintenance when suggested
- 4) Asset details with operational and maintenance information to implement predictive based maintenance

1 Map view



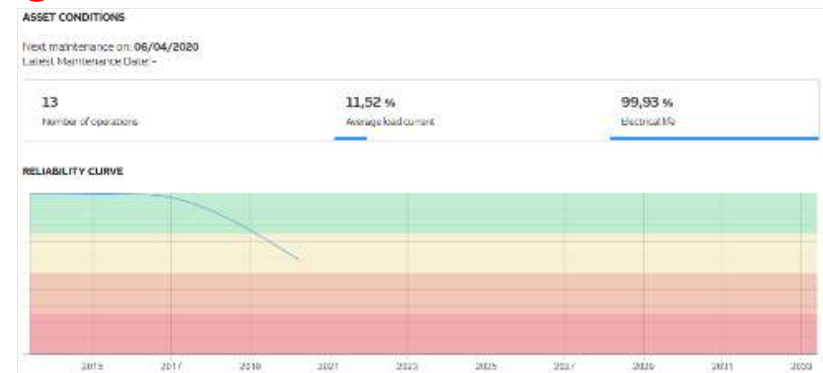
2 Electrical system digital twin



3 Asset health overview and suggested next maintenance date

PLANT HEALTH CONDITIONS				
<div><div></div><div>5 Good</div><div>3 Medium</div><div>0 Moderate</div><div>1 Critical</div></div>				
Product name		Serial Number	Health conditions	Next maintenance (dd/mm/yyyy)
EL25-1250 QG32 - TB		BD61100553	Critical	06/04/2020
EL25-1250 QG3-Trafo 3		BD61100952	Medium	06/04/2020
EL25-1250 QG2-Trafo 2		BD61100953	Medium	06/04/2020

4 Asset details, operational data and estimated asset reliability



ROI: case of a manufacturing plant

Predictive maintenance on existing MV switchgear (20 panels/breakers)

Historical information about failure avoidance savings:

- Avg CoF, caused by MV switchgear¹ (partial production loss + restoration) = \$50K / h
- Avg downtime in last 10 years due MV switchgear = 0,2h/y (avg costs = \$10k/y)
- Savings using predictive analytics (70% monitorable failure causes) = \$7K/y

Historical information about maintenance savings:

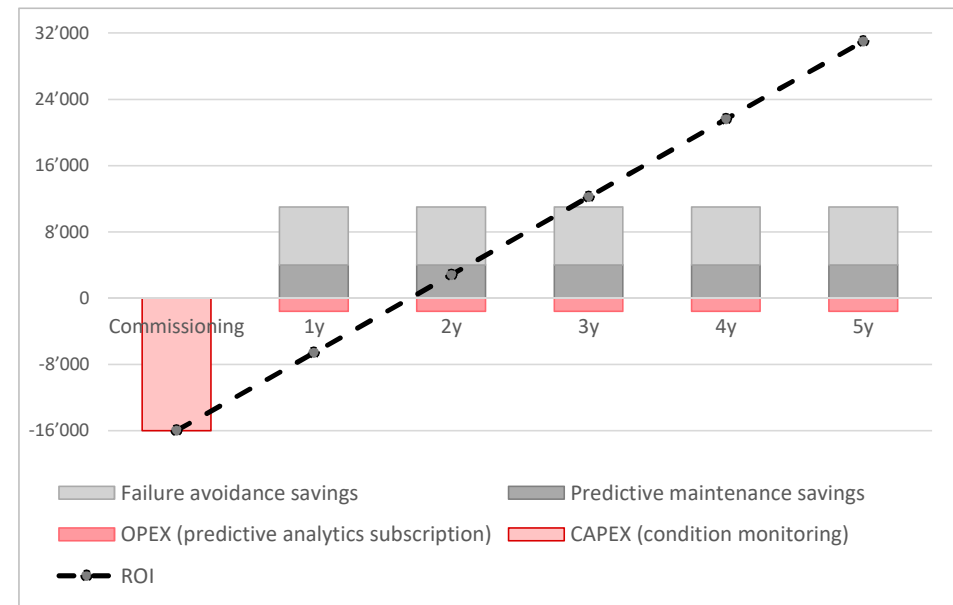
- Average time-based maintenance costs = \$8k/y
- Average predictive maintenance costs = \$4k/y

Information about smart equipment, sensors and analytics costs:

- Digital equipment (condition monitoring, sensors²) + commissioning = \$16k
- Yearly subscription for predictive analytics = \$1,6k/y

¹ One failure 5 years ago interrupted unexpectedly partly the production for 2h

² Includes: circuit breaker mechanical and electrical monitoring, environmental condition monitoring and switchgear main joints thermal monitoring



ROI = 1,6y

Asset management Food and Beverage



Plant

Chocolate producer, Europe



Customer needs

Being sure about the reliability of the main MV primary switchgear supplying the plant and connecting the cogeneration plant. Moving to condition-based maintenance approach



Digital offering

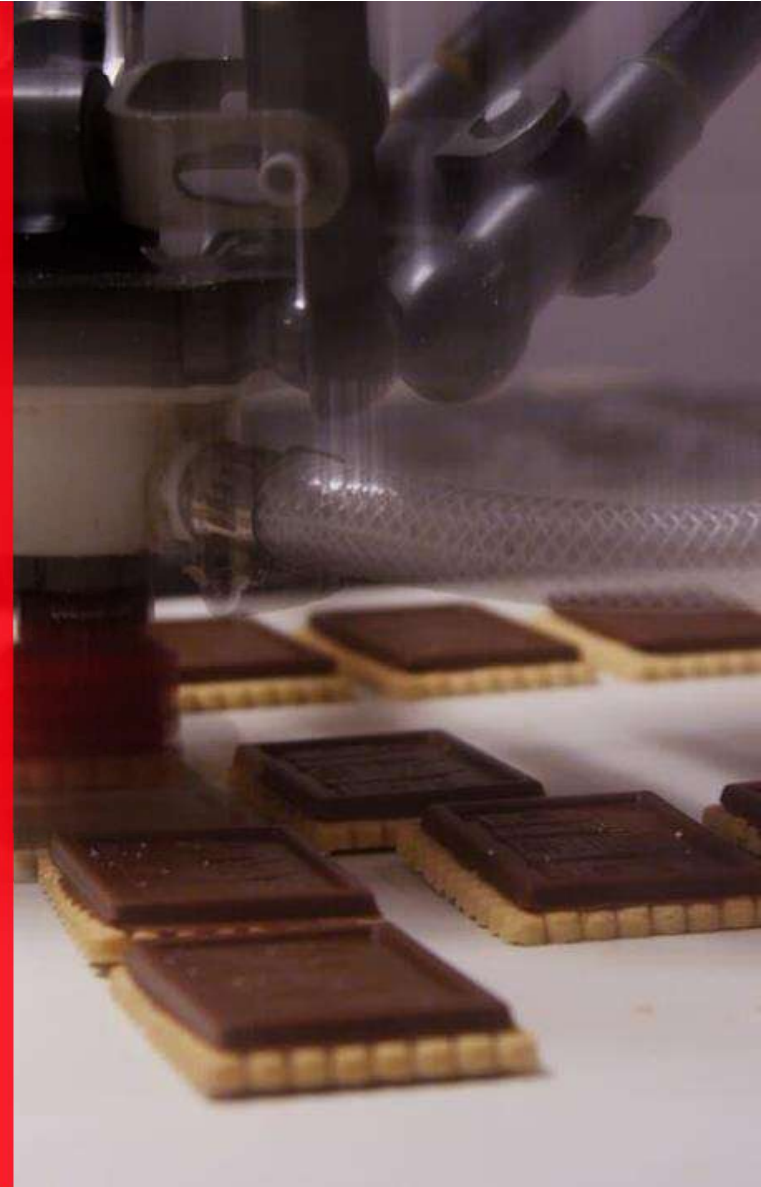
MyRemoteCare asset health for electrical system, with MySiteCare mechanical, electrical and thermal condition monitoring device for 6 main MV incomer and feeders (ABB HD4 breakers)

“

With MySiteCare we discovered in advance the aging of insulations in one bay due to thermal stress.

It saves inspection time of about 30%, with an estimated opex savings of 40%.

”



Asset management Pharmaceutical



Plant

Pharmaceutical producer, Europe



Customer needs

Retrofit existing LV motor control center with latest technology to ensure health condition monitoring for field team, and local data integration for operation



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Digital offering

New ABB MNS Digital motor control center, including the Condition Monitoring for electrical system (CMES)

“

ABB Ability™ CMES offers a seamless integration with local systems and helps the operation and manufacturing team to reduce opex (up to 30%) with quicker troubleshooting.

”



Flexibility and sustainability

Digital asset

Highly configurable and easily upgradable during lifetime.

Advanced sensor technology to lower switchgear power consumption and minimize spare parts.

All-in-one protection

Modular hardware and software solution to protect the electrical network and adapt easily.

Easy integration of renewables with automatic-synchronization function.

Smart substation protection and control

Centralized substation protection and control, ready to follow the evolving grid, with extensive application coverage.

Fully modular and upgradable software.



Digital asset: switchgears

Why?

Flexibility has become a core competitive advantage for the food and beverage industry. Flexibility to produce more, flexibility to modify and extend production, flexibility to scale a solution to different sites.

How?

Digitalization of equipment, as switchgears, is a key step towards flexibility and easiness to engineer/install/operate, higher safety and reliability, while reducing operational costs.

Safe, Smart and Sustainable!

A digitalized equipment is **ready for ABB Ability™ solutions for energy and asset management.**

Safe.

Safer operation: higher reliability⁽¹⁾
Safer service: remote awareness⁽²⁾ and safer tests⁽³⁾

(1) Digital enables design with fewer components, which results in fewer internal failure points. Latest sensors avoid saturation and ferro-resonance (might cause overvoltage failure).

(2) Digital devices enable remote management, so no need to be in front of the switchgear.

(3) Latest sensors avoid high-voltage exposure during tests and inspections. No problems of open circuits on current transformers and short-circuit on voltage transformers, during maintenance.

Smart.

90% less wiring⁽¹⁾
25% reduction in installation and commissioning time⁽²⁾
30% faster delivery⁽³⁾
Higher plant performances⁽⁴⁾

(1) IEC 61850 offers active supervision, high reliability with redundant connection, and with GOOSE more complex logics, substituting inter-panel wires.

(2) Less inter-panel wiring on 30 panels saves 2 working days.

(3) Minimized components (one-size-fit-all sensors), easy to adapt to changing requests.

(4) Digital control and protection, including all-in-one and centralized solutions, extends plant performances, and improve asset lifecycle management

Sustainable.

10% reduced footprint⁽¹⁾
15% optimized weight⁽²⁾
Save energy and CO₂⁽³⁾
Integrate renewables and e-mobility⁽⁴⁾

(1) Avoid a busbar meter cubicle, because voltage sensors are placed in existing panel

(2) Smaller switchgear and sensors weigh 10-15 times less than conventional instrument transformer.

(3) An MV digital switchgear 14 panels, in 30 years, with with latest sensors: save 250MW and 150 tons CO₂.

(4) Digital control and protection enables easy generator synchronization, complex logix and integration of power management functions.

Digital switchgear success case



Plant

Buitoni (Nestlé Group), pizza production, Benevento, Italy



Customer needs

- Extend the electrification system in order to expand the product lines
- MV/LV selectivity study
- Reliable electrification system and communication to electrical control system



Digital offering

UniSec Digital, Relion® 615 Series, featuring IEC61850, GOOSE for logic selectivity.

“

We have now a state-of-the-art electrical system, fully digitalized, ensuring the continuity and performances of our production. As well as secure remote management, for quick troubleshooting.

”

- ✓ Fast installation and commissioning using IEC 61850 standard
- ✓ Arc proof switchgear



Digital transformation?

ABB Ability™.

People and equipment protection

Being committed to world-class products, systems and services with health and safety as our key priority

Efficiency and production continuity

Enable energy efficiency and energy flow control. Pluggable power management solutions to maximize production continuity

Asset performance and optimization

Monitor the reliability and efficiency of your assets to optimize the operation and maintenance processes

Flexibility and sustainability

Enjoy flexible, scalable and modular digital solutions, which allow also an efficient integration of renewables and e-mobility

ABB