Discover Hitachi Energy

CIGRE Croatia 2021

2021-11-03

Hitachi Energy

CIGRE Croatia 2021: Hitachi Energy

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01 Introduction	**Becoming Hitachi Energy**
02 HV Products	Hybrid Switchgears – Andrea Ricotti
03 Software	Lumada Assets Solutions – Alessandro Pedretti

Hitachi Energy – our heritage

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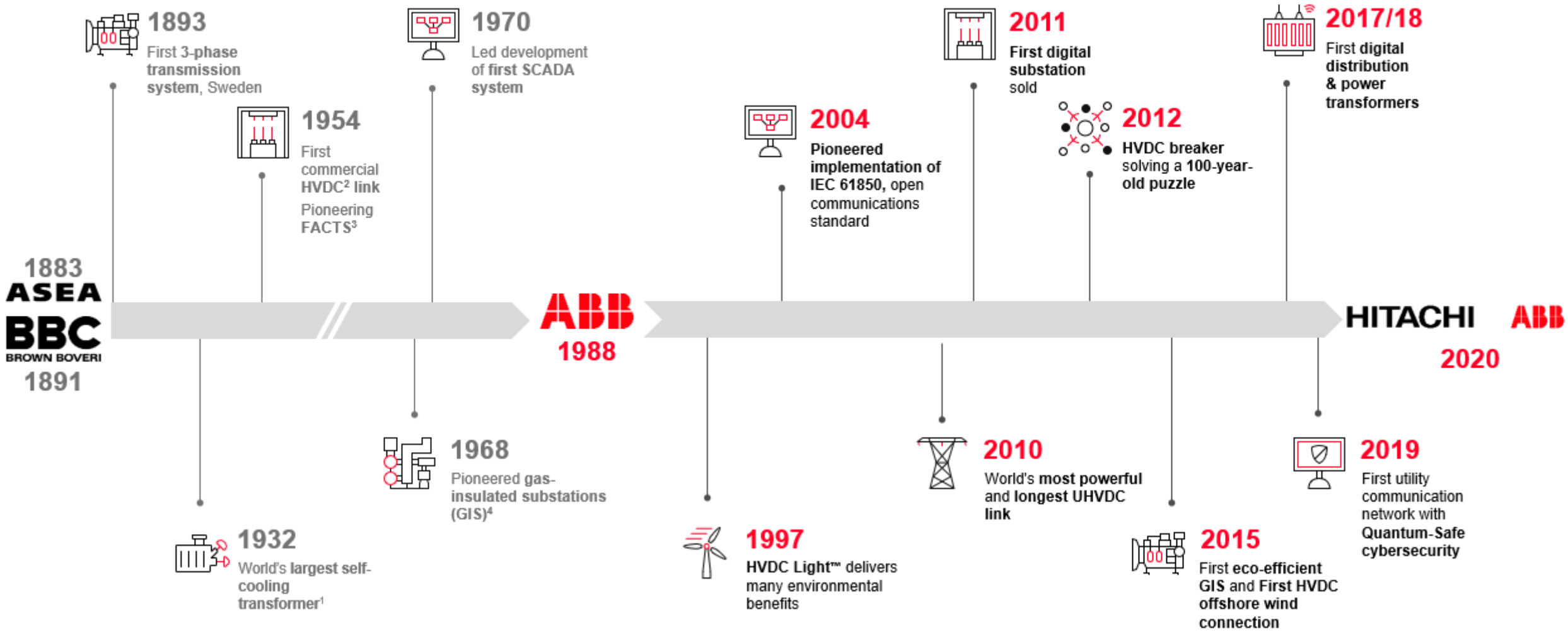

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Hitachi and Power Grids created a Joint Venture in July 2020
HITACHI ABB Power Grids

Divesting Power Grids to Hitachi

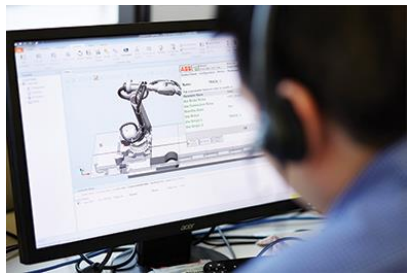
The new ABB – focusing in digital industries

Electrification

Industrial Automation

Motion

Robotics & Discrete Automation



The 4 pillars of the world's #1 power grids business

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Grid Automation

- Supporting **50% of the top 250** global electric utilities with leading portfolio
- **~US $4 trillion** mission critical infrastructure assets managed with our software solutions
- **~480 million** electricity consumers

Grid Integration

- **~15,000 systems** operating around the world
- **Leader in FACTS*** and **power quality**
- **Leader in HVDC systems with 130+ GW** installed

High Voltage Products

- Up to **1200 kilovolts AC** and 1100 kilovolts DC, leading portfolio
- **1 in every 4** high-voltage switchgear installed in the world
- Over **100 locations** worldwide provide 24/7 service support

Transformers

- **Complete range** of power, distribution, traction transformers, components, services
- Up to 1200 kV AC and 1100 kV DC, leading portfolio
- **~60 factories** around the world and ~30 service centers

* Flexible AC Transmission Systems

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Hitachi Energy Cluster

- 7 countries
- Total population 21,8 million
- Hitachi Energy locations:
  - Main Office in Zagreb
  - Another office in Split
  - Representative offices in Serbia and North Macedonia
  - Branch offices in Bosnia and Herzegovina and Albania

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PUBLIC

Hybrid Switchgears

PASS modules – today and tomorrow

2021-11-03

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Introduction over HV business

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Hitachi Energy in Italy at a glance

Country facts

Capital: Rome

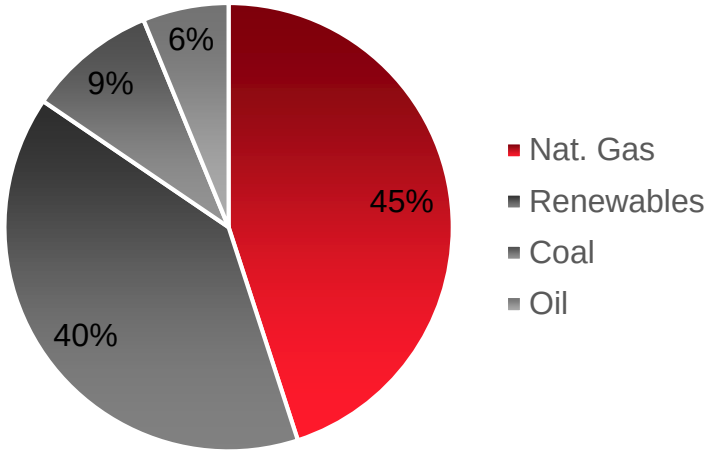
Population[1]: 60.3Mn

GDP/Capita[2]: 34,321 $

Installed capacity[3]: 124 GW

Power consumption[4]: 4,715 kWh pro capita

Energy mix[5]:



[1] ISTAT – Jan 2020
[2] FMI – 2018
[3] 2015, Terna and AEEGSI annual report 2016
[4] CIA Fact book
[5] Statista - 2018

Local presence

Heritage: 1903

Locations (all BU's; production, R&D, offices)**:**

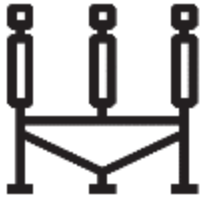
- **Sesto S.G.** (Headquarter)
- **Lodi** (High Voltage factory)
- **Monselice** (Transformers factory)
- **Montebello Vicentino** (Transf. components factory)
- **Santa Palomba** (Grid Automation)
- **Genova** (Grid Automation)

Employees: ~700 (2019)

Revenues: € 262 Mn (2019)

High Voltage unit in Lodi factory portfolio

Hybrid Switchgear
PASS from 72,5 to 420 kV



Compact Switchgear
COMPASS 145 and 170 kV

Mobile switching units
MFM from 72,5 to 420 kV

Single-phase encapsulated GIS
BLF\PASS from 72,5 to 245 kV

Stand alone ITs
TVI, TG, TG Combi
from 72,5 to 420 kV

Power voltage transformer
TIP from 72,5 to 550 kV

PASS (Plug And Switch System)

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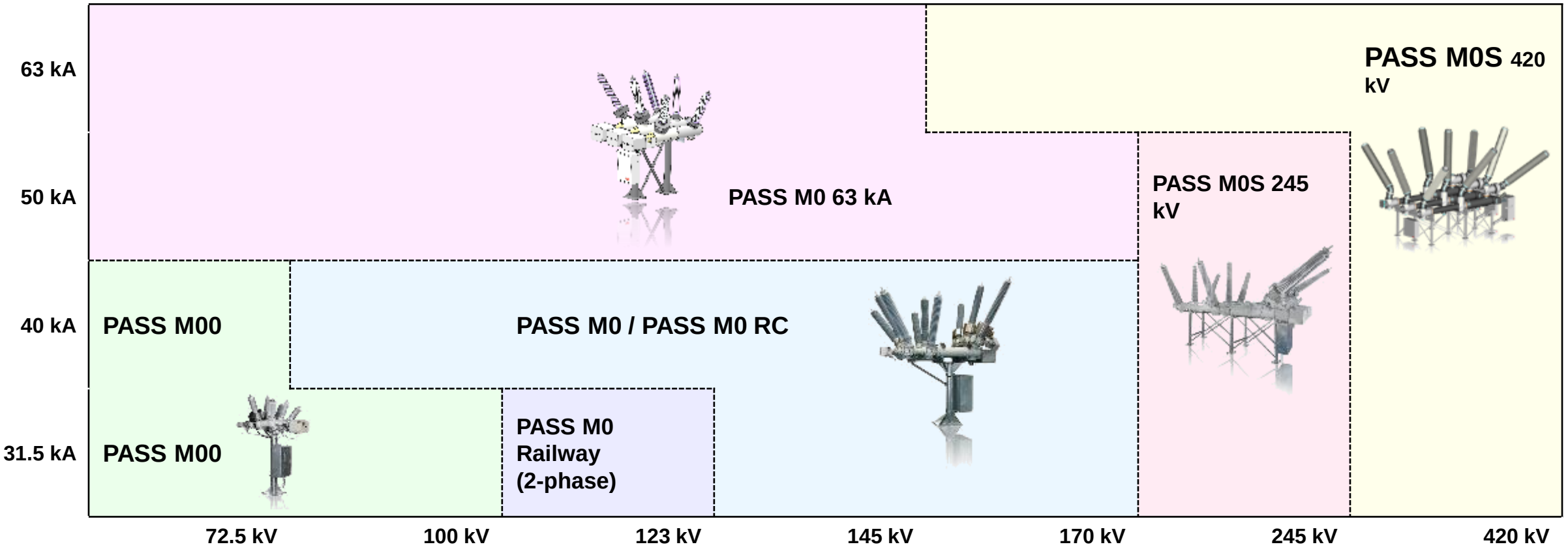
Portfolio



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Introduction to MEB Common Platform

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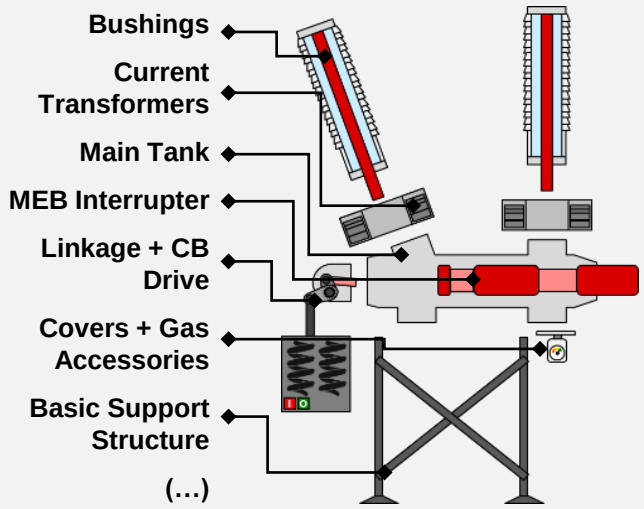
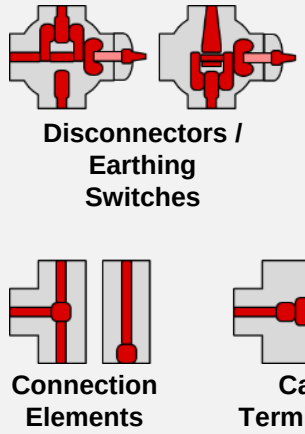
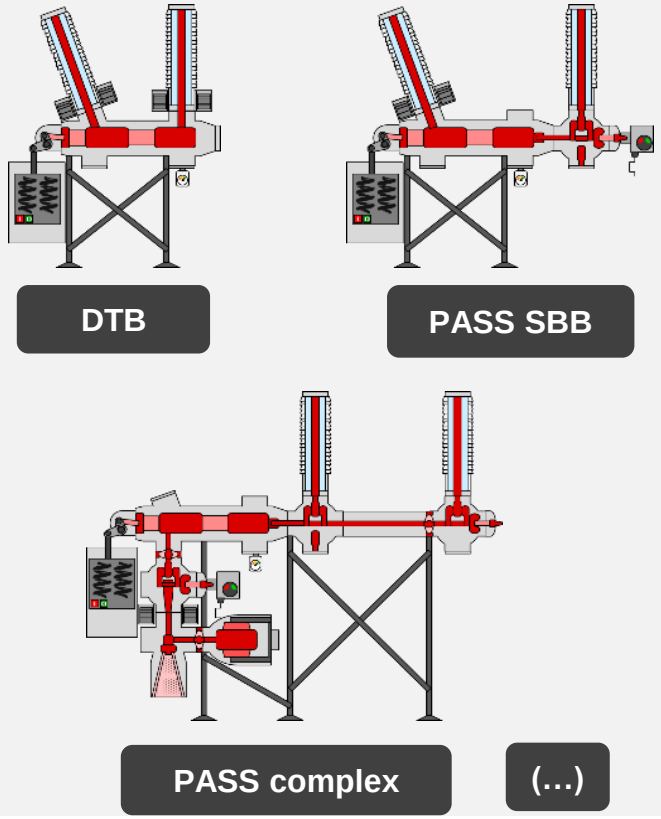
Platform and modules concept







PLATFORM

*«Set of components that are **common to all MEB configurations**, at certain ratings and with a certain core technology»*

- ✓ Each platform covers specific ratings (e.g. 123-170 kV, up to 40 kA) and core technology (e.g. SF_6 vs. alternative gas);
- ✓ Must cover all the relevant DTB & PASS requirements / standards where applicable;
- ✓ Alternative drives (e.g. TPO & SPO) or other variants applicable

MODULES

*«Set of components that are **needed for some (not all) MEB configurations**, at certain ratings and core technology»*

- ✓ Each Platform (at the relevant ratings and with the relevant technology) is associated to a set of compatible Modules. Each Module is needed to achieve specific MEB configurations, either alone or in combination with other Modules;
- ✓ Must cover only the requirements / standards specifically related to the relevant configuration(s);

MEB CONFIGURATIONS

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The concept behind the components

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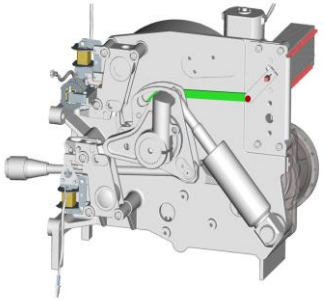
Type MEB0 Interrupter

- Core interrupting components utilized in LTB, DTB, PASS & GIS
  - LTB since 2008;
  - DTB since 2011;
  - PASS / GIS since 2013.
- More than 80,000 interrupters delivered thru 2019
- Self-blast technology with Double-motion of arcing contacts

Type FSA1 / BLK breaker operating mechanism



- Utilized on LTB since 1970’s (FSA1)
  - Flexible mounting positions (horizontal or vertical);
- Spring type mechanism with suitability for both Single Pole Operated or Three Poles Operated mechanism
- Housed in a dedicated cubicle with easy access and removable cover
- Common drive(s) to serve several voltage level products

The concept behind the components

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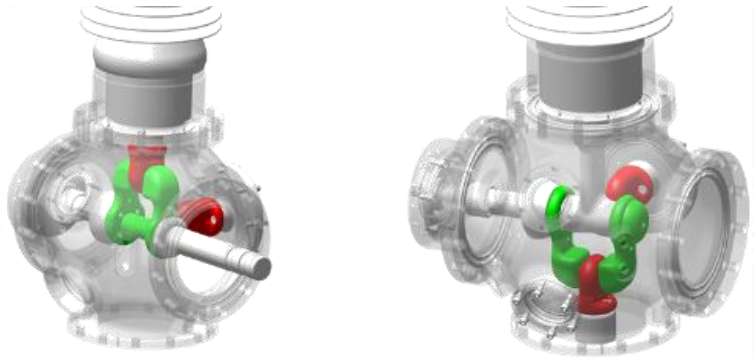
Combined DS/ES housing



- Simple and robust design
  - One rotating shaft with moving contact (green)
  - Separate fixed contacts to be engaged (red)
- Combines disconnecting and earthing functionalities
- Flexible orientation allows to customized earthing direction of the unit

Current and Voltage transformers

- CT ring type, cast resin cores technology
  - Phisically segregated from HV part
  - Stainless steel enclosure
  - Slip over concept: possibility to remove it from bushing at site
- VT SF6 insulated, inductive type
  - Equipped with dedicated gas system
  - Flexible installation criteria (horizontal, upside down…)

The concept behind the components

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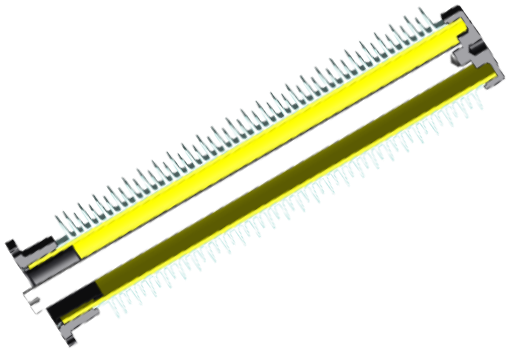
Composite bushing & HV cable enclosure



- Composite bushing made of epoxy impregnated fiberglass tube
  - Design and tested accordingly to IEC 61462
  - Several pollution levels (IEC 60815): heavy or very heavy
- HV cable end enclosure as alternative to OHL connection
  - Flexible installation to allow grounded cables connection
  - Mechanical link inside to manually disconnect it from HV side
  - Suitable for installation with different brand of HV cables and socket (compliant with IEC 62271-209)

Fast Acting Groud Switches

- Spring actuated, needed in case of long grounded cables connection
  - Making capability (E1) and Switching capability of Induced currents (Class A)
- One common component suitable for different voltage levels (from 72,5kV up to 245kV)
- Equipped with view port in order to check position of the mobile contact

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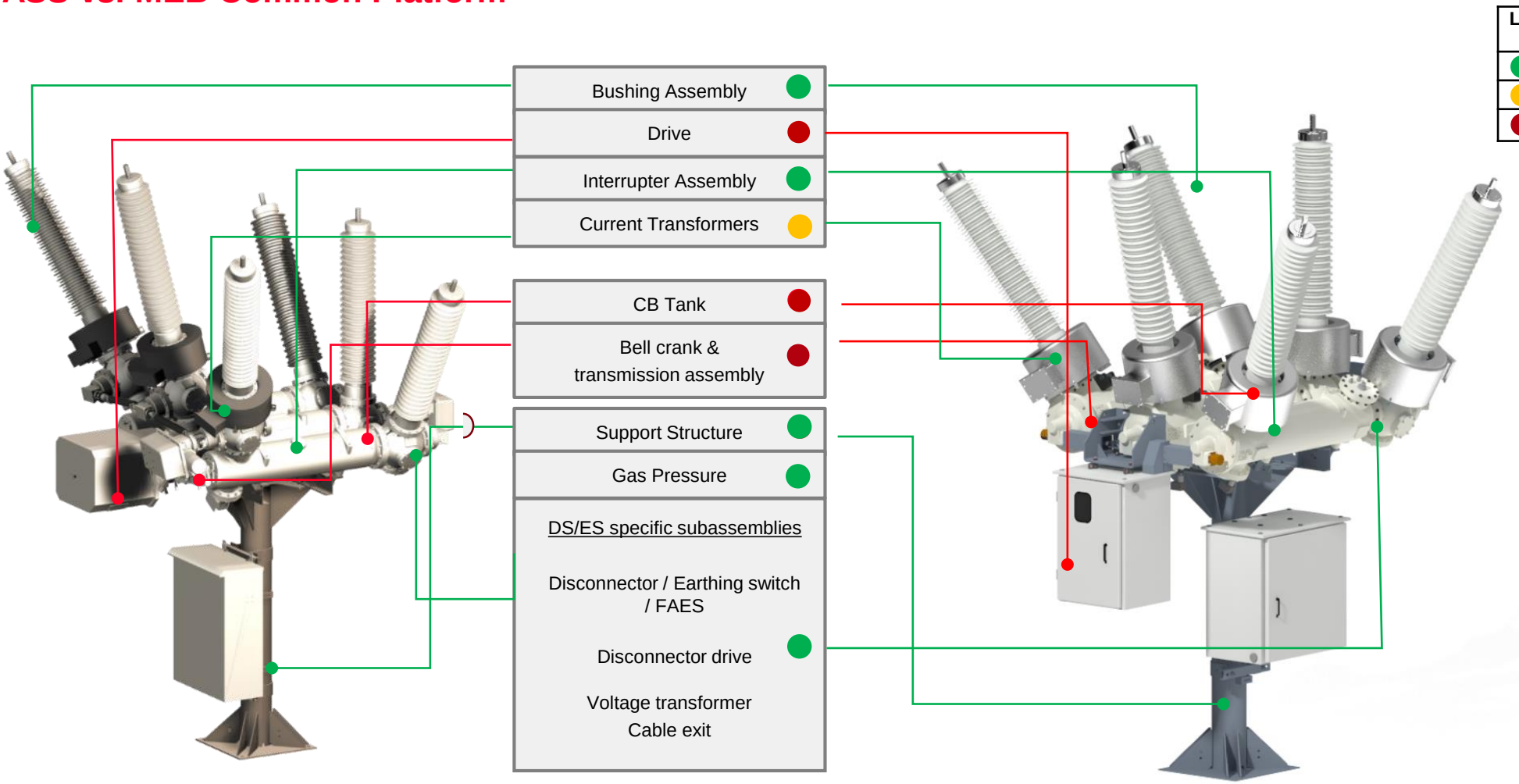
Existing PASS vs. MEB Common Platform



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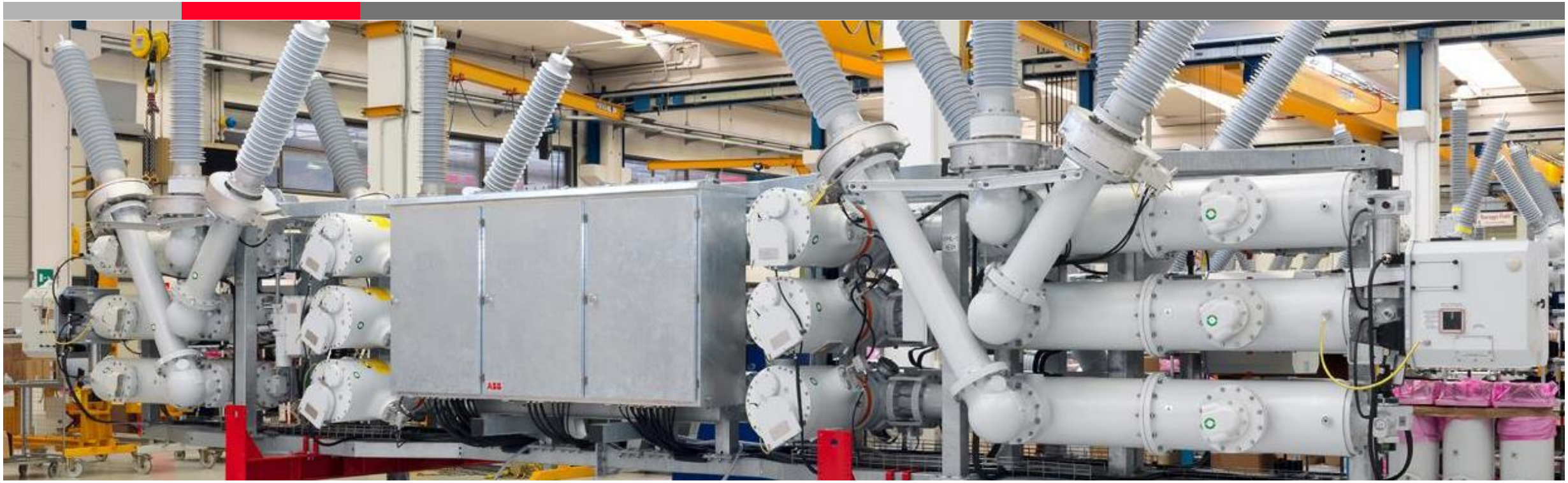
Multi Functional Modules



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PASS modular advantages

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Designed for Outdoors
Mainly designed for use in outdoors conditions. Wide range of application (-50°C; +50°C)

High Functionality & Customized Solution in Smaller Space
Each PASS module is equivalent to a complete and compact switchgear bay (Space saving technology with high customization)

Fast Execution
Fast erection and commissioning of fully-assembled modules (fully-assembled modules delivered from factory). No HV Test on site

Lower Life Cycle Cost
Fully SF6 insulated components means lower maintenance requirements

Introduction to M0H concept

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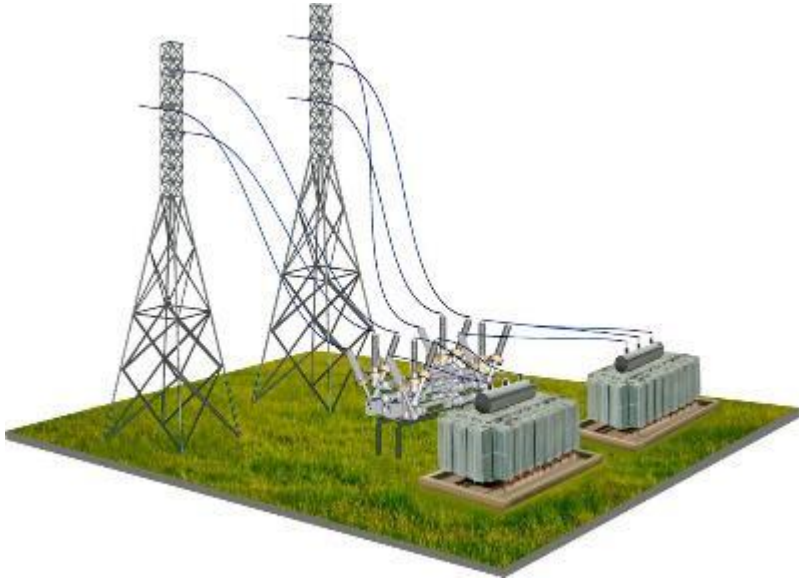
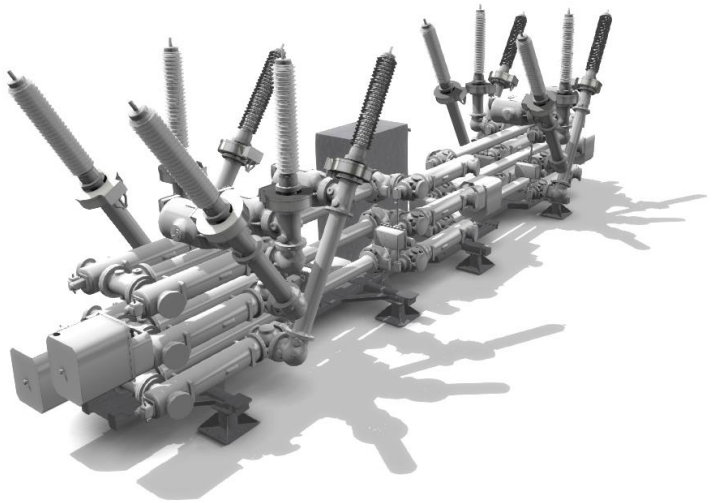
01. **Compactness and modularity lead to space saving and engineering benefits**



02. **Pre tested and pre fabricated approach for quick delivery and fast installation**



03. **Several features combined in one unique module**

Fully customizable unit that combines up to 5 CB on the same module that lead to a space saving compared to a traditional AIS installation up to 65%

Introduction to M0H concept

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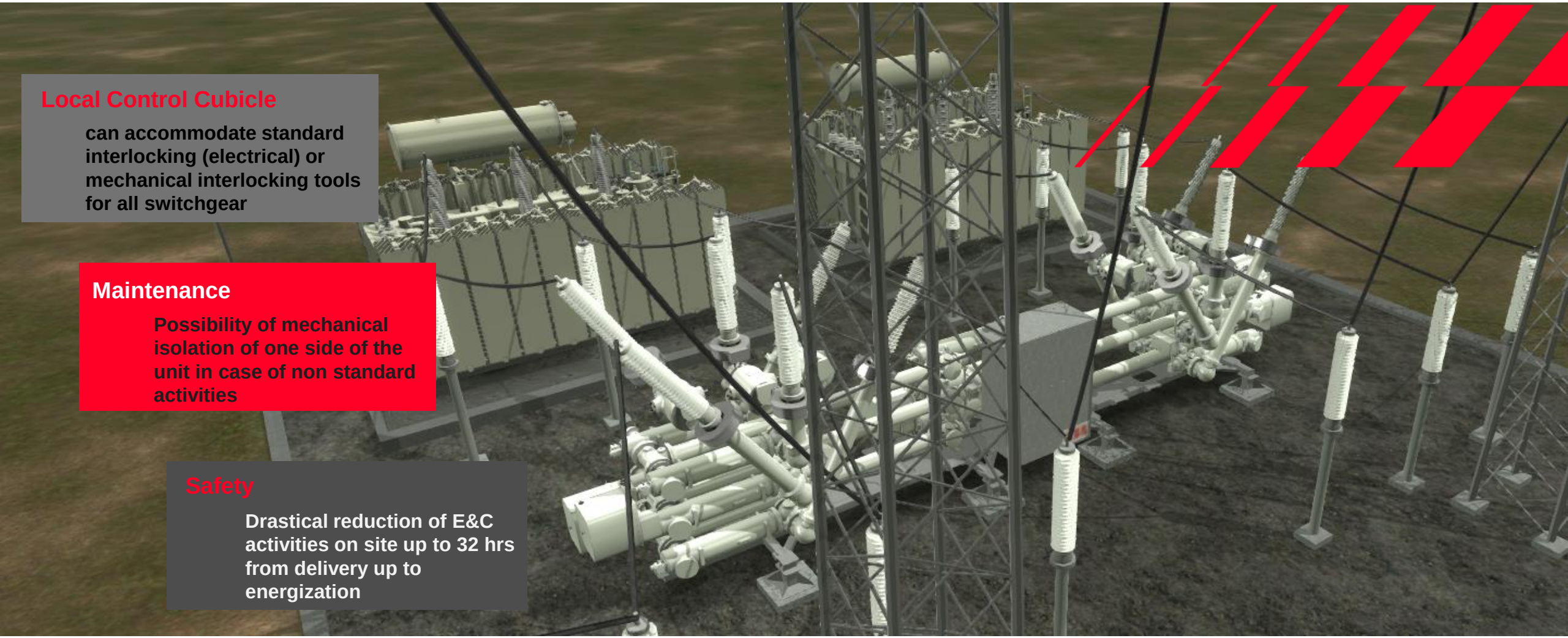

Local Control Cubicle

can accommodate standard interlocking (electrical) or mechanical interlocking tools for all switchgear

Maintenance

Possibility of mechanical isolation of one side of the unit in case of non standard activities

Safety

Drastical reduction of E&C activities on site up to 32 hrs from delivery up to energization

EconiQ in action: Eco-efficient High Voltage Products

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Game changing technology for SF_6 alternatives to reduce environmental impact

1. **Essentially eliminates CO_2 equivalent emissions** related to the insulation gas
2. **Significant reduction of CO_2 footprint** throughout the total lifecycle
3. **Over a decade of innovation** in eco-efficient technologies
4. **Based on reliable technology** for gas circuit-breaker
5. **Longest field experience** worldwide
6. **Scalable to ultra-high voltage** for both interruption and insulation
7. **Standard solution** for the industry
8. **Future proof** compliant to future environmental regulations

EconiQ high-voltage portfolio (today)

Gas-insulated switchgear (GIS)
ELK-04, 145 kV

Live Tank Breaker LTA
72.5 kV

Live Tank Breaker LTA
145 kV

Eco-passive elements for GIS
420 kV

Disconnecting Circuit-breaker (DCB) LTA
72.5 kV

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Accelerating the transition towards a carbon-neutral energy future

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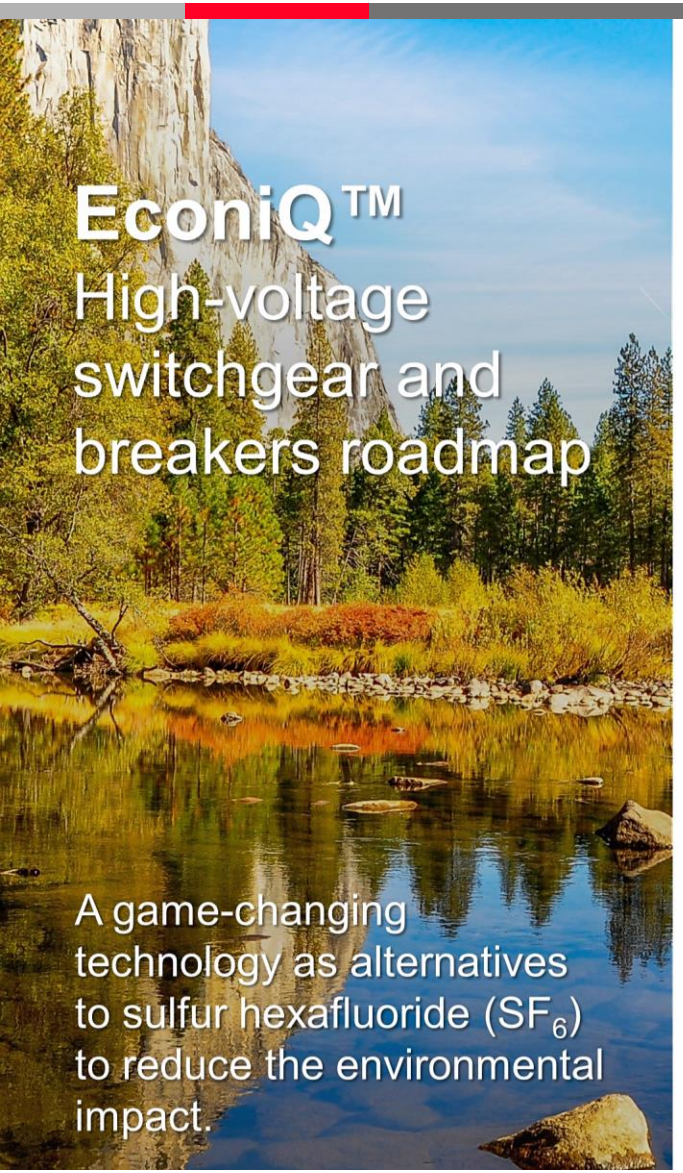

EconiQ switchgear portfolio	Available	2021	2022	2023	2024 and beyond
Live tank breaker (LTB) 	72.5 kV, 145 kV			420 kV	245 kV
Dead tank breaker (DTB) 			72.5 kV 145 kV	362 kV	245 kV
Plug and Switch System hybrid switchgear (PASS) 				72.5 kV 145 kV	245 kV
Gas-insulated switchgear (GIS) 		72.5 kV 145 kV	420 kV		550 kV, 245 kV

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Worldwide references – REE 245kV various SS - ES

During 2018 has been delivered several unit in three-phase or single-phase assembly for 245kV SS

HAPG response

- The customize design allows safe operations on site, such as CB chamber extraction for replacement
- Single-phase design best fit the available space and footprint on site

Customer benefit

- No need of SS extensions from a civil engineering perspective
- Design suitable for safe operations, a total number of 14 modules have been delivered

Worldwide references – Aftissat SS 245kV - Morocco

In 2017 has been delivered 10 modules for Aftissat SS located in Morocco in a remote area.

Customer Need

- Install switchgear in a remote area with high pollution level, dusty environment

Customer benefit

- PASS modules allows relevant savings in terms of civil works and less truck for equipment delivery onsite

Worldwide references – ComEd 420 and 145kV SS - US

Customer need
Necessity to upgrade (4) power transformer feeder through (4) additional Circuit Breaker with no space available (replacing the existing equipment)

HAPG response
Introduction of PASS Hybrid with one built-in disconnector and CTs on both Ends

Qty: 4 bays on 420kV equipment

Customer benefit
Customer avoided to relocate the Power Transformer
- Breaking capabilities
- Minimal impact caused to the existing infrastructure
- Full ANSI design

Worldwide references – ENGIE COMPASS H5 SS - Slovakia

Customer need

- Complete new SS in H5 configuration

HAPG response

- Compass 132kV with Nabla busbars

Customer benefit

- Easy adaptation of Compass modules with already existing air insulated equipment

Worldwide references – Deutsche Bahn - Germany

Deutsche Bahn AG, the German national railway company, had to retrofit a number of switchgears for their two phases, 145 kV and 16,7 Hertz frequency converter and traction railway substations. ABB has studied the solution with Deutsche Bahn winning five frame agreement in a row and delivering more than 200 modules.

Issues to solve:

- Deusche Bahn had always been forced to select oversized 245 kV AIS switchgears, since the standard 145 kv equipment can't support the 16,7 Hz requirement.

HAPG response

By using the innovative Motor Drive, the travel curve of the circuit breaker can be adjusted to meet non-standard frequencies, such as the 16,7 Hz. PASS has been configured in a customized two-phases module.

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Lumada Assets and Works Solutions

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By combining digital technology capabilities, we can deliver greater customer value

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Hitachi Energy

130+

years of engineering know-how

~$4T

worth of assets managed every day

- Asset & work management
- Asset performance & investment
- Workforce management
- Energy portfolio management
- Energy market management

- Intelligent data operations
- IoT insights and outcomes
- Artificial Intelligence & Machine Learning
- Edge-to-cloud data infrastructure
- SI & Advisory Consulting

Hitachi Vantara

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60+

years of data and IT transformation

Leader

IIoT, Gartner 2020 Magic Quadrant[1]

Business applications for asset intensive industries

IT strategies, solutions & expertise for digital transformation

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Business challenges around asset management

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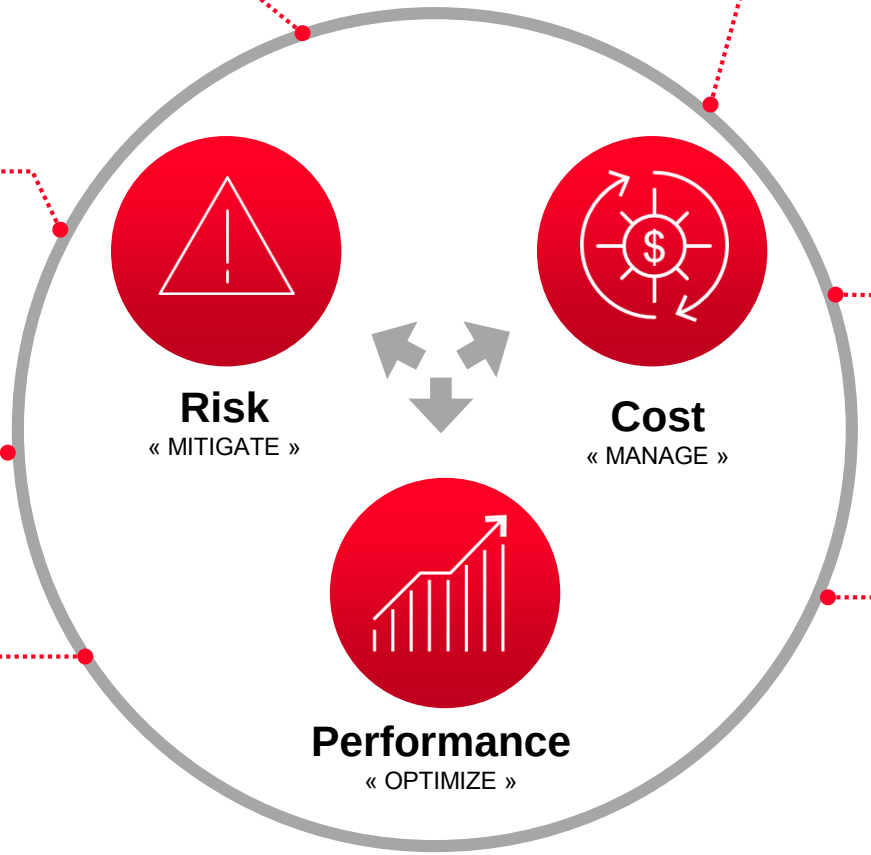
Aging infrastructure
Maintaining and/or replacing existing infrastructure is a constant battle.

Reliability
Increasing pressure for continual reliability improvement and customer satisfaction.

Customer engagement
20.8 billion customers will be connected to the IoT by 2020[1].

Business model disruption
Whether it's Uber or AirBNB, our traditional business models are changing.



Safety & transitioning workforce
The need to keep all workers safe and continually train new workers.

Spending justification
Revenue challenges and regulatory inspection will drive total expenditure focus and cost constraints.

Cyber security
Attacks are increasing in regularity and sophistication. Through 2018, 50% of IoT device manufacturers will not be able to address threats[2].

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ISO 55000 – Standardizing asset management

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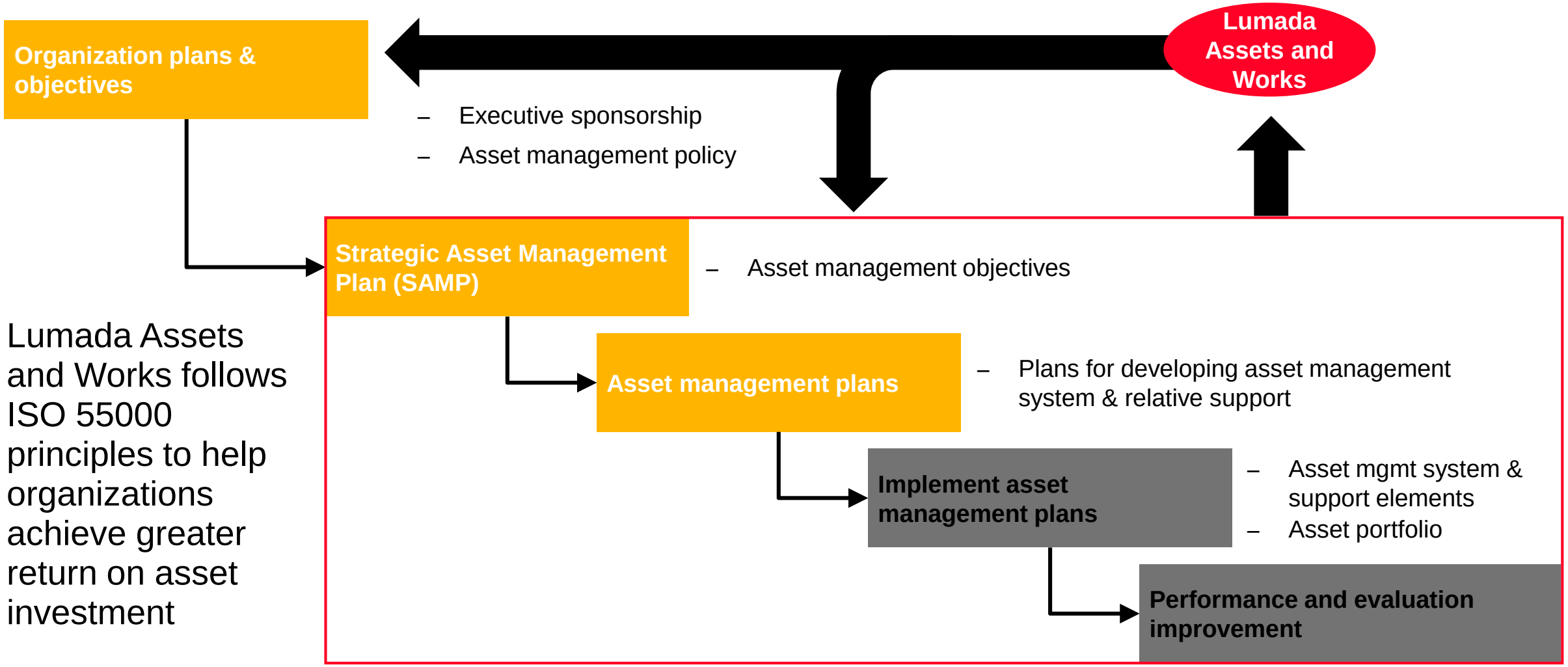

Lumada Assets and Works follows ISO 55000 principles to help organizations achieve greater return on asset investment

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Lumada Asset Performance Management

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Lumada Asset Performance Management

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Enterprise asset health analytics to improve processes through risk-based optimization

Expert models
Analysis of all assets in the fleet in a geospatial or tabular view

Advanced operational business intelligence
Optimize decision making based on predictive and prescriptive analysis

Maintenance management
Prioritize maintenance or replacement and automate work requests

- 20% improvement in labor productivity*

Feed data into analysis stage to re-start the cycle

01 **Analyze** → 02 **Anticipate** → 03 **Inform** → 04 **Act** → 05 **Track** → 06 **Connect / collect** → 07 **Re-start the cycle**

Prognostic models
Simulate risk, asset health and probability of failure based on loading of assets

Asset utilization

- 15% improvement in asset availability*
- 10% reduction in asset running costs*

All data sources:

- Databases
- Historian
- Sensors
- EAM
- ERP
- …

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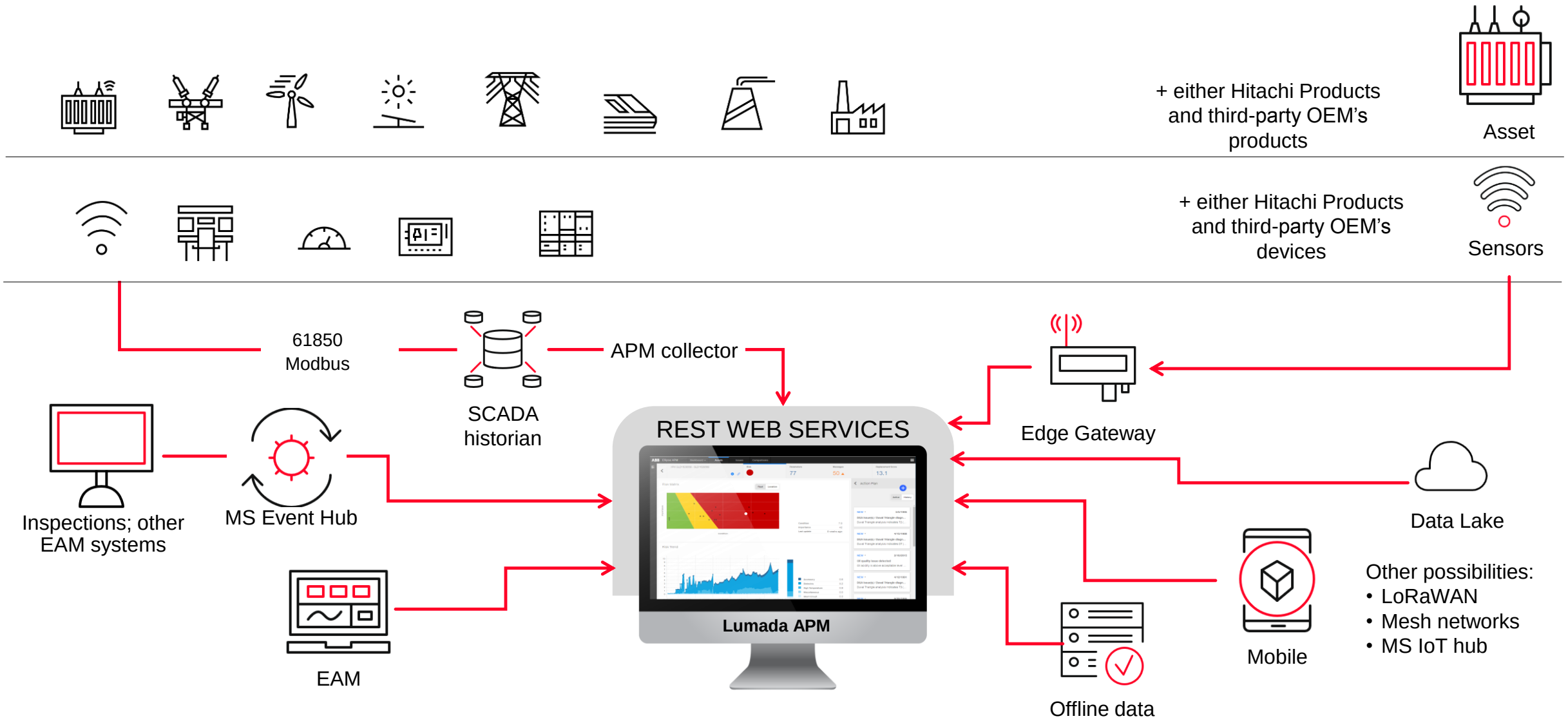
How Lumada APM works?



Lumada APM Performance Models

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Expert Models
Built based on the foundation of 70 plus years of experience in servicing equipment's

Advanced Physics based Algorithms
Years of domain knowledge gone into building these algorithms

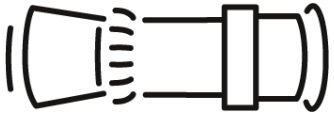
Thousands of Expert Recommendations
Codified servicing expertise to recommendation

Advanced Mathematical Models
Stochastic process model (Markov), Stochastic inference model (Bayes)

Remaining Useful Life curve
For rotating equipment's like turbines, motors, pumps etc.

Revenue Impacting Critical Assets


Transformers


Gas Turbines


Hydro Turbines


Steam & Gas Generators


Circuit Breakers


Wind Turbines


Motors

Electrical and Rotating Equipment's (200 plus)

- Steam Turbines
- Capacitor Banks
- Reactors
- Battery Banks

- Cables
- Motors
- Pulverizer
- Draft fan

- CCVT
- Surge Arrestors
- Proppant mixer
- Variable speed drive motor

- Lube oil system
- Conveyors, feeders
- Cyclone pump
- Tertiary crusher

- Lube oil system
- Diesel engine
- Cyclone pump
- Tertiary crusher

- Heat Exchangers
- Suction rolls
- Compressors
- Ventilator

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How do we do it

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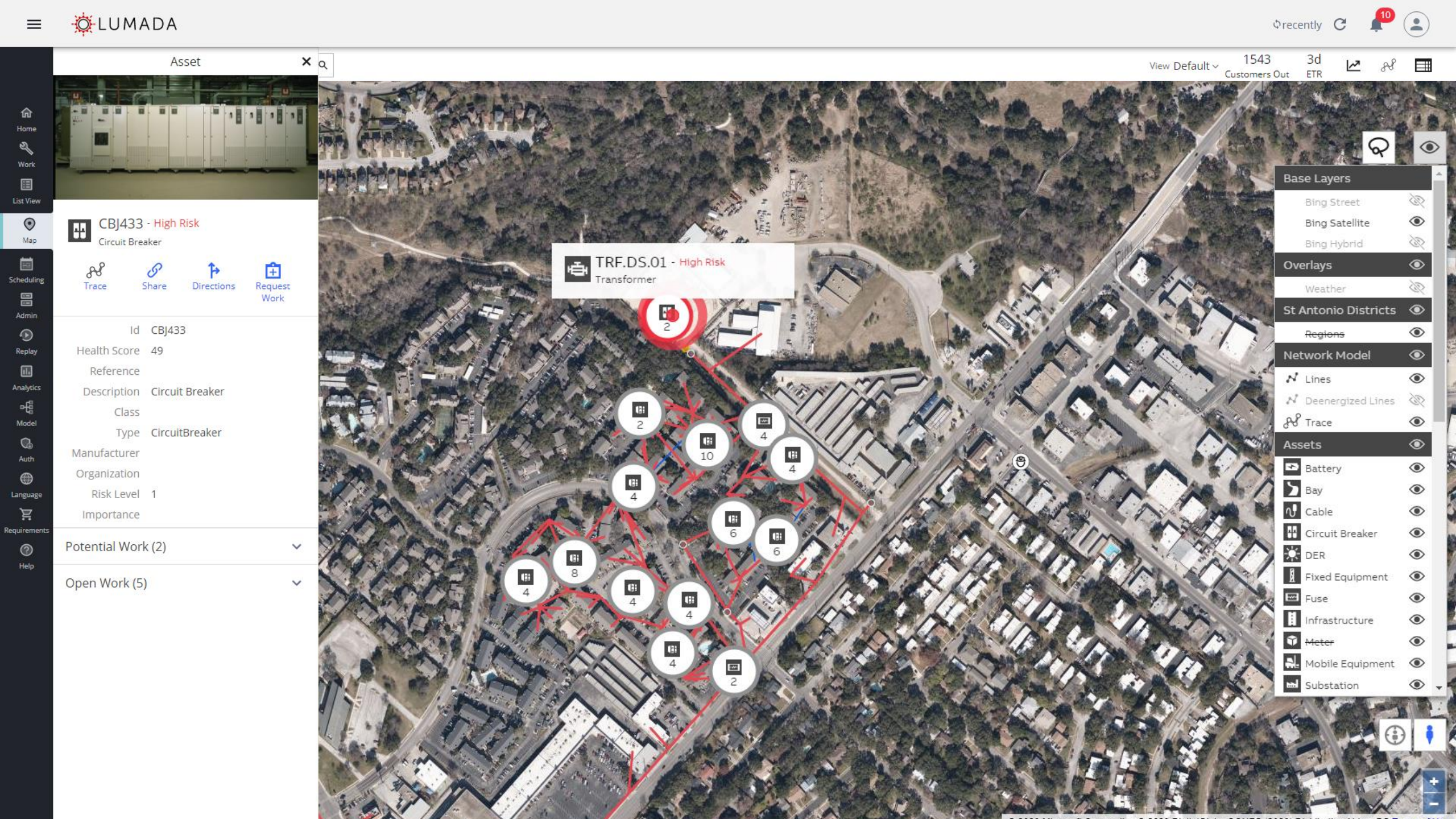

LUMADA
recently
10
Asset
Home
Work
List View
Map
Scheduling
Admin
Replay
Analytics
Model
Auth
Language
Requirements
Help
CBJ433 - High Risk
Circuit Breaker
Trace
Share
Directions
Request Work
Id CBJ433
Health Score 49
Reference
Description Circuit Breaker
Class
Type CircuitBreaker
Manufacturer
Organization
Risk Level 1
Importance
Potential Work (2)
Open Work (5)
View Default
1543
Customers Out
3d
ETR
TRF.DS.01 - High Risk
Transformer
Base Layers
Bing Street
Bing Satellite
Bing Hybrid
Overlays
Weather
St Antonio Districts
Regions
Network Model
Lines
Deenergized Lines
Trace
Assets
Battery
Bay
Cable
Circuit Breaker
DER
Fixed Equipment
Fuse
Infrastructure
Meter
Mobile Equipment
Substation

XFM.PLTTHERM191212 - PLTTHERM191212

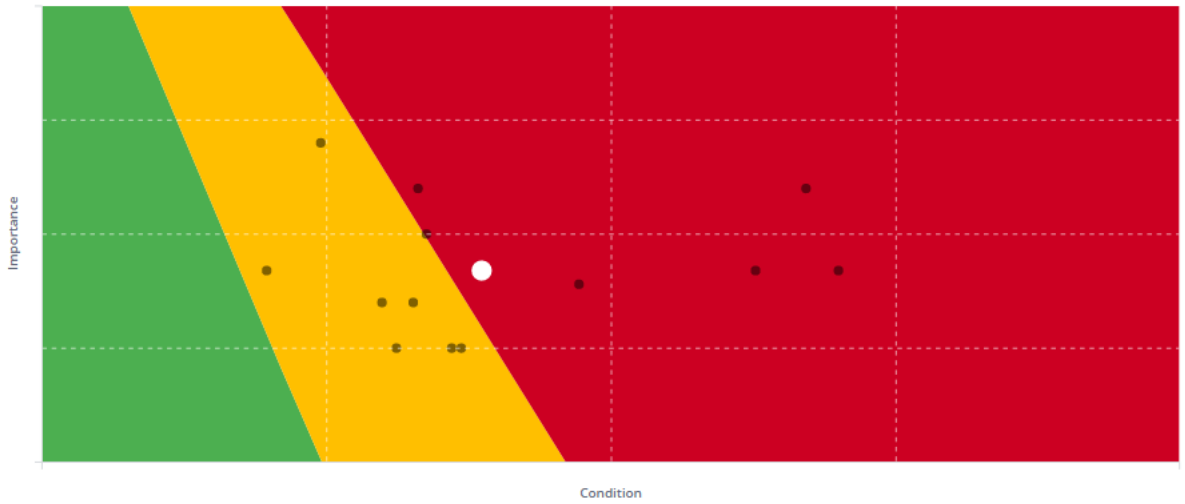
Calculate

Last update
3 months ago

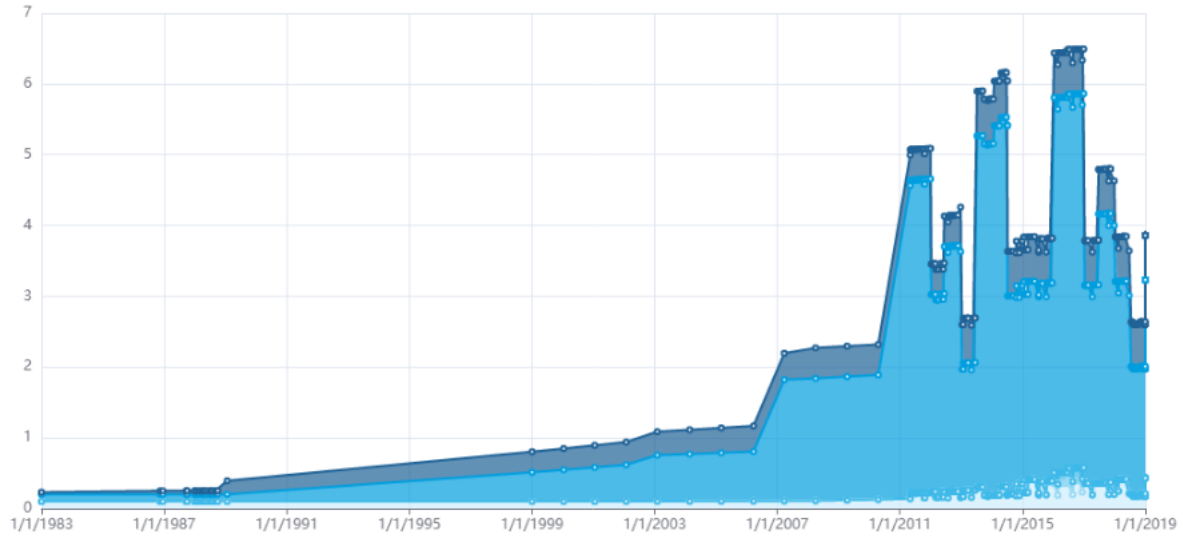
Risk	Condition	Importance	Parameters	Messages	Replacement Rank
	3.9	42	122	46	#5 out of 85 Transformer

Risk Matrix

Fleet | Location



Condition Trend



Action Plan

Active | History

NEW 7/18/2018 Edit

DGA issue(s) / Duval Triangle diagnostic

Condition

Duval Triangle analysis indicates T2 (thermal fault between 300°C and 700°C). Possible causes include defective contacts at bolted connections (especially bus bar); connections within tap changer; connections between cable and draw rod of bushings;; circulating currents between yoke clamps and bolts; clamps and laminations; in ground wiring; bad welds or clamps in magnetic shields;; and abraded insulation between adjacent parallel conductors in windings.

Recommendation

Recommended actions include thoroughly verifying the cooling system (fans; valves; pumps; radiators; coolers; oil preservation system; etc.); checking the leads and LTC connections; and determining if a recent DETC change caused a connection issue. An infrared camera may show hot spots on tank walls; oil ducts; radiators; and so forth. If performing an internal inspection; look for lead and LTC connection issues as well as circulating core currents and blocked oil channels. If no external issue identified; then consider degassing. Missing data for DGA and/or dynamic load is preventing accurate calculation of correlation between DGA and dynamic load. To achieve correlation; operate the transformer for some time at reduced load. Stable or diminishing gas levels indicate correlation with load. If positive correlation consider load shedding to mitigate risk as required. Missing data for DGA and/or oil temperature is preventing accurate calculation of correlation between DGA and oil temperature.
Recommended actions should be taken within a year.

Urgency	Maintenance Priority	Comments
As Soon As Possible	#5,290th out of 5,891	0 - Add

Actions

No Actions assigned

+ Add Action

NEW 9/1/1988

DGA issue(s) / Duval Triangle diagnostic

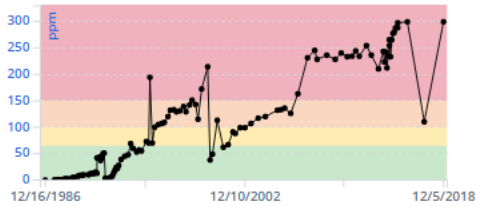
XFM.23444 - GD778899

Calculate

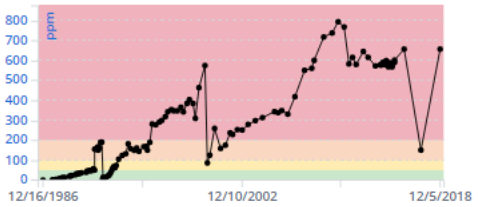
Last update	Risk	Condition	Importance	Parameters	Messages	Replacement Rank
4 months ago		7.0	42	57	49	#11 out of 85 Transformer

Data Source: Online | Offline

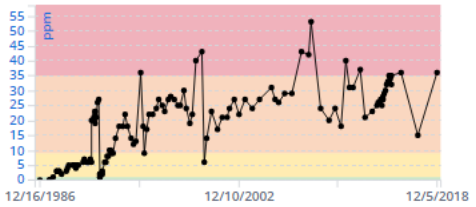
Ethane: C_2H_6



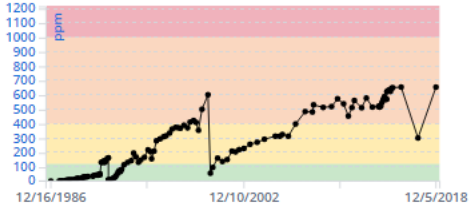
Ethylene: C_2H_4



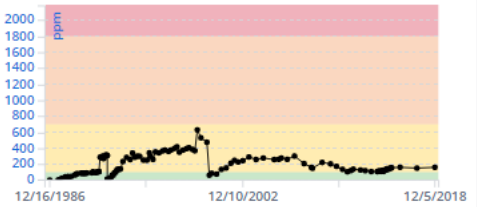
Acetylene: C_2H_2



Methane: CH_4



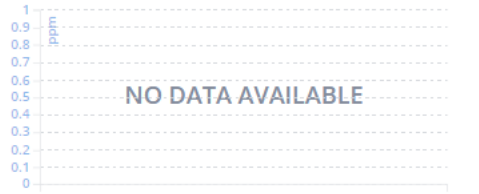
Hydrogen: H_2



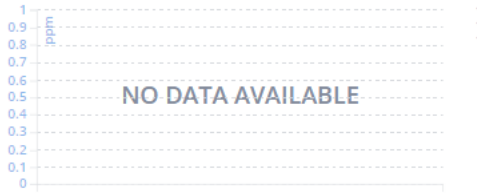
● Offline data

Gas Standard IEEE: Condition 4 | Condition 3 | Condition 2 | Condition 1

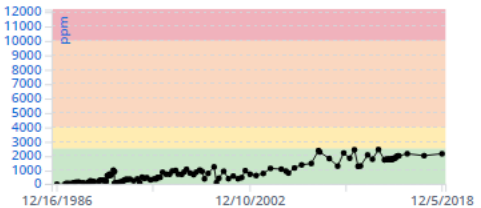
Oxygen: O_2



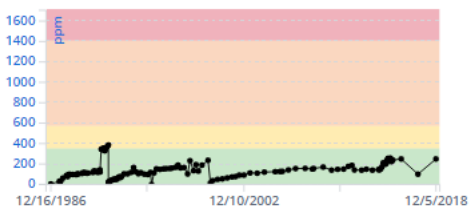
Nitrogen: N_2



Carbon Dioxide: CO_2

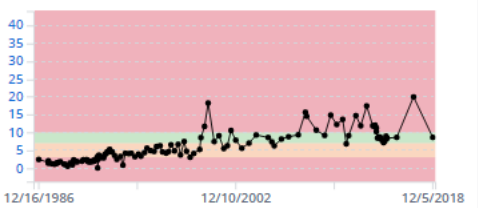


Carbon Monoxide: CO



CO_2/CO

Switch Ratio

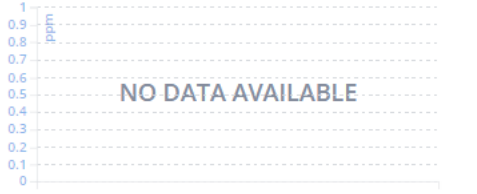


● Offline data

Gas Standard IEEE: Condition 4 | Condition 3 | Condition 2 | Condition 1

Total DCG

Hydran



● Offline data

Gas Standard IEEE: Condition 4 | Condition 3 | Condition 2 | Condition 1

XFM.PLTTHERM191212 - PLTTHERM191212

Calculate

Last update	Risk	Condition	Importance	Parameters	Messages	Replacement Rank
3 months ago		3.9	42	122	46	#5 out of 85 Transformer

Parameters | Factors | DGA | Duval Analysis | Rogers Ratio | Standard Oil Tests | Bushings | Online Bushings | Thermal | LTC | Partial Discharge | Embedded reports

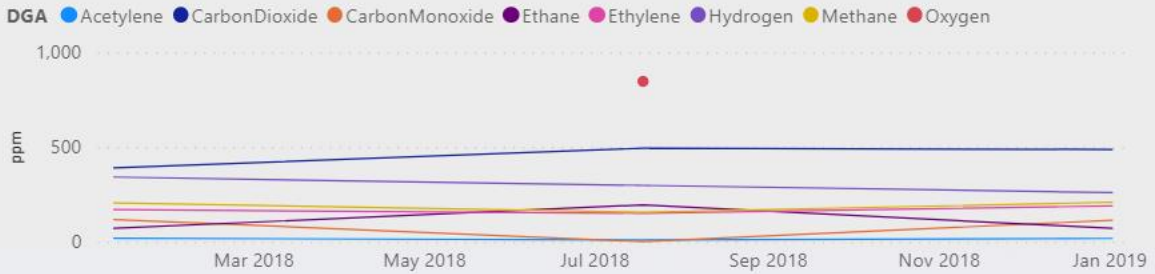
XFM.PLTTHERM191212
Asset Id

Generator Step Up
Type

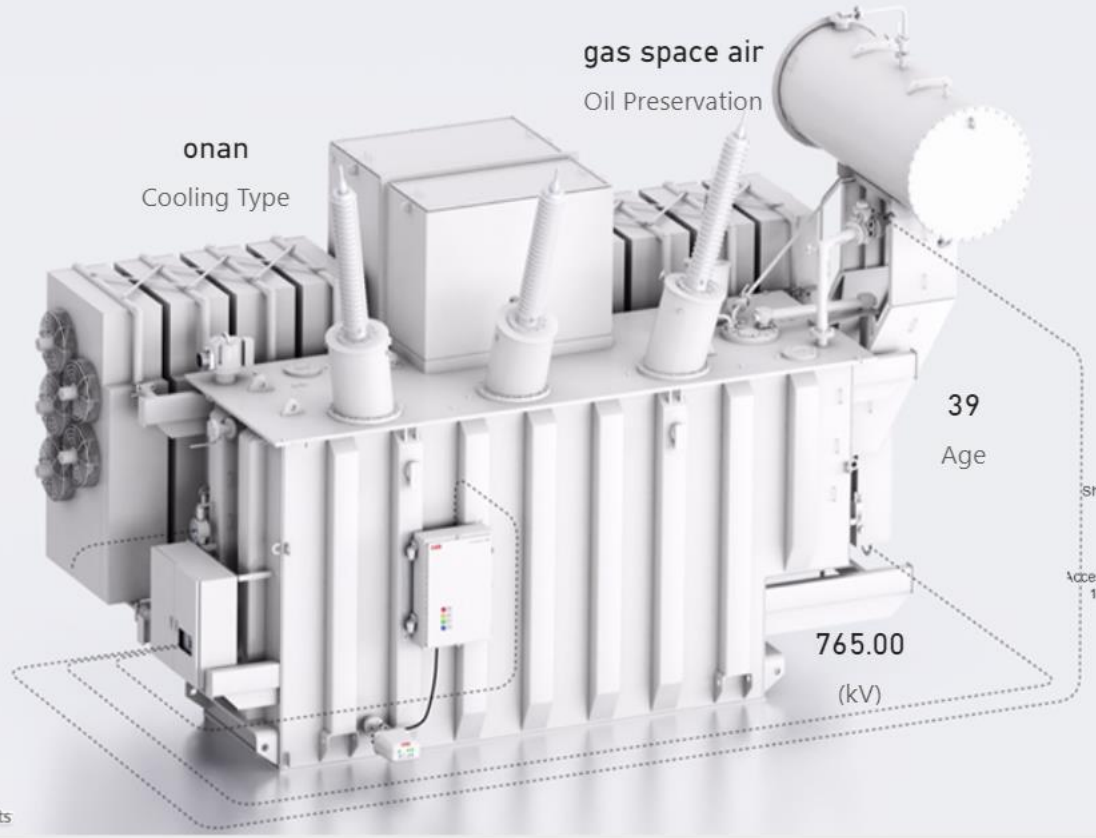
42
Criticality

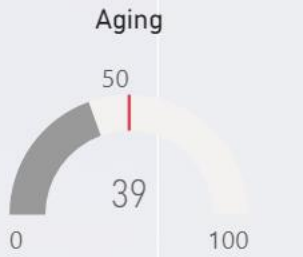
5
Replacement Rank

AE
Manufacturer



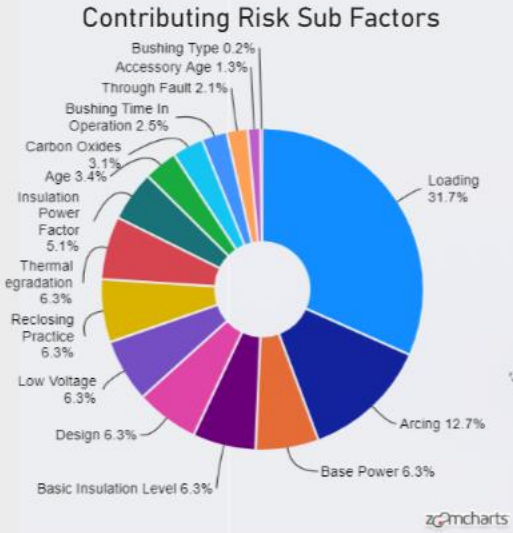
7
Unactioned Issues

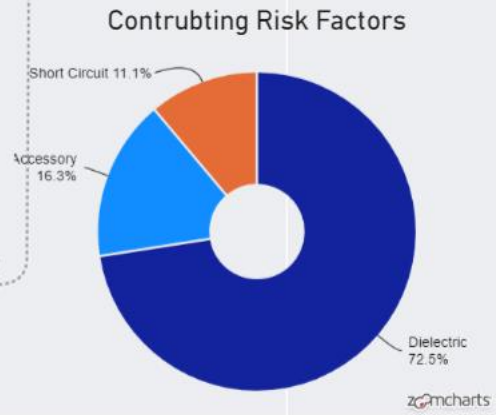




3.86
Condition

High
Asset Risk





Filters

Asset Detail

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Remote Sensing Technology

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Remote Sensing Workflow

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Planning

Monitor/ Surveil

Ingest Data

Data Insights

Trigger Alerts

Sensors & IT Sources

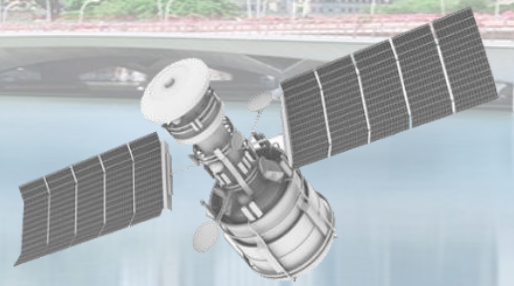
- Sensor of anykind
- IT Systems
- Meteo / Environment

Rotory Drone

- Medium Range Distance
- Non or Licenced Operation
- Focus on detail
- High Sensor Capacity

Fixed Wing Drone

- Large Distance
- Licenced Operation
- Wider Coverage
- Reduced Sensor Flexibility



Satellite Imagery

- Wide coverage
- High Cost for Detail
- Fixed imagery
- No Sensor flexiblility

Automated image-based inspection boosts precision and efficiency of transmission line inspection

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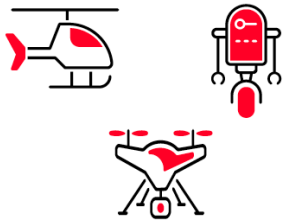
Image-Based Inspection

Image gathering



Raw asset images/videos

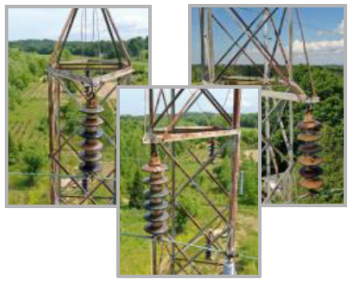


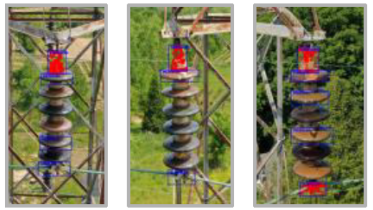
Image-based inspection

- Image ingestion and pre-processing
- AI-based analysis
- Selective human quality assurance

Asset condition dashboard

- a) Location
- b) Defect type
- c) Defect severity
- d) Time stamp
- e) …

Processed images



Potential integration

APM

Maintenance prioritization
- Failure prediction
- Failure mode prediction
- Asset risk score
- Remedial action

- Reports
- Dashboards
- API

EAM

Maintenance work order management

FSM

GIS

Geographic visualization of defects

Automated Image Based Inspection Processing

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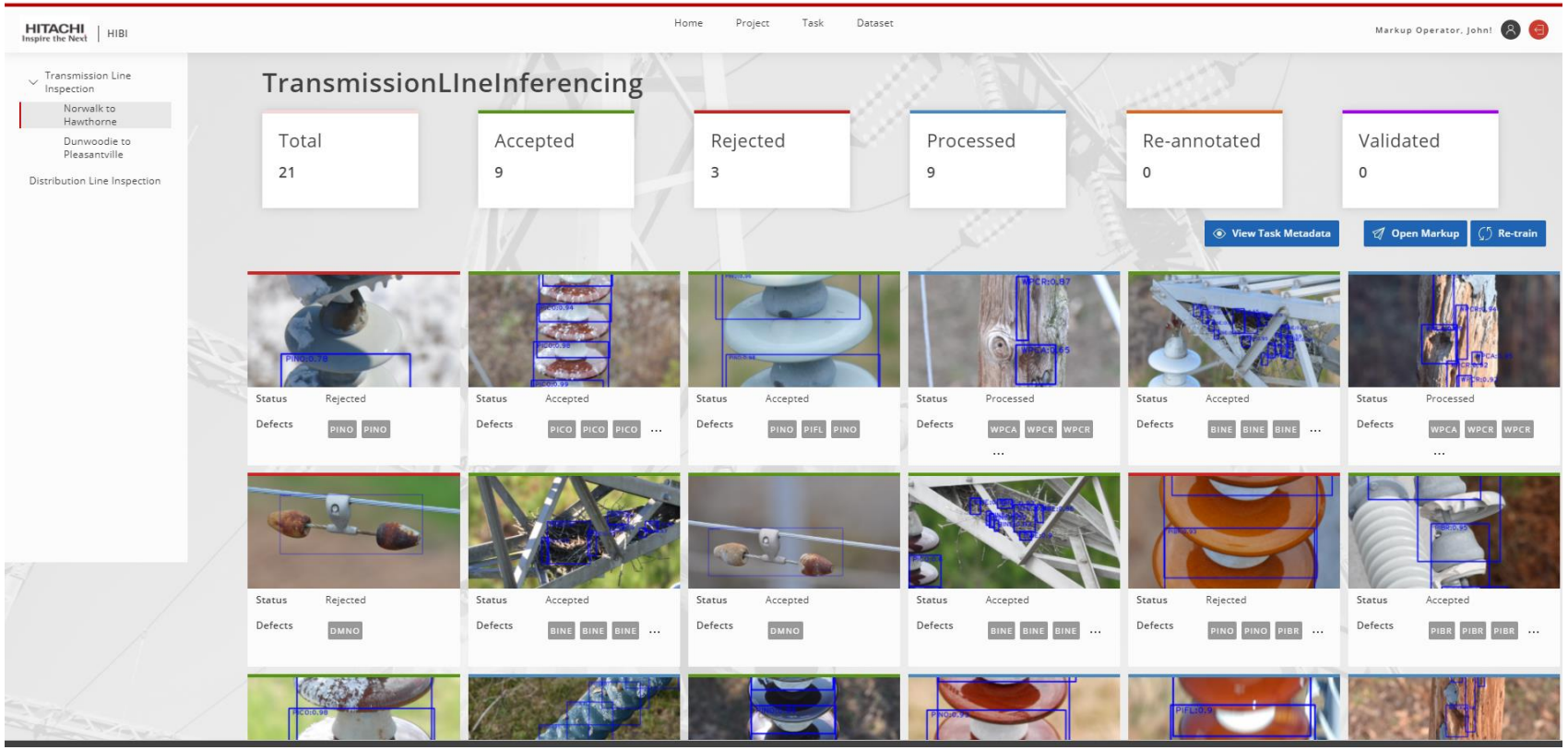

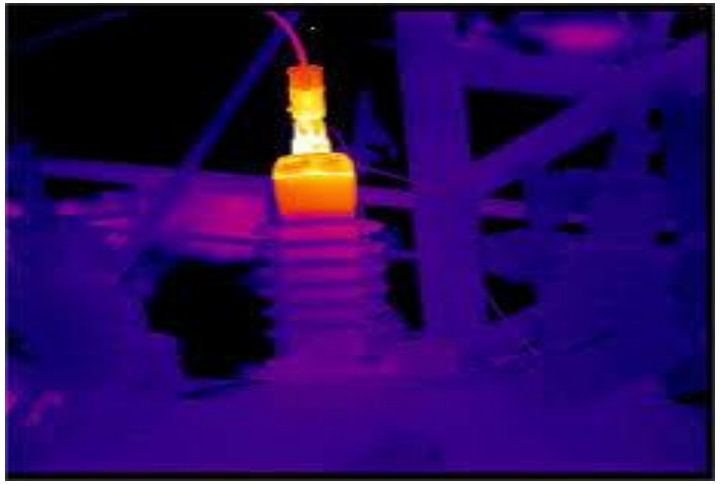

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Benefits of Lumada APM

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One source of IT/OT truth means better decision-making and improved execution

Business is driving the push towards digitalization with the reward of improved operations, lower costs and increased agility. Digitalization will help:

Identify risks early so they can be reliably resolved or mitigated

Enable risk-optimized maintenance schedules

Make more informed long-term investment decisions

Facilitate the adoption of accepted industry standards such as ISO

Quickly establish an asset performance management solution that grows with you

Replace time-based maintenance with condition-based maintenance for cost-effective reliability

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