Uncover the hidden potential of your plant
Digitalization of electrical assets and associated benefits
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

Goods movement
Packaging
Site & process management
Green generation
HVAC
Water treatment
Batch processing
Heating / Cooling
Utility connection
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*

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

*C.S. Lewis*

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

*Stephen Hawking*

**Start simple and scale**
- Faster to learn and use
- More efficient
- Fewer mistakes
- Effective
- Modularity

**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

**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

~300 annual deaths in the US alone are caused by energized electrical equipment

80% of all electrical accidents are caused by arc flash incidents

$1M to 15M potential cost of one arc flash incident

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.
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

Plants
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.

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.

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 (Uninterruptable 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.

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.

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

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

2. **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. **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.
ABB Grid Integration solutions help to balance the demand created by new electricity consumers entering ports with traditional and renewable power generation by enabling a stronger, smarter and greener port grid.

Patrick Fragman
Managing Director,
ABB, Power Grid, Grid Integration

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 require sterilization and costs more than 28 hours.

Digital offering
PCS100 AVC-40

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

LV network
LV loads management and microgrid LV islanding.

MV/LV network
Medium plant with few substations, power management requirements, and integration with MV/LV protection systems.

Complex network
Large plant with several substations, full power management requirements, and integration with process automation.

Emax2 can feature embedded load shedding logics for LV loads and supports islanding microgrids.

PML630 is MV/LV compact power management controller manages, up to 60 feeders, 20 load priorities and 6 busbars, up to 6 generators and 4 subnetworks (islands).

ABB offers MV/LV complete power management solution, for unlimited feeders, up to 100 load priorities and 80 busbars, up to 31 generators and 15 subnetworks (islands).
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.

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: Busbar with two feeders
Example: Busbars with two feeders and bus-coupler breaker
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, São 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.

**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.

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Maintenance</th>
<th>Frequency</th>
<th>Time/ asset</th>
<th>Predictive</th>
</tr>
</thead>
<tbody>
<tr>
<td>MV circuit breaker</td>
<td>Visual/Basic</td>
<td>2 years</td>
<td>2 h</td>
<td>0 h</td>
</tr>
<tr>
<td></td>
<td>Advanced</td>
<td>5 years</td>
<td>2 h</td>
<td>1.4 h</td>
</tr>
<tr>
<td>MV switchgear</td>
<td>Visual</td>
<td>0.5 years</td>
<td>0.5 h</td>
<td>0 h</td>
</tr>
<tr>
<td></td>
<td>Basic</td>
<td>5 years</td>
<td>0.75 h</td>
<td>0 h</td>
</tr>
<tr>
<td></td>
<td>Advanced</td>
<td>10 years</td>
<td>2.5 h</td>
<td>1.75 h</td>
</tr>
<tr>
<td>Low Voltage Motor</td>
<td>Basic</td>
<td>1 year</td>
<td>1 h</td>
<td>0.25 h</td>
</tr>
<tr>
<td></td>
<td>Advanced</td>
<td>1 year</td>
<td>4 h</td>
<td>0 h</td>
</tr>
</tbody>
</table>

USD 336 /y USD 168 /y

Example based on ABB experience
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.

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

SWitchgear COndition Monitoring reads data from:

- **Relion® protection relays** offer breaker monitoring function, such as operations timing, trip 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** 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.
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.
**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
Predictive maintenance on existing MV switchgear (20 panels/breakers)

Historical information about failure avoidance savings:
- Avg CoF, caused by MV switchgear\(^1\) (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, sensors\(^2\)) + 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: case of a manufacturing plant

\[ \text{ROI} = 1.6 \text{y} \]
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.”
ABB Grid Integration solutions help to balance the demand created by new electricity consumers entering ports with traditional and renewable power generation by enabling a stronger, smarter and greener port grid.

Patrick Fragman
Managing Director,
ABB, Power Grid, Grid Integration

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

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
- Safer service: remote awareness and safer tests

Smart.
- 90% less wiring
- 25% reduction in installation and commissioning time
- 30% faster delivery
- Higher plant performances

Sustainable.
- 10% reduced footprint
- 15% optimized weight
- Save energy and CO₂
- Integrate renewables and e-mobility

(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.
(4) IEC 61850 offers active supervision, high reliability with redundant connection, and with GOOSE more complex logics, substituting inter-panel wires.
(5) Less inter-panel wiring on 30 panels saves 2 working days.
(6) Minimized components (one-size-fit-all sensors), easy to adapt to changing requests.
(7) Digital control and protection, including all-in-one and centralized solutions, extends plant performances, and improve asset lifecycle management.
(8) Avoid a busbar meter cubicle, because voltage sensors are placed in existing panel
(9) Smaller switchgear and sensors weigh 10-15 times less than conventional instrument transformer.
(10) An MV digital switchgear 14 panels, in 30 years, with with latest sensors: save 250MW and 150 tons CO₂.
(11) 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