



HITACHI

ABB

Increase reliability of your transformers through forthcoming CompactCool Technology, Prognostics & Predictive Analytics

POWERING GOOD FOR SUSTAINABLE ENERGY

HITACHI ABB POWER GRIDS

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Liquid Immersed and Dry-type Transformers Values



Uses **LIQUID** for main dielectric and cooling media

Liquid-immersed	Feature	Dry-type
✓	Size & Weight ←	
✓	Initial Cost	
✓	Losses/Efficiency ←	
✓	Noise	
✓	Overload capability	
	Fire Safety	✓
	Environmental Safety	✓
	Total Installation Cost*	✓
	Maintenance Cost	✓
	Short Circuit Strength	✓



Uses **SOLID INSULATION** materials for main dielectrics and natural **AIR** for cooling

Meeting Footprint Requirements

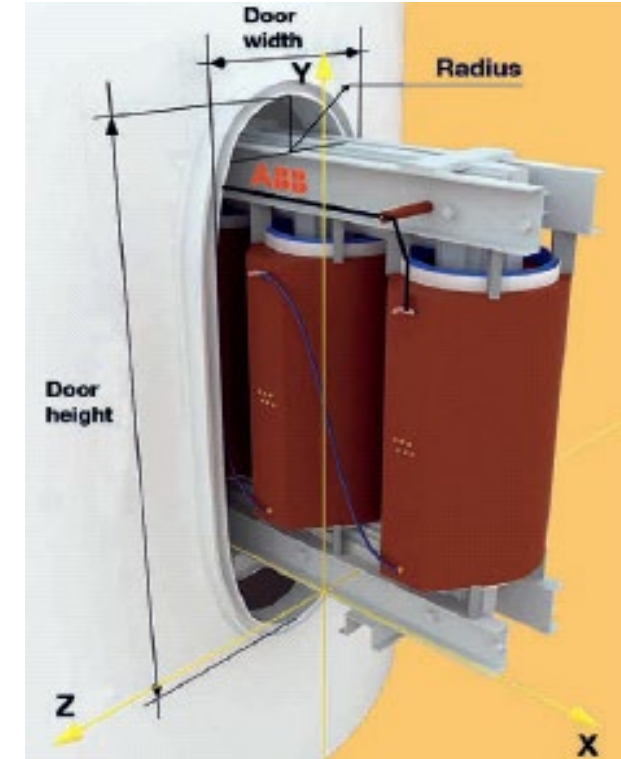
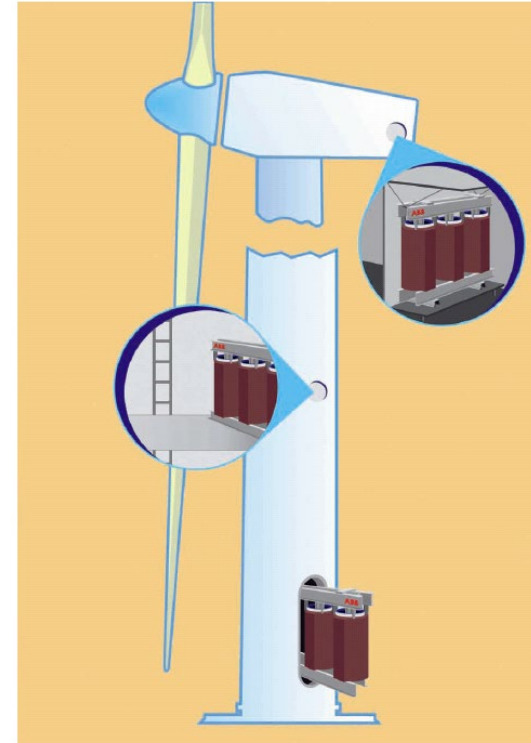
Due to the cooling and insulation methods of Dry-type transformers, meeting dimensional requirements has been one of the challenges.

Compactness and **small footprint** requirements are two of the main challenges of the segments where the demand of **higher power density** is increasing.

Control of Internal Substation Losses

Data centers' efficiency metrics is based on **power usage effectiveness** (PUE) and electrical losses have negative impact on PUE.

Similarly, transformer losses extracted into wind towers and solar containers are causing customers to invest on additional HVAC equipment to cool down the ambient.

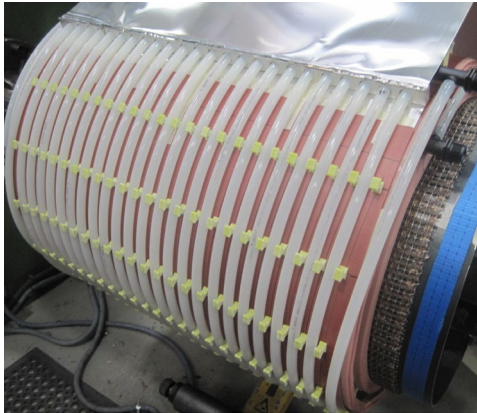


The solution: CompactCool

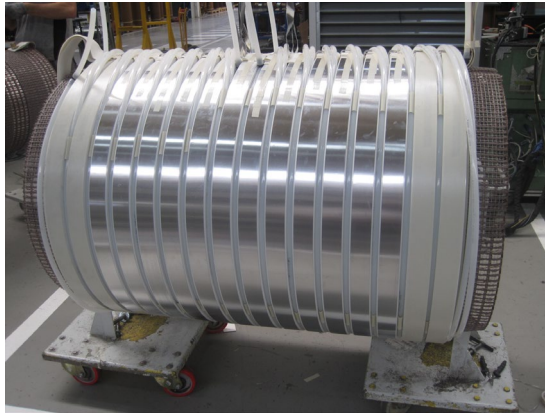
Introducing new cooling technology

CompactCool is the technology combining dry-type solid/air insulations with direct liquid cooling.

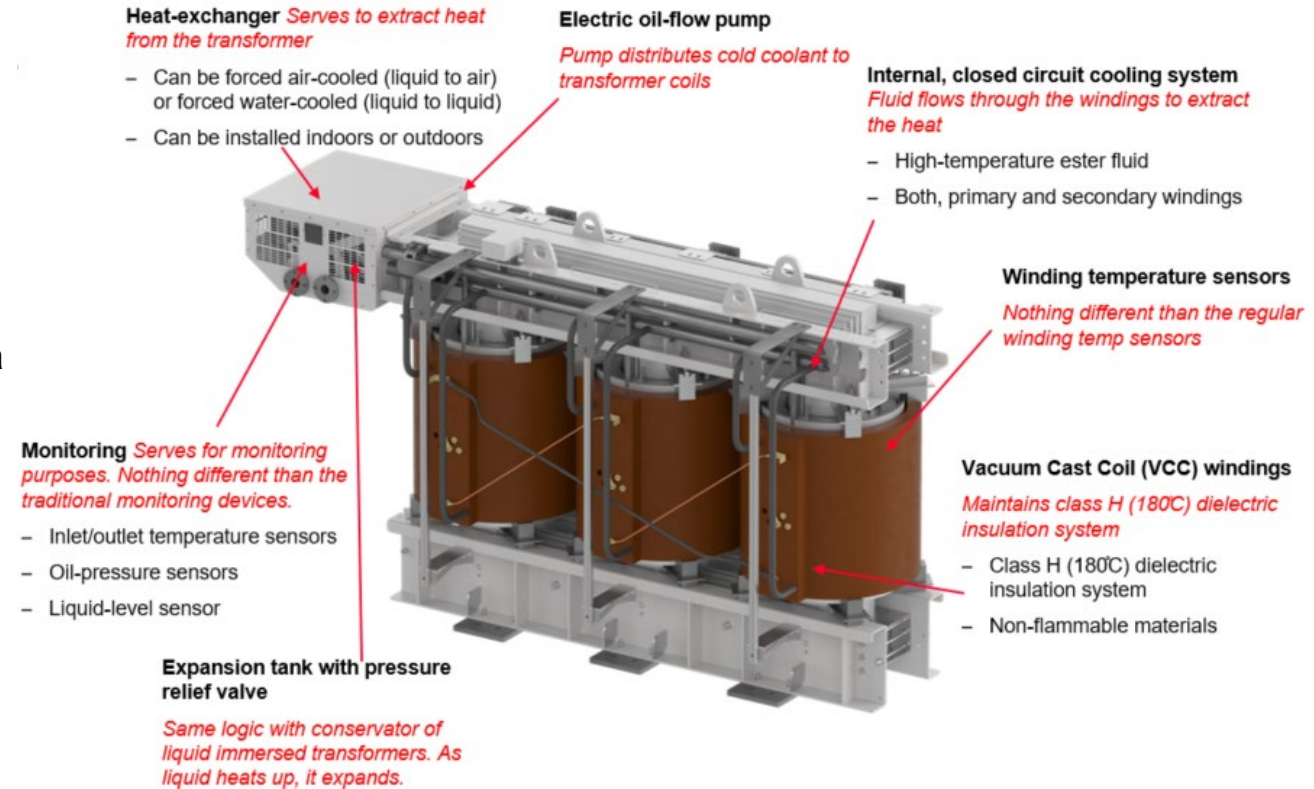
It forces a **fluid** to flow through the **windings** of the dry type transformer in order to **extract the heat** and transfer it to an **external heat-exchanger** that dissipates the losses; either to the ambient with a liquid-air heat-exchanger or to a fresh-water source through a liquid-liquid exchanger.



LV winding



HV winding



The solution: CompactCool

Footprint, Controlled Losses, Environmentally Friendly

– Weight and size benefits

- Conventional dry type technologies: Starting at 5 MVA and up (the larger the better) (~15-50%)
- More watts per box (ideal for containerized solutions)

– Environmentally friendly

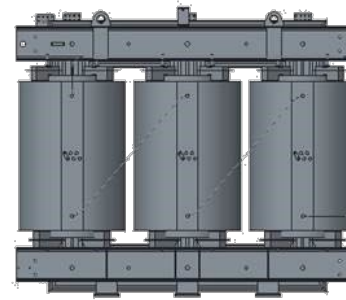
- 98% reduction of cooling liquid volume (compared to liquid immersed transformers)
- Ester fluid (non-hazardous waste), less losses and less material

– Less HVAC requirement on site

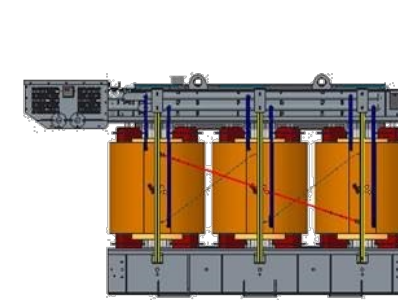
- External heat exchanger connected to customer's central cooling system: no need to install fans/air extractors on enclosures.
- Up to 90% of the losses can be captured at 100 % loading

– Conventional Dry-type transformer values are maintained.

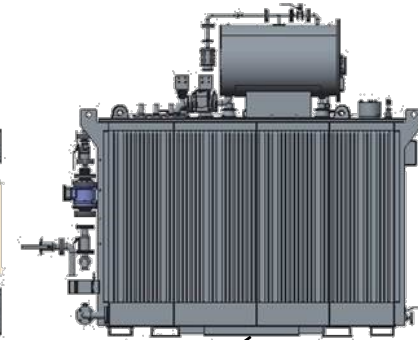
6.8 MVA Conventional Dry-type Transformer



6.8 MVA Dry-type Transformer with CompactCool Technology



6.8 MVA Conventional Mineral-Oil Transformer



Volume reduction: 32%
Weight reduction: 26%

Volume reduction: 30%
Weight reduction: 5%

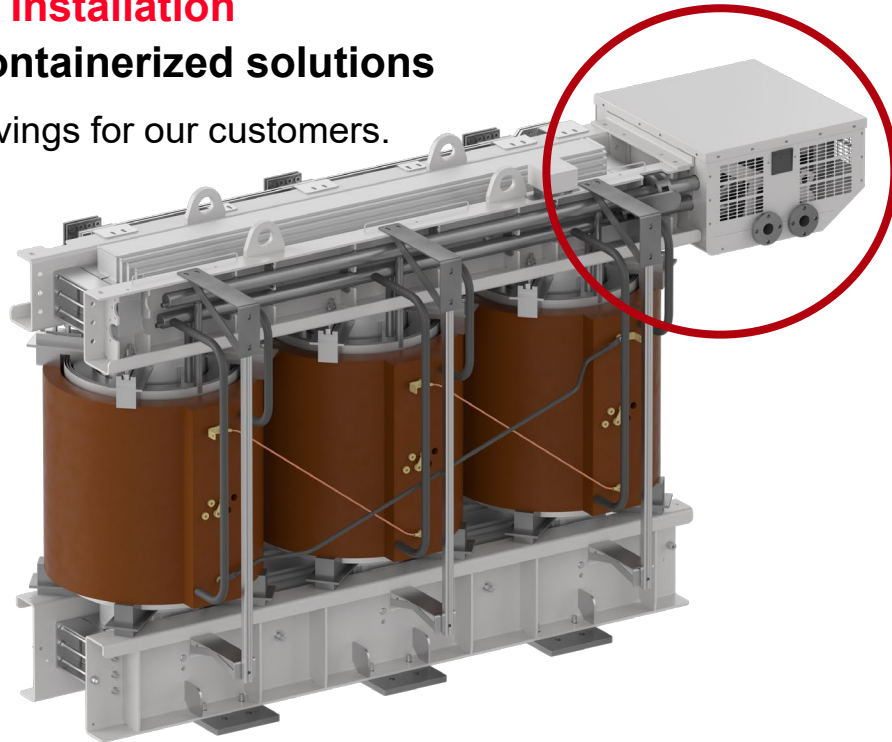
Scope

- Up to 30 MVA, 72kV
- VCC
- Cooling fluid: only Ester
- ≤ (2) LV windings

Data Center Installation

Ideal for: Containerized solutions

Brings cost savings for our customers.



Extraction of losses in a controlled way.

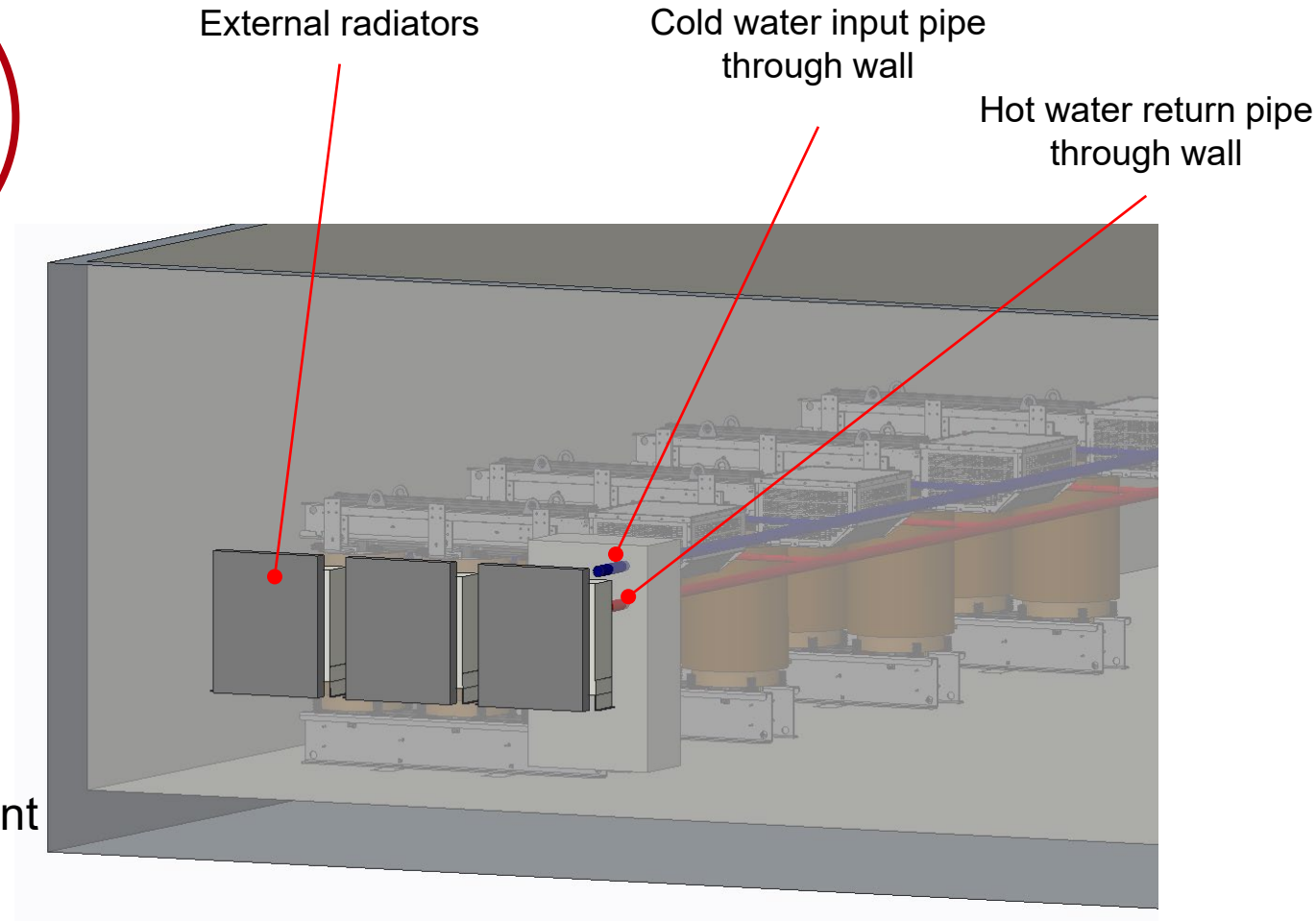
Up to 90% of the losses can be extracted when transformer is 100% loaded.

Reduced Costs

Possibility to use central cooling systems

Possibility to extract the losses to an outside ambient

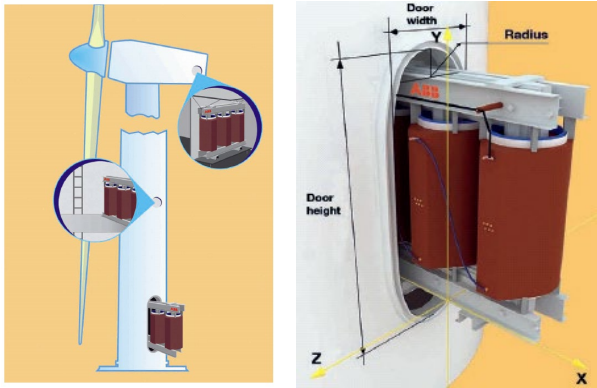
Less HVAC system installation for our customers



Wind Installation

Ideal for: Above 5 MVA

Heat Exchanger is installed externally to extract the losses outside of the turbine.



Reduced Costs

Possibility to use central cooling systems
Possibility to extract the losses to an outside ambient
Less HVAC system installation for our customers

Extraction of losses in a controlled way.

Up to 90% of the losses can be extracted when transformer is 100% loaded.

Wind Turbine
Tower

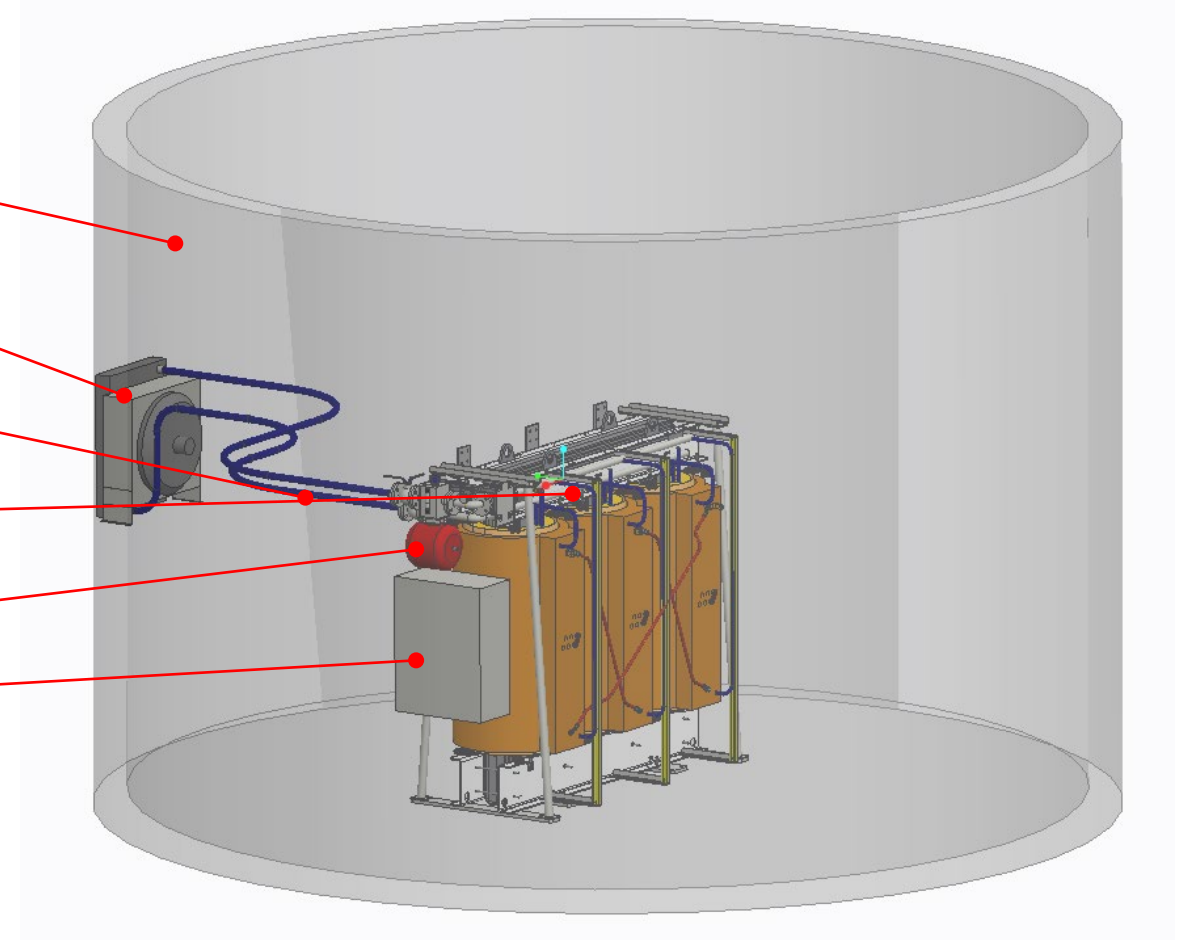
Liquid-AirHeat
Exchanger

Input & Return
pipes for ester fluid

Pump

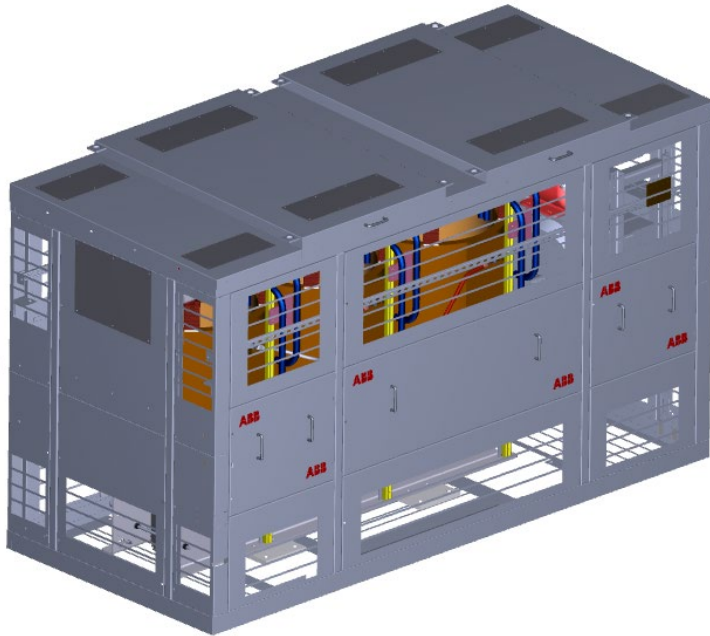
Expansion Tank

Control Cabinet



Solar Installation

Ideal for: When there is height limitation



Alternative 1:

- 3510 kVA Dry type transformer with CompactCool technology with reduced dimensions

Alternative 2:

- 5000 kVA Dry type transformer with CompactCool technology to fulfill same dimensional restrictions as base case

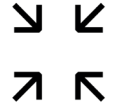
Alternative 3:

- 7000 kVA Dry type transformer with CompactCool technology to be installed in same enclosure (considering +200 mm height due to extractor elimination)

**More Watts
per
Box!**

Reduced Size

Up to 50% reduction depending on power rating; the larger the better



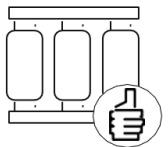
Weight & Size Reduction



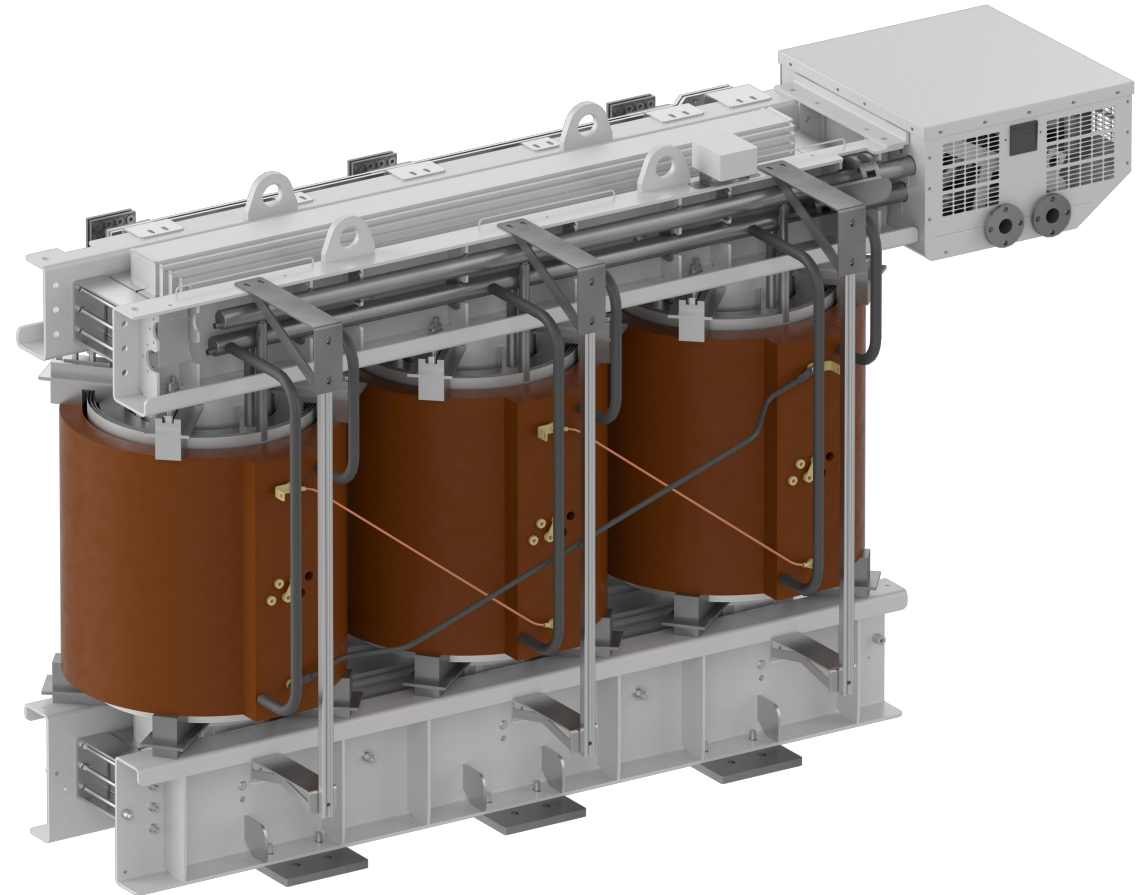
Less HVAC Investments for Customers



Environmentally Friendly



Conventional Dry-type transformer values are maintained



Liquid Immersed and Dry-type Transformers Values



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Digital Transformation & Data Modernization

Advising and supporting customers on their digital transformation journey, enabling better access to insights from data.



Intelligent Operations Management

Helping customers more efficiently and effectively operate and maintain their assets.



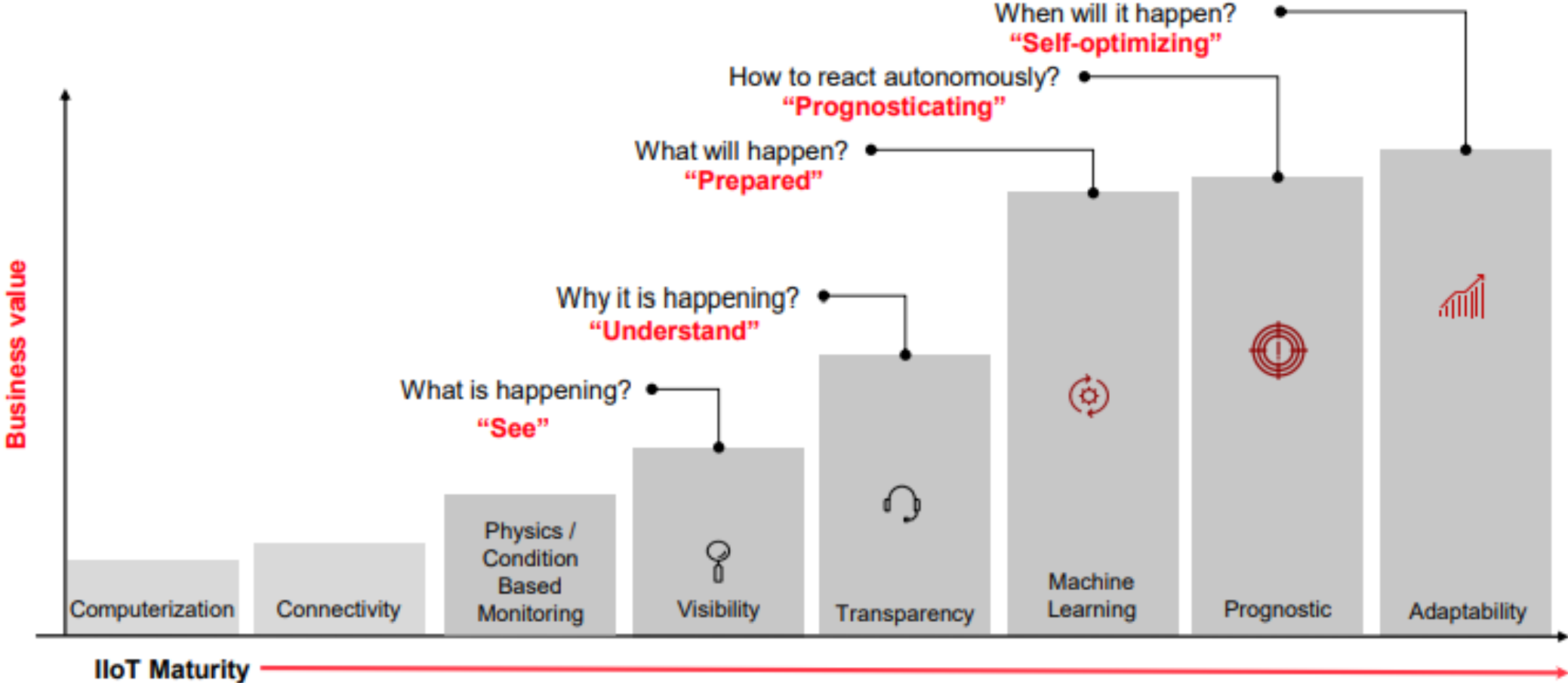
Health, Safety & Environment Solutions

Helping to ensure safe practices for workers and a safe environment for the public.

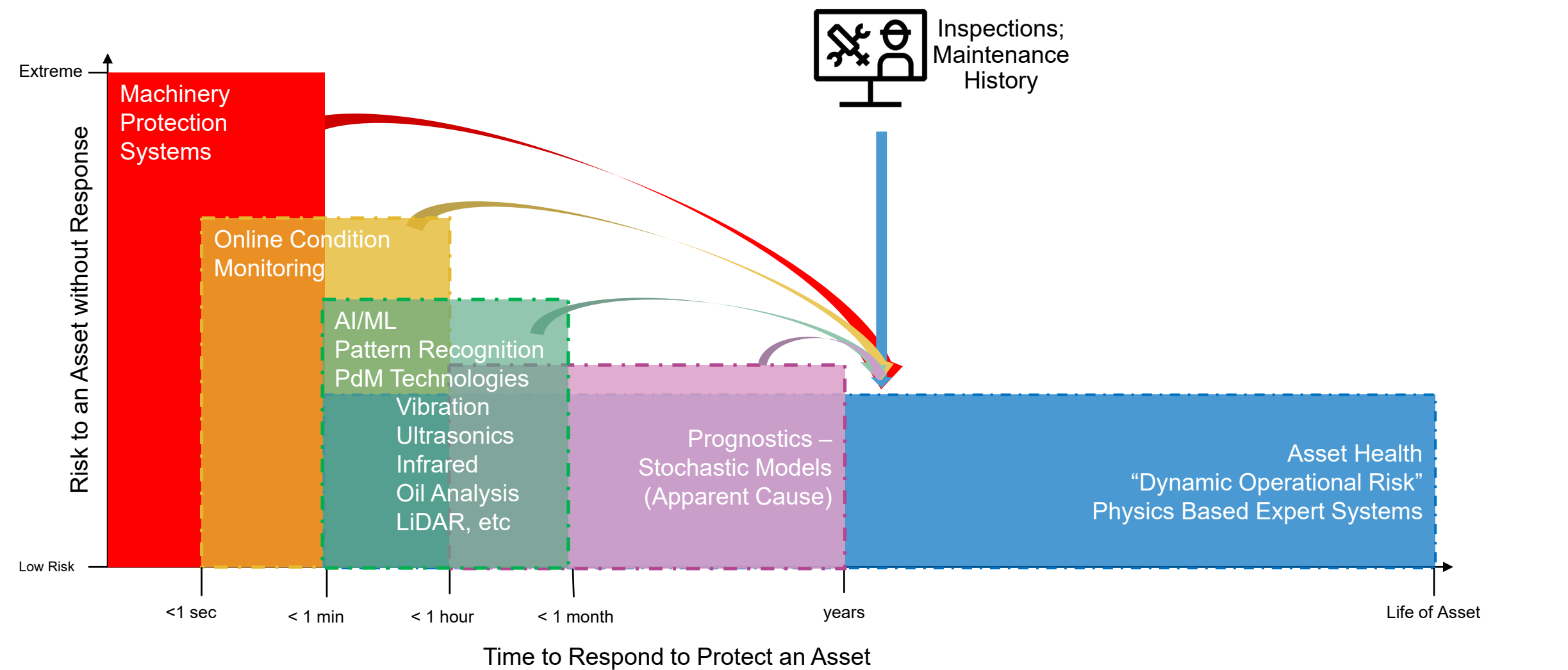


Connected Asset Performance

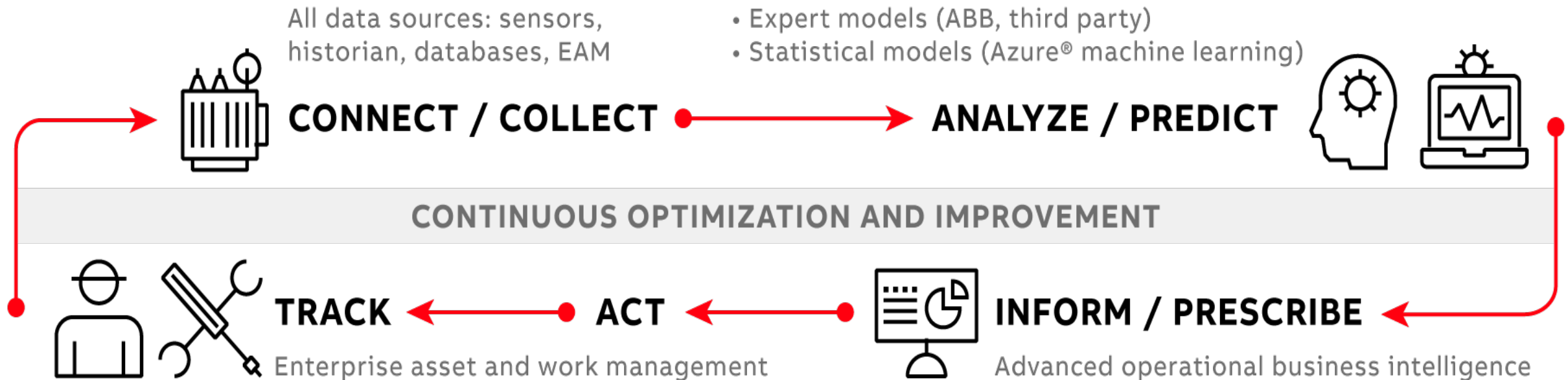
Helping customers predict and prevent failures, optimize maintenance strategy.

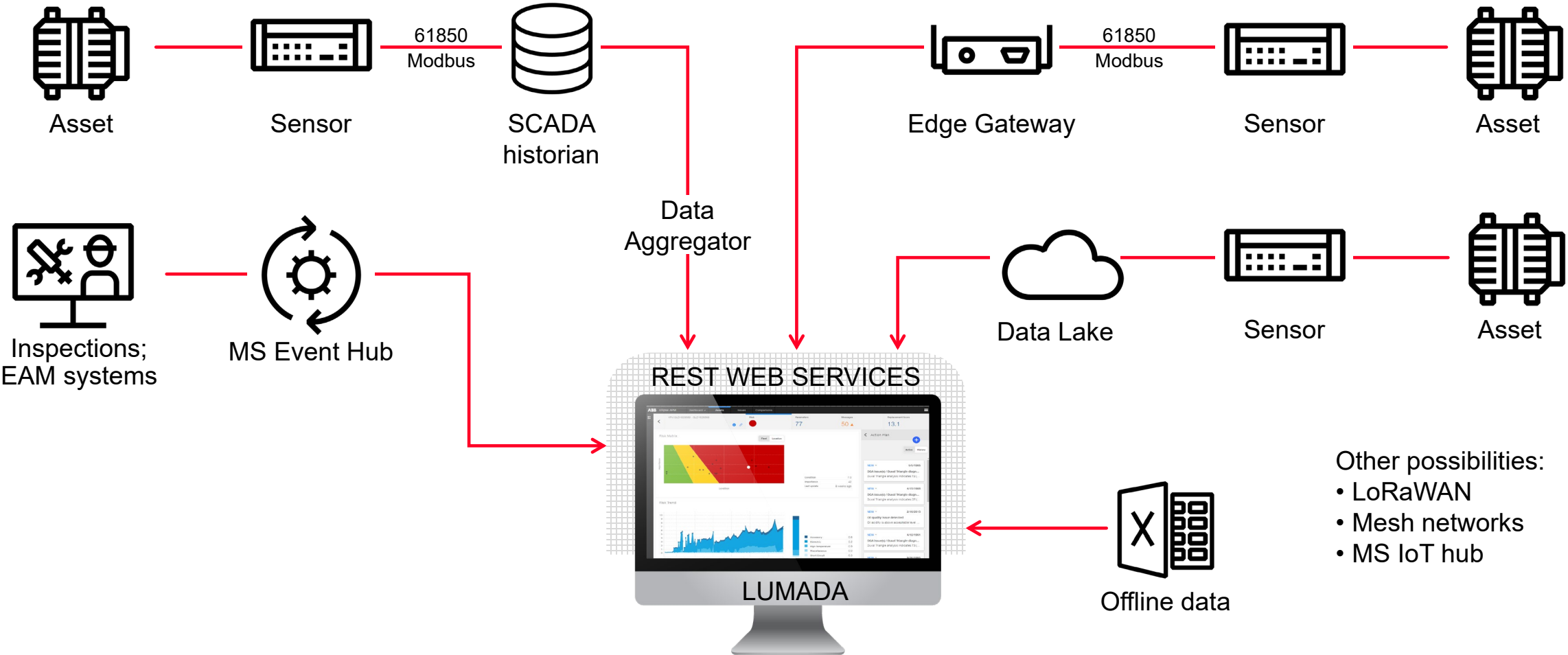


Risk to Asset without Response



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





- Other possibilities:
- LoRaWAN
 - Mesh networks
 - MS IoT hub



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

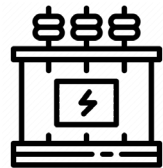
Stochastic process model (Markov), Stochastic inference model (Bayes)



Remaining Useful Life curve

For rotating equipment's like turbines, motors, pumps etc.

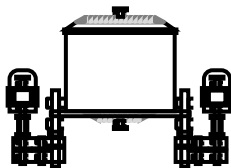
Critical Assets



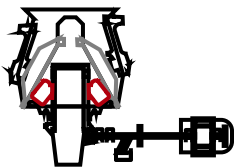
Transformers



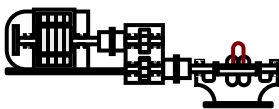
Circuit Breakers



SAG Mill/Cracker



Pressure Valves



Pump/Compressors



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

Conveyors, feeders
Cyclone pump
Tertiary crusher

Ball Mill
Diesel engine
Sag Mill

Heat Exchangers
Suction rolls
Compressors
Ventilator

The CVT allow creation, validation and management of prognostic performance models

English
Deutsch
Français
中文
Русский

Prognostic report

DEMO

WF
CMP
SSP
HPP
CCPP
CM
FFPP
NPP
RCP1
RCP2
RCP3
RCP4
TRS
SC
REF
RCP (NPP)
WT (WF)
Generate new report
Configuration log

ABB

Report no.: DEMO.DEMO.NPP.RCP4.20181004053550-00
Date: 05 Sep 19
Version: 2.14, Release: 0.2
Observations

Prognostic report

Provided by ABB Power Grids

Equipment specification

Operator name: Demo
Unit name: NPP
Unit location: Midwest, USA
Contact person: Ed Example
Phone: 123-456-7890
E-mail: ed.example@examplecorp.com
Component type: Reactor coolant pump
Component OEM & model: Areva 100D
Component group: RCP4
Serial number: RCP4
Elements monitored: Motor, impeller, shaft, coupling, bearings, seal
Alarm owner: Don Demo
Phone: 123-456-0987
E-mail: don.demo@examplecorp.com

View: Specification Location

Condition diagnostics

Select

Appendix

Vibration data
Thermal data (SC)
Lubricant data
Pressure data
Flow data
Electrical data

Vertical pump
High voltage motor
Coupling
Impeller

Malfunction prognostics

Select	Malfunction modes	Data sources	Oct18	Jan19	Apr19	Jul19	Oct19	Jan20	Apr20	Jul20	Oct20	Jan21	Jul21
<input checked="" type="checkbox"/>	M1.1 Rotor shaft instability	T4 V1 V2	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
<input checked="" type="checkbox"/>	M1.2 Shaft crack	E1 V1 V2 E3	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
<input checked="" type="checkbox"/>	M1.3 Shaft unbalance	T1 T2 T3 V1 V2	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
<input checked="" type="checkbox"/>	M1.4 Motor rub	V1 V2 T1 T2 E1	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
<input checked="" type="checkbox"/>	M1.5 Impeller looseness	P1 V1 V2	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
<input checked="" type="checkbox"/>	M1.6 Flywheel sliding/inertia	T4 T5 T6 V1 V2	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
<input checked="" type="checkbox"/>	M1.7 Bearing misalignment	T1 T2 T3 T4 V1 V2	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
<input checked="" type="checkbox"/>	M1.8 Bearing degradation	T1 T2 T3 T4 V1 V2	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
<input checked="" type="checkbox"/>	M1.9 Bearing insulation fault	T1 T2 T3 T4 E1 E4	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%
<input checked="" type="checkbox"/>	M1.10 Stator winding insulation fault	T4 T5 T6 V1 V2	1%	4%	7%	9%	10%	11%	12%	12%	12%	13%	13%
<input checked="" type="checkbox"/>	M1.11 Motor bearing oil leakage	T5 T6 T7 T8	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
<input checked="" type="checkbox"/>	M1.12 Degradation of oil quality	T1 T2 T3 T4 T5	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
<input checked="" type="checkbox"/>	Total risk		1%	4%	7%	9%	10%	11%	12%	12%	12%	13%	13%

Next maintenance: 30 Sep19 (proposed) Schedule
Prognostic horizon: Short (12 days) Long (12 weeks) Maximum (12 quarters)
View: Percentages
History start: 01 Jan06 Reference date: 04 Oct18 History end: 07 Nov18
Vary load and data history (Europe/Berlin)

Parameter type specification

Number	Parameter type index & description	Measure unit	Value limits	Value intervals
P1.1	HIT_BGP_GEJ_OPS Operational hours	Hour	120000 117000 115000 -50	[120000, +∞) [117000, 120... [115000, 117... [-50, 115000]
P1.2	HIT_BGP_GEJ_CTA Cylinder temperature average	°C	650 600 570 -50	[650, +∞) [600, 650] [570, 600] [-50, 570]
P1.3	HIT_BGP_GEJ_GMP Gas mixer position	%	40 30 25 -5	[40, +∞) [30, 40] [25, 30] [-5, 25]
P1.4	HIT_BGP_GEJ_VEX Voltage excitation	V	37 35 30 0.1	[37, +∞) [35, 37] [30, 35] [0.1, 30]
P1.5	HIT_BGP_GEJ_CW Cooling water pressure			

Malfunction modes (Scenarios)

M1.13. Hitachi health index	M1.1. Insufficient gas quality	M1.2. Gas mixer defect	M1.3. Fail-safe gas loop defect	M1.4. Ignition system defect	M1.5. Engine knocking
0.10%	0.07%	0.09%	0.04%	0.10%	0.07%
P(M) = Likelihood of observing a malfunction based on indications in step 6					
P(Ci M) = Likelihood of reaching an alarm level given malfunction (scenario)					
10	10	10	5	10	20
10	10	10	5	10	50
10	10	10	5	10	20
10	10	10	5	10	20
70	100	70	85	70	90

Examples & illustrations

Shaft unbalance cannot be detected by 0.5X shaft vibration

Shaft unbalance can always be detected by 0.5X shaft vibration

Shaft unbalance can always be detected by increasing 2X vibration

Bearing looseness can often be detected by increasing 2X vibration

Bearing looseness will show a clear 0.5X amplitude signature

Oil additive depletion may be detected, but is not serious issue

Rotor rub has a high impact on 1X vibration, leading to shaft rub

Fortunately, we have a mechanical protection against rotor rub

A locked turbine blade will lead to rapid shutdown

A broken turbine blade will lead to immediate shutdown

Provision for zero assessment, please double check

Short cycle / Not close / wrong position / Fly a gun

Cracked blade

Broken blade

Anything

Dislike

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The background of the entire image is a photograph of a landscape. In the foreground, there is a field of low-lying green bushes. Behind this, a rolling green field stretches towards a line of trees in the distance. Several wind turbines are visible against a bright, slightly cloudy sky. One turbine is prominent on the left, and a cluster of three is in the center. A fourth turbine is on the right. The overall scene is bright and green, suggesting a clean, natural environment.

HITACHI **ABB**

HITACHI ABB POWER GRIDS

From this October, we are evolving to become **Hitachi Energy!**

Together, with customers and partners, we are excited to be accelerating the transition towards a **carbon-neutral energy future.**



Thank you!

HITACHI

