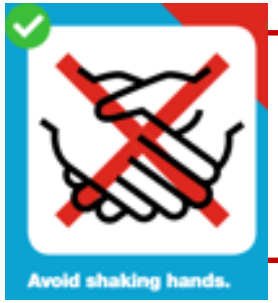
ELECTRIFICATION | DIGITAL

Energy Management and Asset Supervision

through ABB Digital Solutions

Mazin Abdalla

Safety and COVID-19



Avoid close contact with people, such as shaking hands.

Ensure there is a sufficient distance between individuals (two meters), especially in confined spaces.

Stay at home / alert

Agenda

Energy Management and Asset Supervision

through ABB Digital Solutions

20’ | ABB energy management

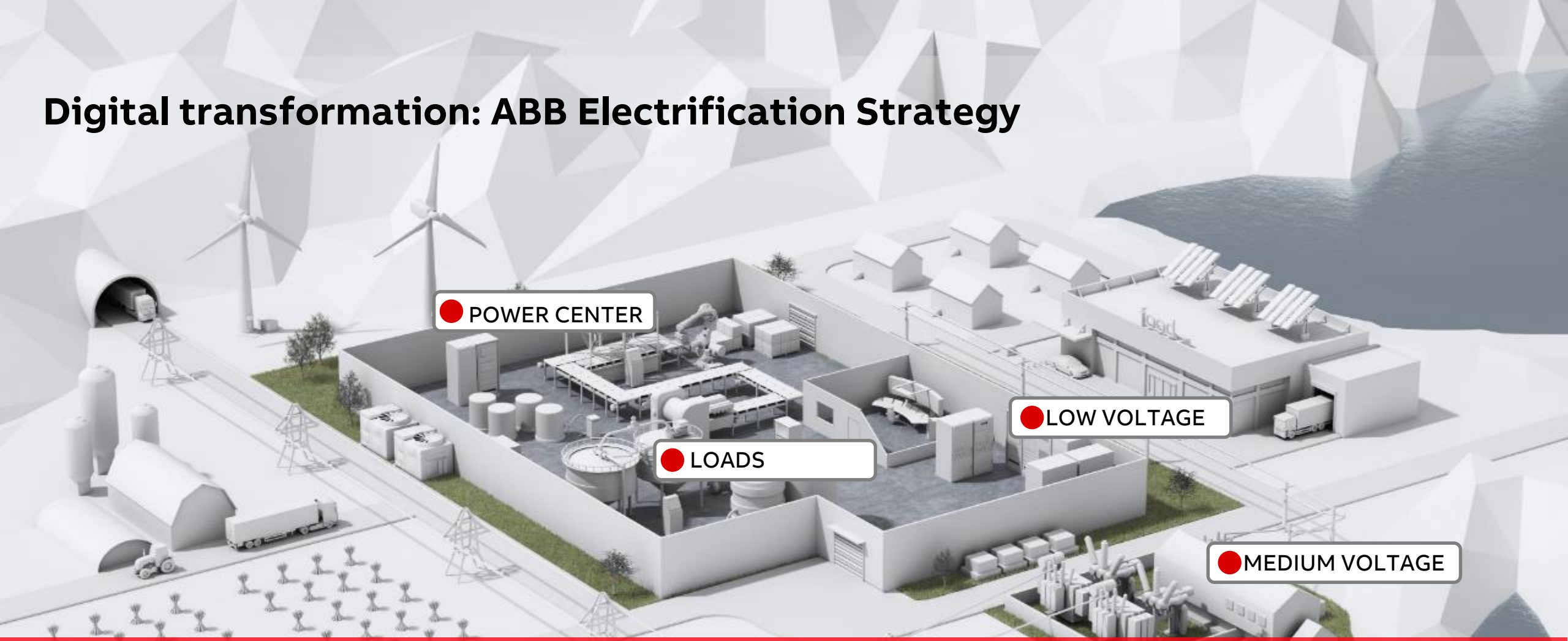
15’ | ABB asset supervision

5’ | ABB Ability™ electrification solutions

10’ | Live ABB Ability™ dashboard walkthrough experience

10’ Q&A

Digital transformation: ABB Electrification Strategy



Safe

Protection and Control everywhere, from anywhere on every device

Smart

No need for engineering, moving your business to **Software as a Services** model

Sustainable

A plug and play solution for ABB Equipment

Energy Management

Global growth drivers require more reliability

Urbanization

+2 billion

people living in cities
(+1 billion world population)

Shift to electricity

+50 %

Ensuring better energy mix to ensure sustainable availability
Energy efficiency means more comfortable lives and lower energy bills

Data and digitalization

7.5 x

Demand to translate such valuable data into actionable insights towards higher efficiency, reliability and safety

Source: International Energy Agency, 2018
Energy Efficiency Report 2019
Energy Security Report 2018

Energy Management

Measuring, Monitoring, Management of energy

Energy Management aim at monitoring, controlling, and optimizing the performance of a facility in order to reduce the energy consumption and increase the overall efficiency and productivity.

Energy Trilemma

Multi-tiered energy management solutions required to help customers manage the “energy trilemma”

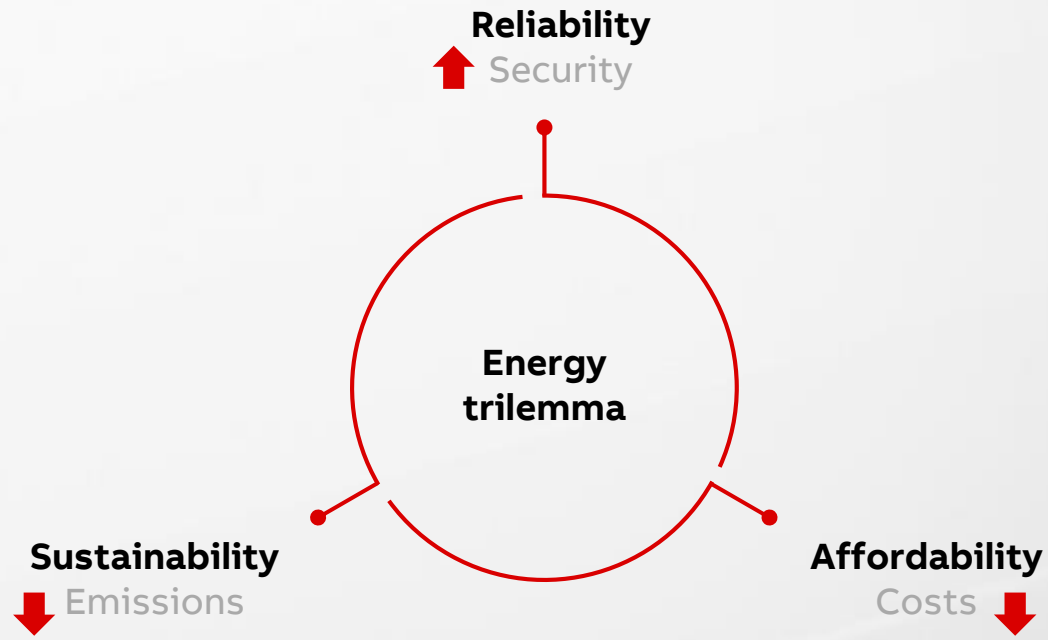
Providing visibility, advanced analytics and optimizing power supply and demand

Market optimization
Forecasting, aggregating & trading flexibilities

Site optimization
Real time optimization & coordinated control of multiple resources at site level

System monitoring
Local / remote system monitoring, analytics & reporting

Smart devices
Device level monitoring & control



Energy Cost reduced up to 20%

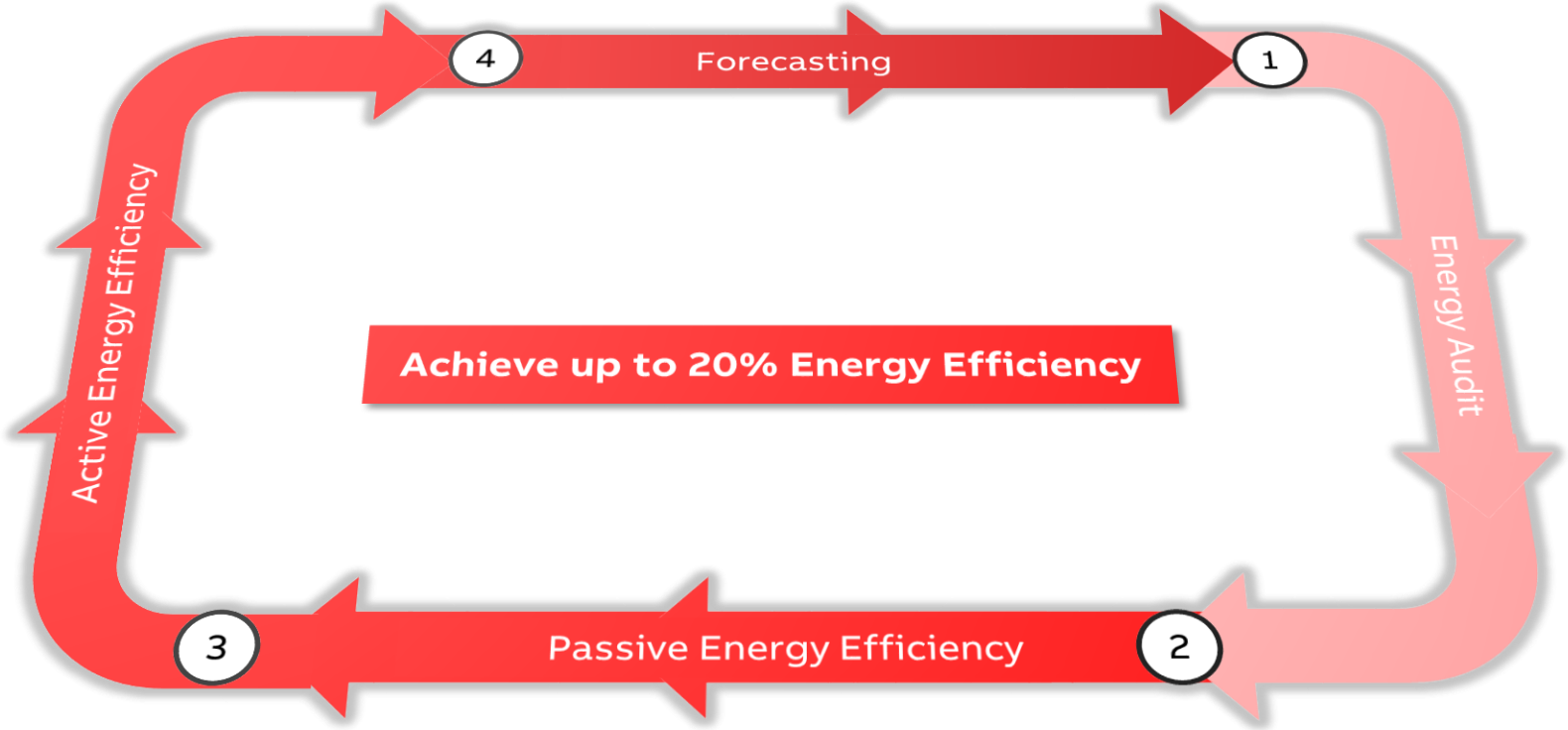
Towards Energy Efficiency

Measure and audit consumption — 1

Install low consumption devices, power factor correction — 2

Optimize through controlling — 3

Forecast and predict your facility behaviors — 4



Energy Inefficiency Factors

“Energy management can be seen as important instruments to recognise and observe existing economic energy efficiency potentials by systematic procedures to gain knowledge and developing a strategy to achieve energy efficiency targets.“

“The Energy Efficiency Directive 2012/27/EU (EED) establish promotion of energy efficiency in order to ensure the achievement 20% target on energy efficiency and to pave the way for further energy efficiency improvements”

Relevant British standards
BS 7671:2018 – Draft New Part 8, Section 801 Energy Efficiency response to IEC 60364-8-801
ISO 50001, BREAM

[1] Source: Energy Efficiency Trends and Policies In Industry, EU Commission

Example based on ABB experience

Equipment	Main reason	Impact on Energy Bill (incl. penalties)	Impact on Opex
HVAC	Pilot or ignition problems	High	High
	Blown fuses or tripped breakers	Low	High
Drives	Harmonics	High	High
	Pilot or ignition problems	High	High
Feature		**Impact on Energy Bill**	**Impact on Opex**
Power Factor	< 0.95	High	High
Power Quality	Harmonics, Sags	High	High
Peak Monitor	Peak above contractual power	High	Low

100%

AVOID PENALTIES FOR LOW POWER FACTOR

20%

ENERGY SAVINGS

30%

OPEX COST REDUCTION

Optimize energy bill

Reduce hidden costs and manage unpredictable peaks of energy

20%

Energy saving with predict power consumption

Data mining used to predict power consumption helps facility manager to reduce energy used up to 20%.

6%

Electricity bill saving with prediction of PV generation and consumption

Prediction of consumption and PV generation bring to reduction of 6% of electricity costs.

Power factor – Typically caused by large amount of motors. Identify the part of the plant that use majority of the motors and we measure it, and implement a corrective capacitor bank or take other corrective actions.

Harmonics – Produced by inverters, DC converters, Switch mode power supplies, AC or DC motor drives, variable speed drives. They are typically used to improve the efficiency but we also need to take care of power quality – Poor power quality can cause malfunction of machines and devices.

Compare similar production lines, even if they are in different sites

Review utilities contract based on your specific energy demand

Sources
https://www.eia.gov/consumption/commercial/reports/2012/energyusage/
https://www1.eere.energy.gov/buildings/publications/pdfs/corporate/bt_stateindustry.pdf
https://balkangreenenergynews.com/new-eu-energy-performance-of-buildings-directive-an-opportunity-for-highly-efficient-healthy-and-comfortable-buildings/
https://www.gminsights.com/industry-analysis/distributed-solar-pv-market

Avoid energy waste

Be sustainable, don’t waste your energy

38%

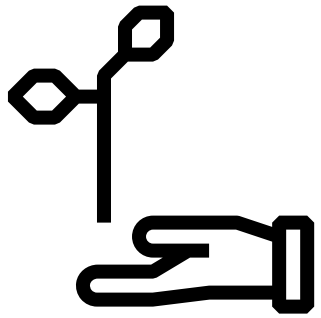
Energy consumption

Industry is responsible for around 38% of global final energy consumption

24%

Carbon emissions

24% of the world’s total CO2 emissions are due to industry sector



Plan for sustainability, reach your **Mission to Zero**

Our planet worth, be sustainable means being able to use and control the correct mix of energy sources, more reliable, more sustainable.

- Unexpected consumption can be identified based on alerts and thresholds, in realtime.
- Take under control you renewable sources, like PV. Compare generation with consumption.
- Motors are high energy consumption load in industrial application, define a baseline and take consumption under control for each single motors and identify immediately bad working situation generated by usage or other cause. Upgrade plant and save up to 10% of power consumption.*
- **Peak** shaving can bring to reduction of peak demand of 18% and increase of peak-off demand of 12%.

https://www.iea.org/digital/

* According to a study from the US Department of Energy. Main contributor is upgrade of fixed speed motors to frequency control.

Cost allocation

Bind consumption to each specific product line, production process or subprocess.

Energy consumption is a huge cost of production, How to understand who is consuming and charge back according to it

Put **submeters** by department or production line or process and allocate energy cost to encourage energy efficiency behaviors

Logical groups aggregate the consumption or the generation of more than one equipment, panel, loads. With logical group you can take under control a specific part of the process, crossing the border of the single production line or floor. You can group all the loads on a specific production line and calculate the total energy consumption.

Cost widget show the **real consumption** based on the Utilities tariffs, compare in real-time the billing information with the measured information.

ABB Ability™ Energy Management Solution

Plant
F&B Plant

Customer needs
Set **sustainability targets** that require significant advances in energy efficiency. More **precise monitoring** of the power consumed in every part of its operations is key.

1100101001

Digital offering
ABB Ability™ Energy Management Solution
- Peak Monitoring
- Cost Planning
- Energy Audit

“ABB’s digital solution comprehensively monitors our energy consumption. Combining Energy Management Solution with ABB’s circuit monitoring system means we can track all our consumption, right down to the building’s lighting.”

- ✓ Low-voltage distribution boards
- ✓ Emax 2 circuit breakers, Tmax T4 and T5 molded case circuit breakers
- ✓ CMS-700 circuit monitoring sensors
- ✓ **ROI 2 years**

ROI: case of a F&B small 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):

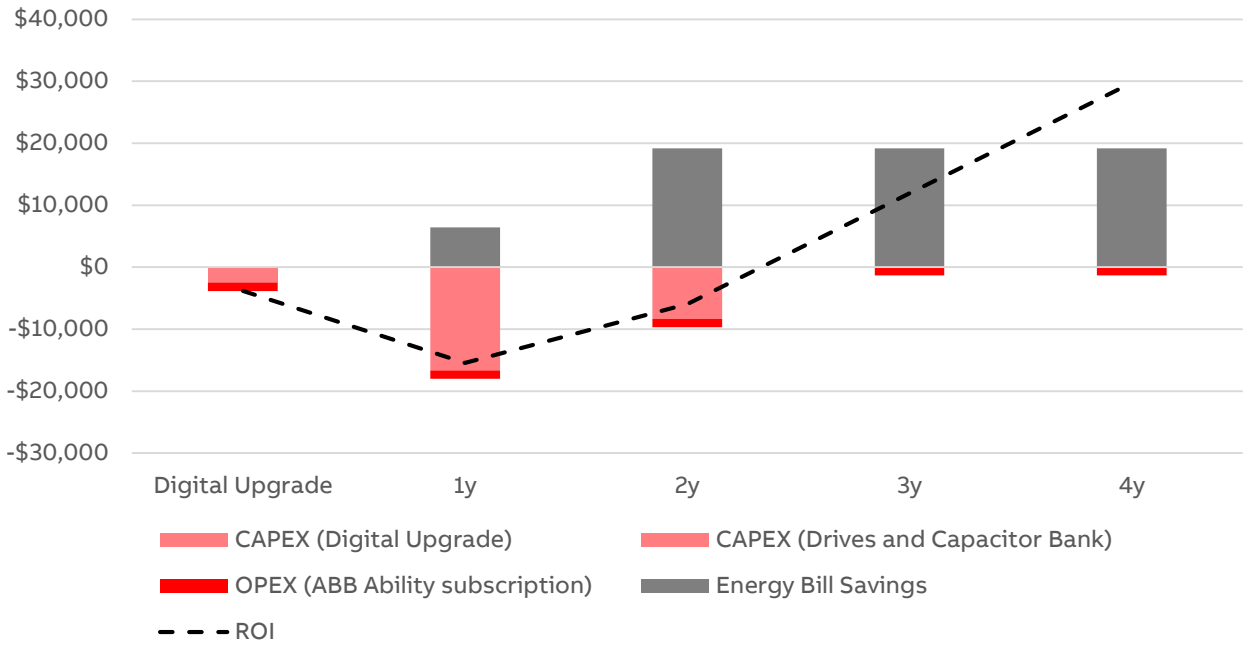
- 2 main breakers (Emax 2)
- 8 breakers (XT2, XT4)
- 1 control Unit with 96 sensors (CMS-700)
- 9 power meters (M4M)

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

Features utilized

Grouping, alerting and scheduled reporting



ROI = 2,2y

Peak Monitoring, Cost Control and Alerting

Energy Savings = $19 k / Year

Asset Supervision

Global growth drivers require more reliability

Data and digitalization

7.5x

Demand to translate such valuable data into actionable insights towards higher efficiency, reliability and safety

Experienced workforce

-50%

Utilities experienced workforce will retire by 2025

Health, Safety, Environment

+47 %

Direct and indirect costs of workplace injuries with increased compliance cost

How digitalization helps electrification reliability and power availability

Asset performance management (APM) systems act to improve the reliability and availability of physical assets while minimizing risk and operating costs.

Keep production up and running
Mega-trends are challenging industries to get higher availability, sustainability, and flexibility.

Installed base
Getting older, so with higher risks in terms of safety, flexibility, scalability and security.

Optimize maintenance
Decreasing maintenance budgets, higher system complexity and quicker troubleshooting

Risk of failure
Direct and indirect costs, getting higher nowadays due to reasons above.

Risk of failure (RoF)

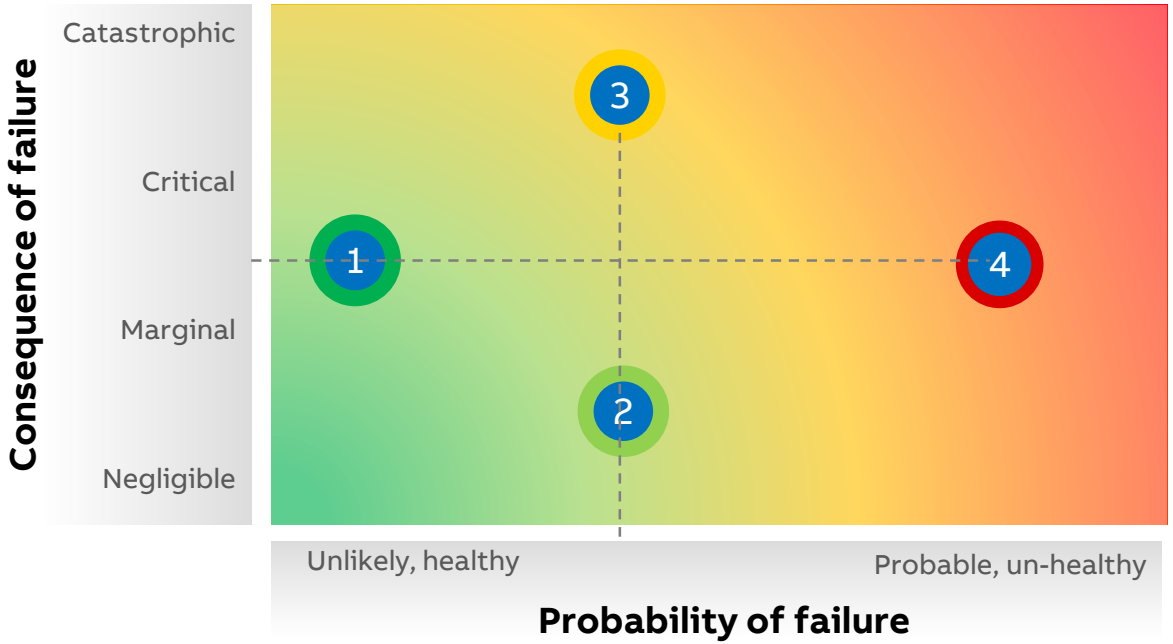
Asset managers, facility managers, maintenance managers apply (maintenance and asset life cycle) strategies to keep under control the risk of failure. It is made of two factors: consequence of failure (CoF) and probability of failure (PoF).

Example in the risk map:

Asset (1) and (4) have same level of criticality but different health condition.
(4) needs to be addressed first.

Asset (2) and (3) have same health condition, but different critical level.
(3) needs to be addressed first.

Example of assets risk map



Risk (RoF) = Probability (PoF) x Consequence (CoF)

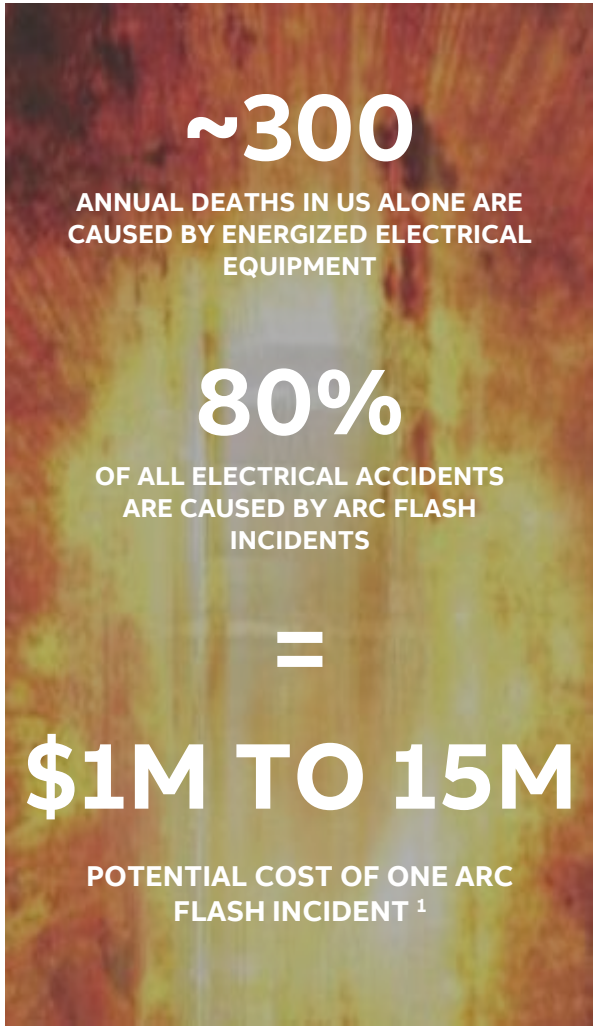
Consequence of failure

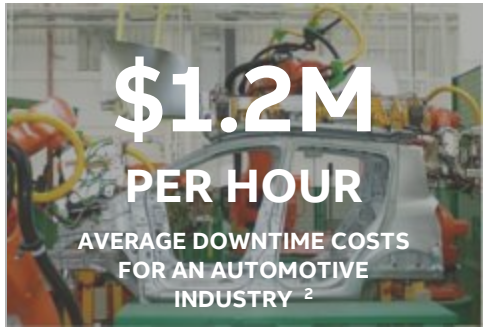
It is the severity of the consequences of failure.

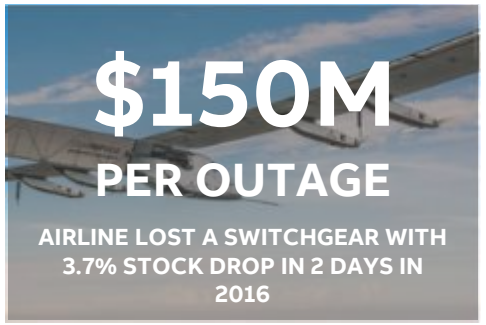
It can go from “negligible”, like a spare feeder, up to “catastrophic“, like a main incomer - which might include matters such as loss of life and injury to persons.

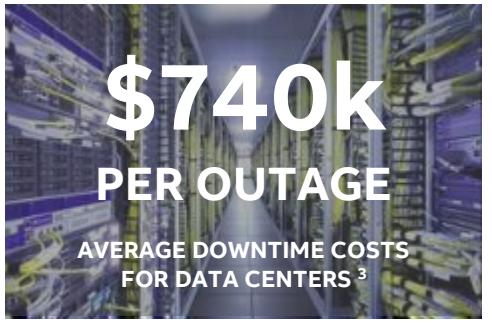
Type of Consequences:

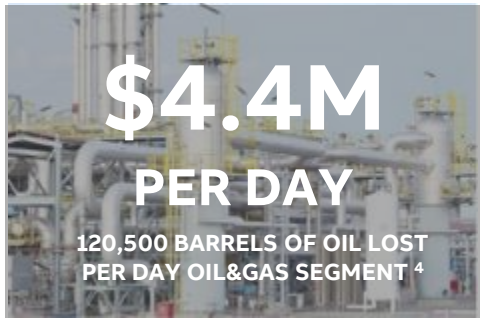
- Physical (e.g. assets disruption)
- Financial (e.g. increased costs, loss of production)
- Legal (e.g. fines, penalties)
- Social/psychological/community









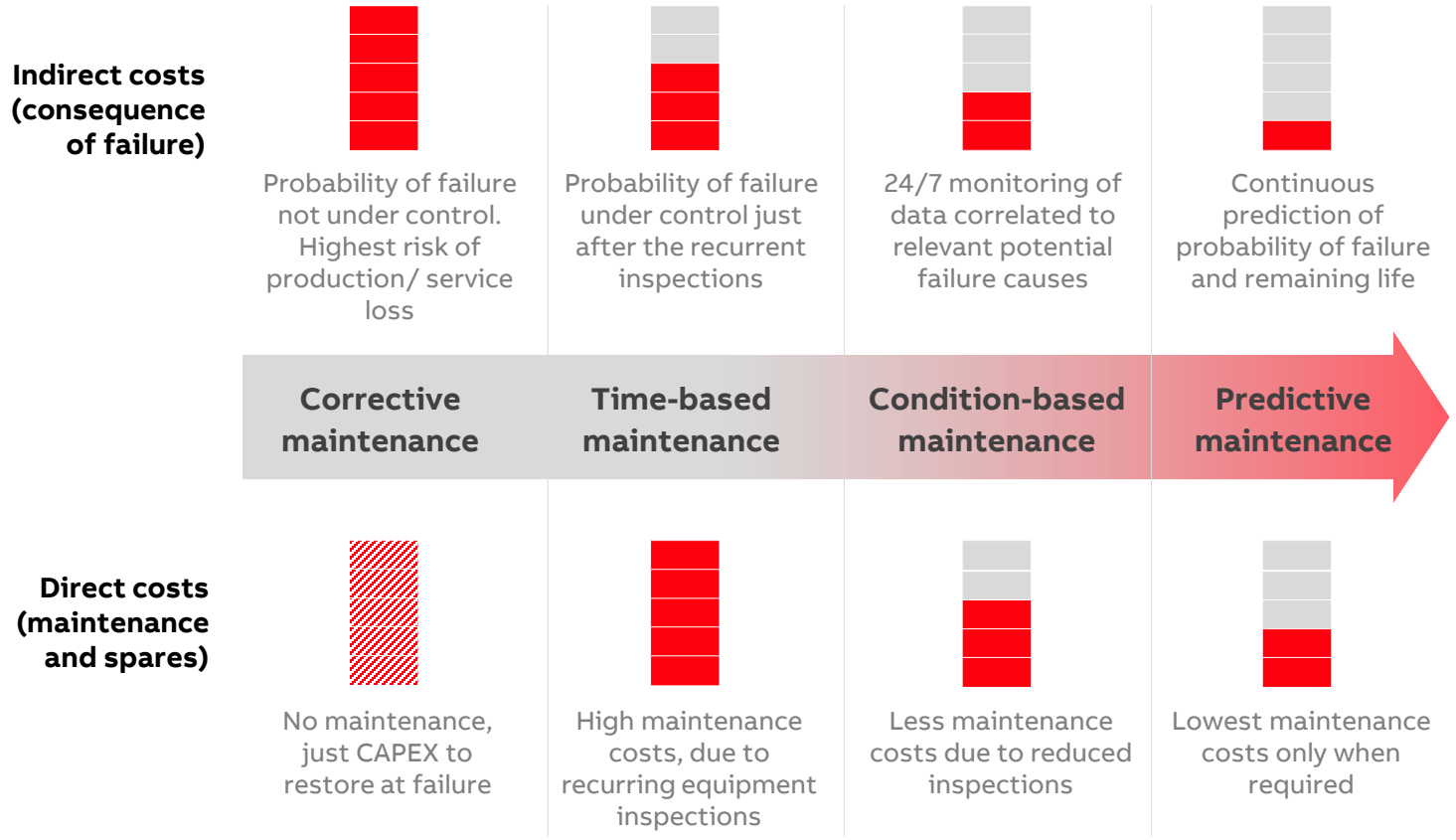


1) A 1999 Electric Power Research Institute (EPRI) study pegged total direct and indirect costs of an arc flash incident
2) News.thomasnet.com/company story/downtime-costs-auto-industry-22k-minute-survey-481017
3) Cost of Data Center Outages, Ponemon Institute
4) The Economic Impact of August 2003 Blackout done by ELCON

Maintenance strategy

To keep under control the probability of failure of an asset, different maintenance strategies are available:

- **Corrective maintenance**, or run-to-failure: do maintenance only when problems occur
- **Preventive maintenance** regularly scheduled, using either time intervals, or usage (operations/cycle count) as a trigger. It can be enhanced with root-cause analysis and troubleshooting instructions **(proactive).**
- **Condition-based maintenance**, is a preventive maintenance supported by condition monitoring of the asset, with basic diagnosis on read values.
- **Predictive maintenance**, combines various sensor readings (condition monitoring), sometimes external data sources and performs powerful analytics on thousands of logged events/data (e.g. simulation, statistical analysis, etc.). It can be enhanced further adding **prescriptions** to support the mitigation actions



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.

Example based on ABB experience

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/LV 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**

100%

PREDICTION AVOID HIGH COSTLY UNPLANNED LABOR

30%

DECREASE MAINTENANCE TIME

=

40%

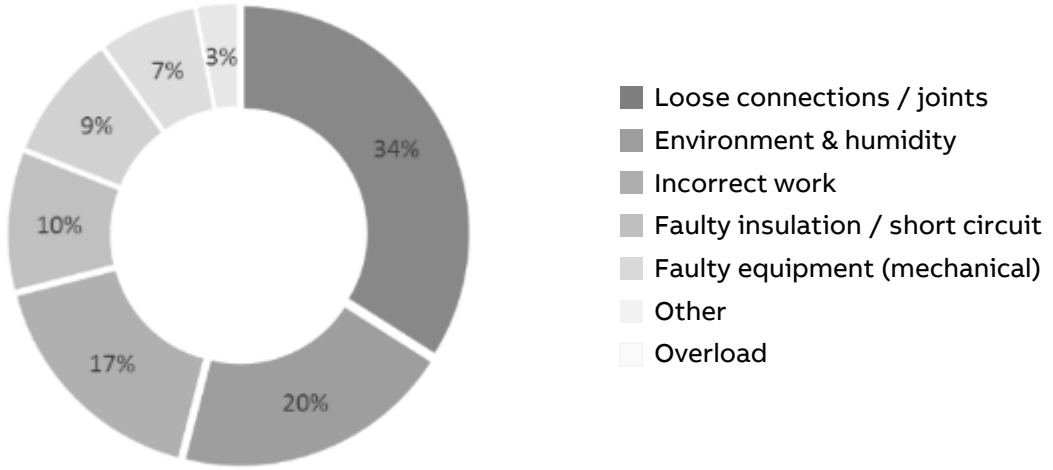
OPEX COST REDUCTION

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 potential failure causes monitoring, 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

Running predictive maintenance

Why?

Predictive maintenance provides benefits that improve the bottom line, with a focus on maintenance and retrofit cost optimization. It is not just cost effective maintenance with maintenance based on best predicted scenario, but also full visibility on assets risk analysis, used to prioritize remedial actions. Accurate prediction saves from costly breakdowns.

How?

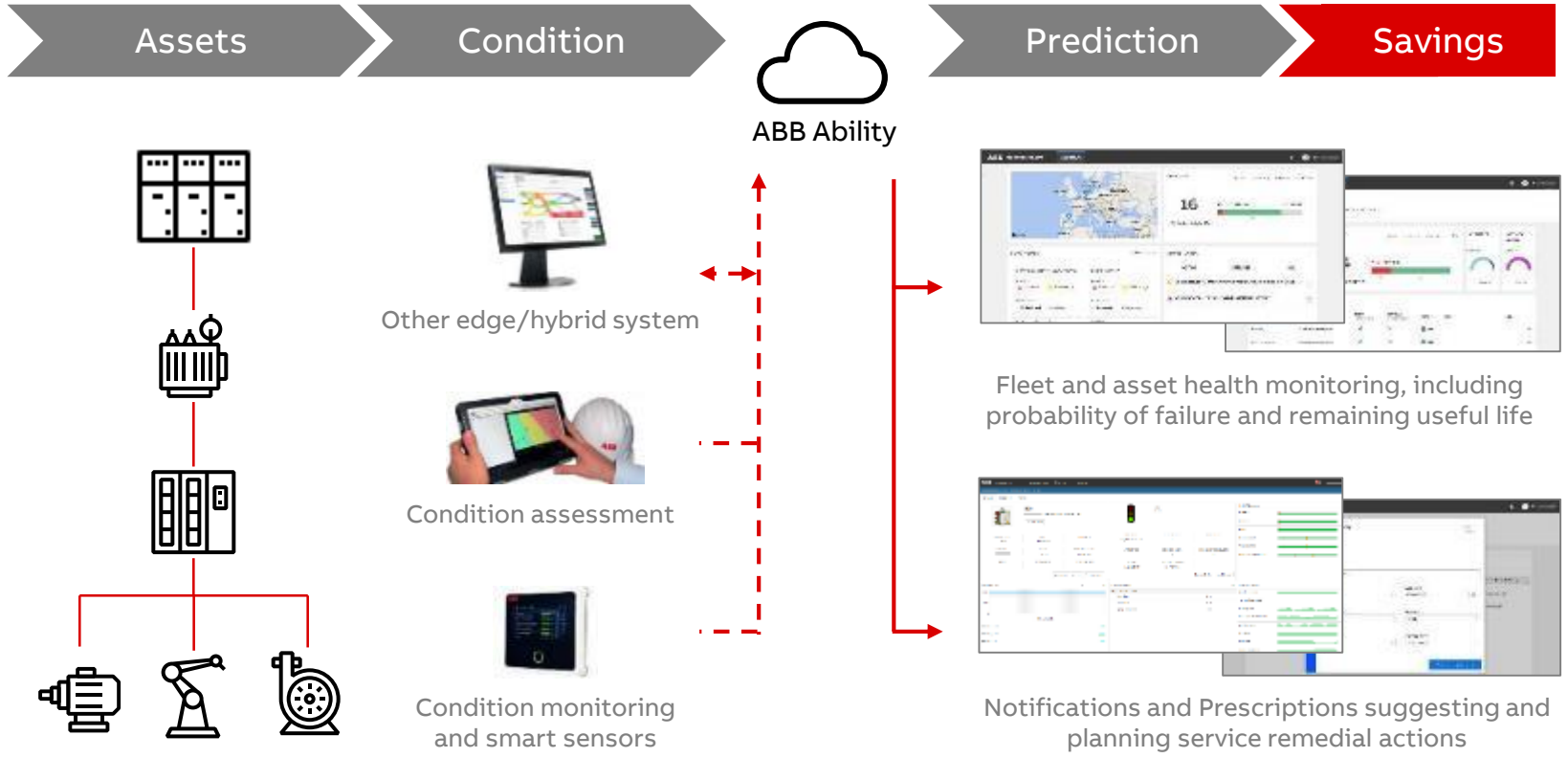
Predictive maintenance is based on predictive analytics, which exploits collected data with offline assessment and/or online condition monitoring.
Typical calculated outputs are probability of failure within a year, remaining useful life, service prescriptions, and risk map analysis.

Asset condition data collection

Relevant electrification assets in the plant can be monitored to track condition. Raw and calculated data can be predictive analytics.

ABB Ability™: gain insights on assets

ABB Ability solutions offers asset health dashboard, and predictive analysis to optimize maintenance and improve availability, reliability.



Predictive maintenance journey

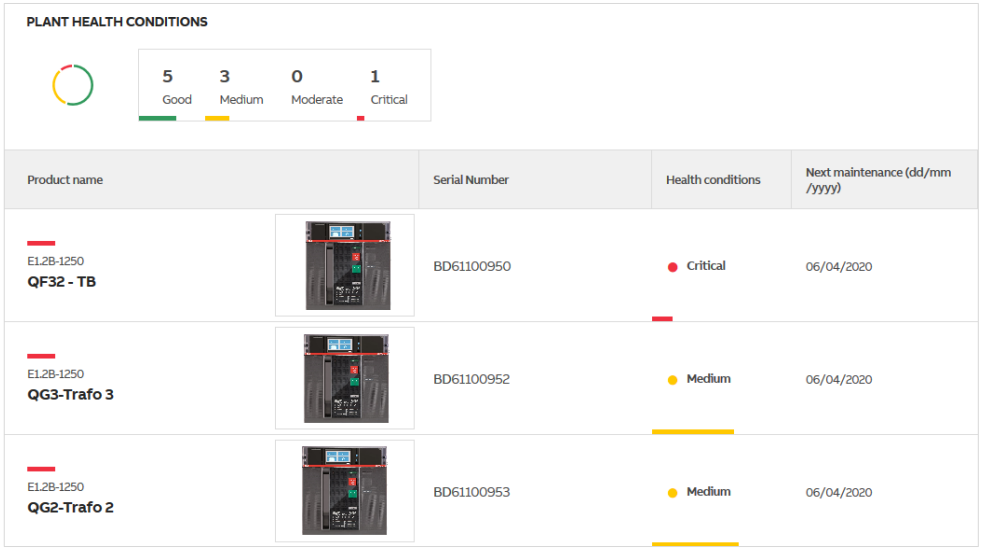
Here is a typical journey of a user using ABB Ability asset management solution:

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



4 Asset details, operational data and estimated asset reliability

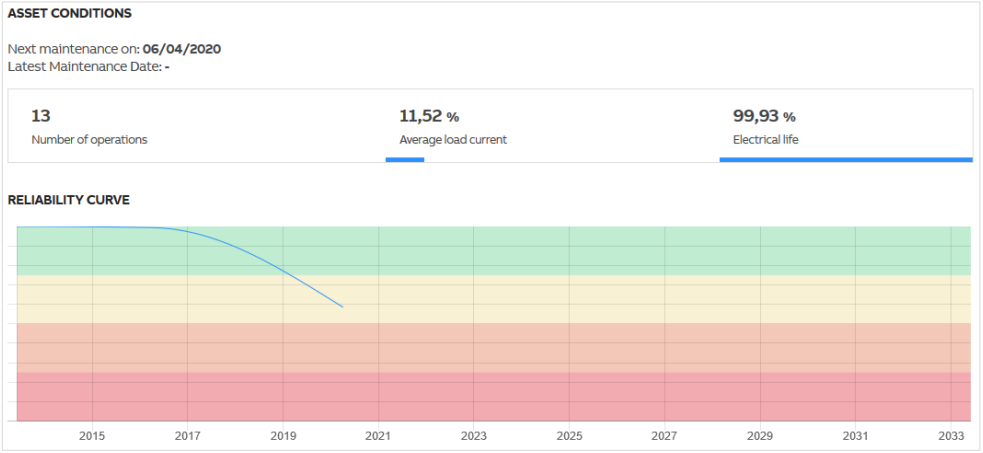


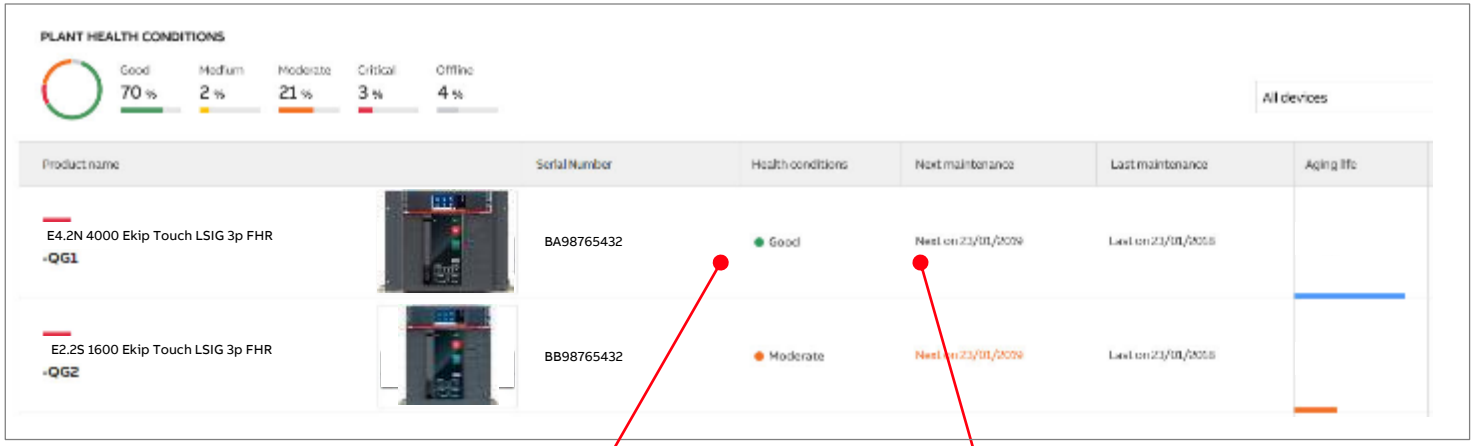
ABB Ability™ Asset Management

Why?

ABB Ability™ enables a digital twin of the electrical system, with health information and maintenance planning (prediction).

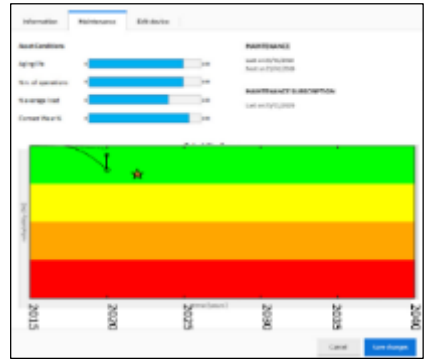
- **Remote supervision of the facility** (multi-site): owner or service provider can take action everywhere, anytime.
- **Ease of use**: interactive images through tags & markers.
- **Alerts management**: reduce downtime and service planning

Plant and asset health conditions



Digital twin of each component

Next maintenance plans



Predictive maintenance

Plant
Consorzio di Bonifica Veronese, wine yard

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

"With ABB solution we had a payback of les than 3 months, 30% savings on annual operating costs. The system sends alerts to prevent downtimes, optimized personnel travels and service activities."

- ✓ With Ability EDCS **avoid power quality penalties** with the integrated analysis.
- ✓ With Ability EDCS **Avoid external energy audit**, with embedded reporting.

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 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

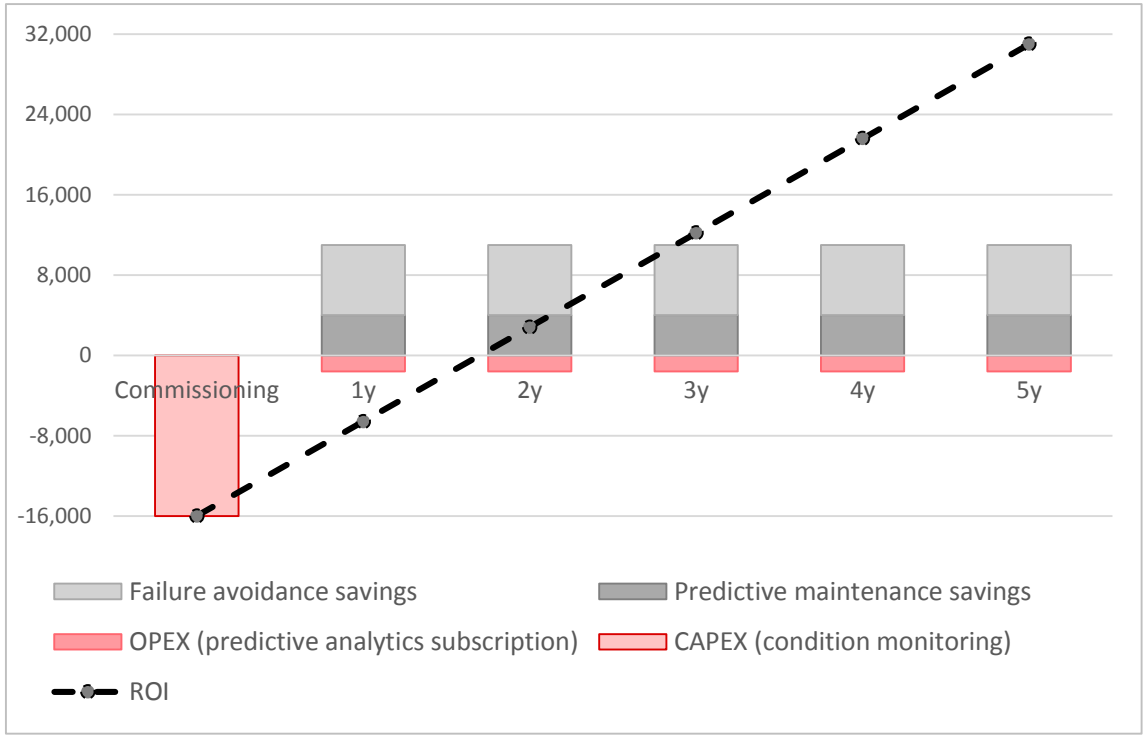
Historical information about maintenance savings:

- 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.

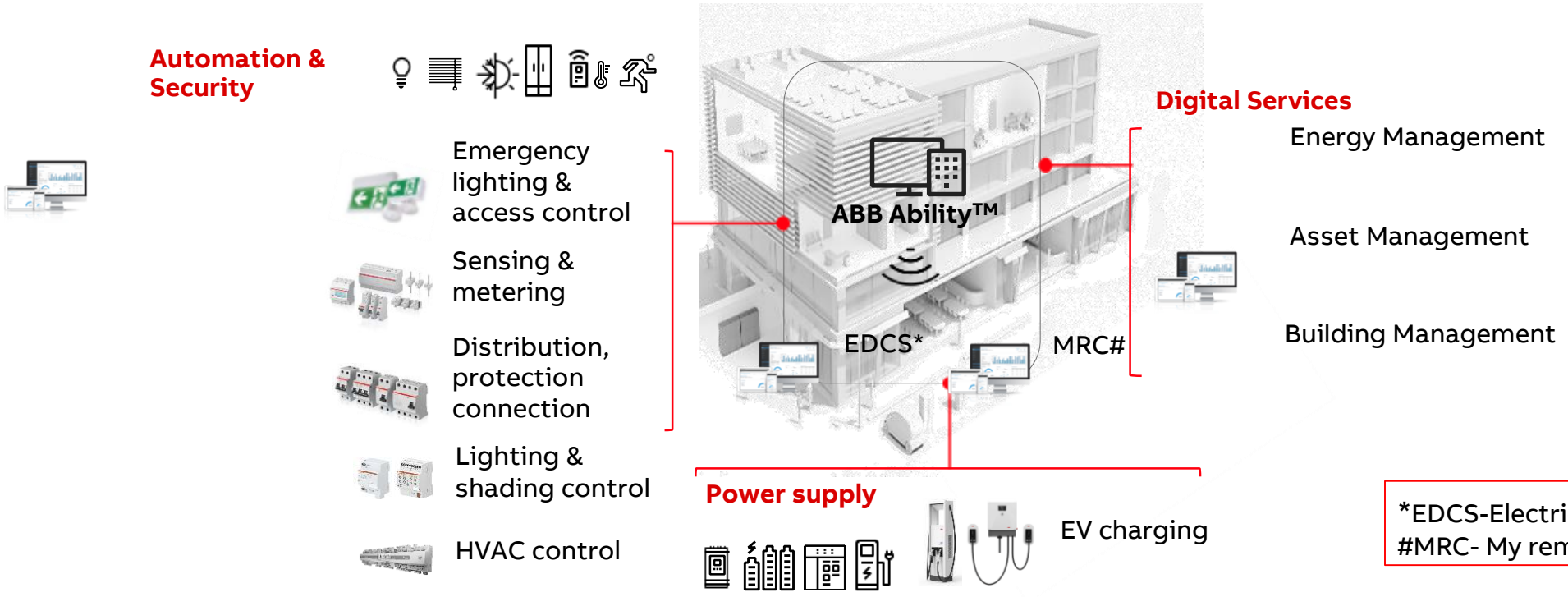


ROI = 1,6y

ABB Ability™ electrification solutions

ABB Ability™ Electrification Common Platform

Combined solution offering to deliver customer value



*EDCS-Electrical Distribution control system
#MRC- My remote care

ABB Ability™ Electrification Solutions

Technical Electrical and Communication architecture

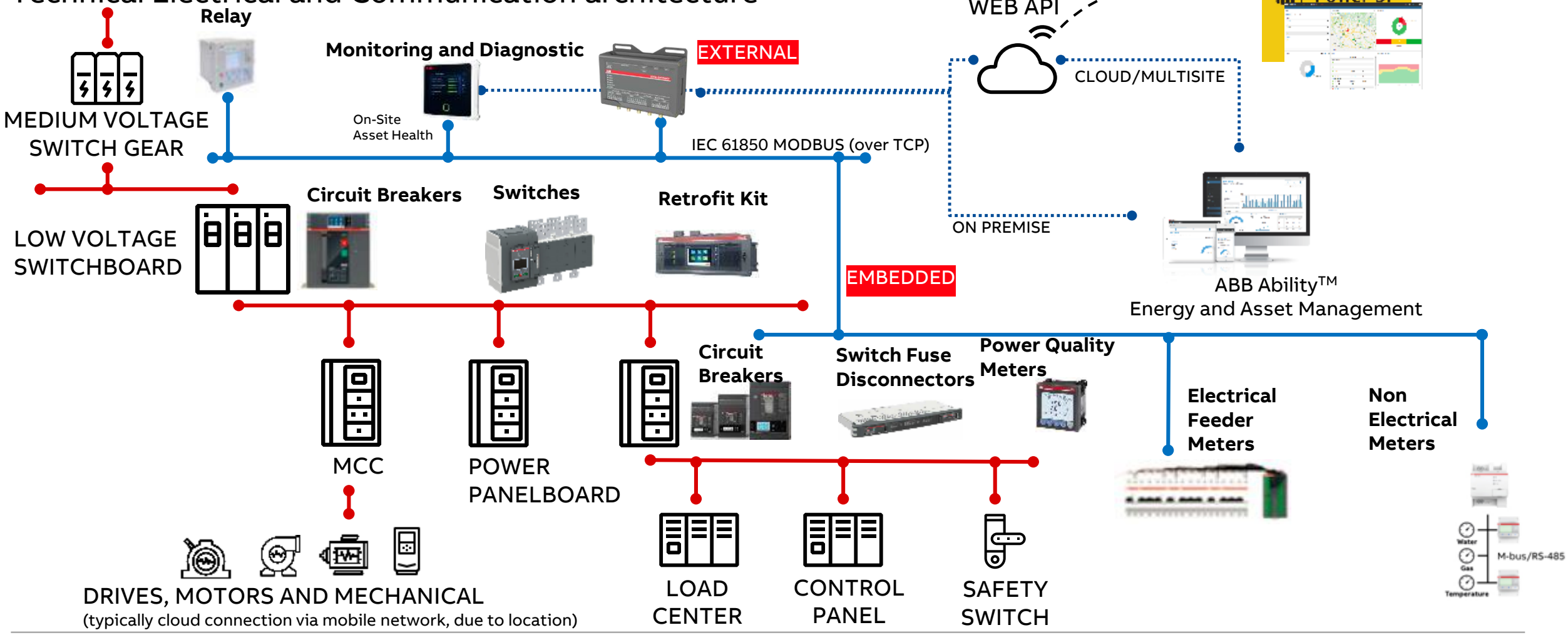


ABB Ability™ Electrification Solution

Why?

Customers want to increase awareness on owned resources, improve performance and optimize their assets **to reduce total operating costs**

How?

ABB Ability™ Energy Management Solution simplifies building management, offers predictive capabilities that **reduce downtime and maintenance**, and enables users to **dramatically reduce operational costs.**

25%

Space savings
Space saving, modularity and flexibility

30%

Lower operational costs

Cloud Connected
monitor and analyze the data to take decisions improving efficiency.

Lower acquisition cost
The embedded intelligence in one single device.

ABB Ability™ Electrification Solution

Why?

Customers want **to increase awareness on owned resources**, improve performance and optimize their assets to reduce total operating costs

What?

ABB Ability™ Electrification Solution is a **cloud-based energy management and asset supervision solution** for buildings and industrial sites.

How?

It helps **simplify facilities management**, and reduce energy and maintenance bills, enabling a 30% reduction on operating costs

PLUG & PLAY

EASY TO USE

COST EFFECTIVE

The power of understanding at your fingertips

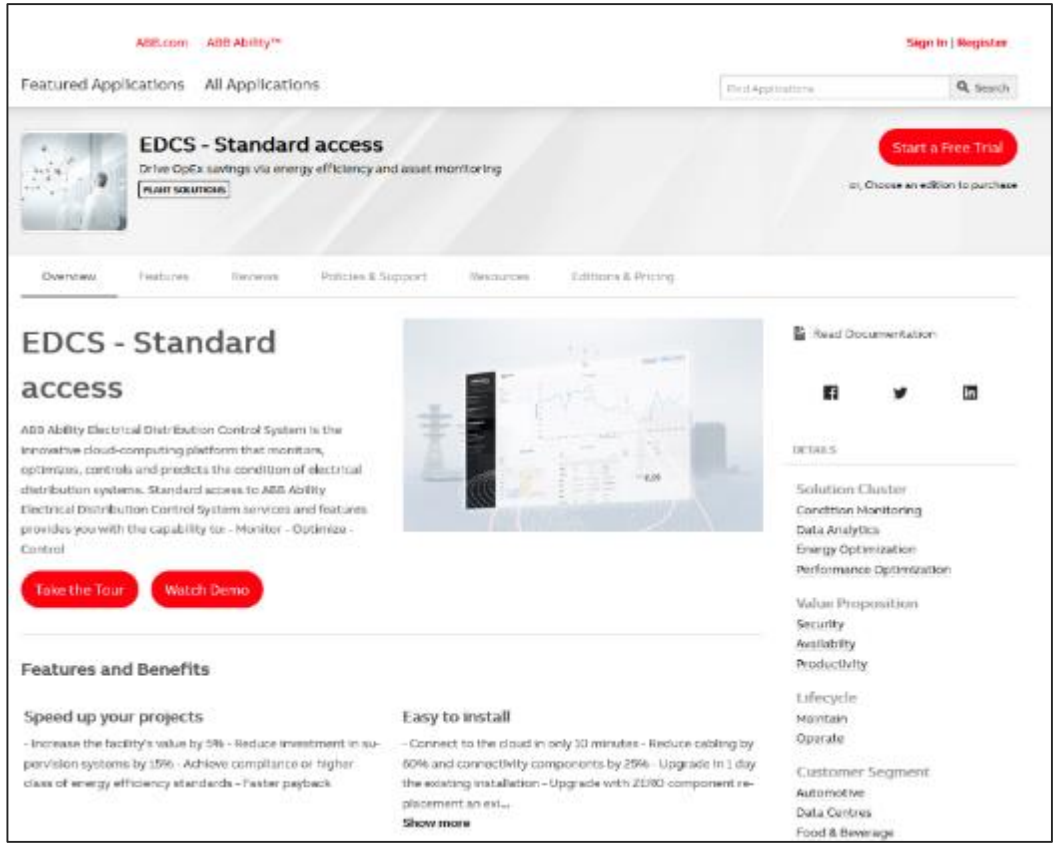
New business model for software: from CAPEX to OPEX

Subscription model
easy to purchase. Get only what you need, only pay for what you get

Software as a Service
no need to implement complex system on premise

Quick return of investment
no big investment upfront reduces the payback period

ABB Ability Marketplace



Free Digital solutions throughout 2020

Helping customer achieve operational stability & savings during COVID-19 crisis

Waiving charges for ABB Electrification Software-as-as-Service solutions for 12 months - as a sign of our commitment to resilience over the difficult times

Leveraging ABB Ability Marketplace™

Live ABB Ability™ dashboard walkthrough experience

Summary

ABB Ability™ Electrification Solutions

ENERGY MANAGEMENT

- **Optimize energy bill:**

  Evaluate the best energy tariff based on your consumption profile, avoid overcommitment from the utilities with load shifting, peak shaving and power control.
- **Avoid energy waste**:
  Identify unexpected consumptions and eliminate unwanted energy usage
- **Cost allocation**:
  Calculate appropriate energy cost allocation over different cost centers.

ASSET SUPERVISION

- **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

Digitalization support from design to service

Digital specialists

Local technical teams, able to consult on how to digitalize the electrification system and apply asset management solutions.

Service centers

Supporting the customer in adoptive predictive maintenance, offering Power Care service agreements with remote support and extended warranty.

Any Questions?