Sustainable Operations in Captive Power Plant

Combining Automation & Digitalization is key

CII Conference on energy efficiency

ABB

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25 years of experience in Industrial Automation and Product Development.

Working closely with customers in implementing digital transformation. Leading Sustainability and Enterprise Digital solutions for IMEA (India, Middle East and Africa) region.

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Today's Topic

01.

About ABB

02.

Optimize and improve what exist - Now

03.

Energy transition - Priority

04.

Decarbonization – Looking ahead in future

05.

Case Studies

1

About ABB

Well positioned across global markets

Employees
~105,000

Countries
~100

Revenues
~$26 bn

Europe
~$9.6 bn

Americas
~$7.9 bn

AMEA
~$8.4 bn

2020 figures

ABB is a leading global technology company that energizes the transformation of society and industry to achieve a more productive, sustainable future.

By connecting software to its **electrification**, **motion**, **process automation and robotics & discrete automation** portfolio, ABB pushes the boundaries of technology to drive performance to new levels.

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2

Optimize & Improve what exist - Now

Customer Challenges

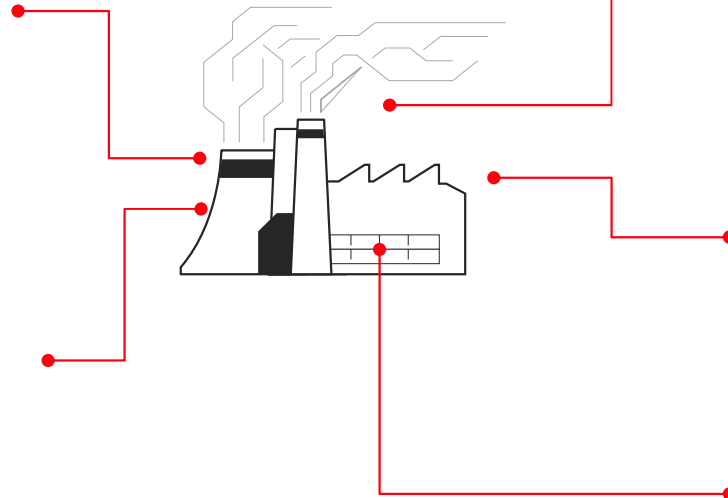Optimizing operations and maintenance with fewer resources and expertise

Higher generation cost

- Fuel price volatility
- Regulatory compliance & use of renewable
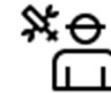- Process is priority

Sub-optimal control performance

- Major control loops running in MAN mode
- Large variations in critical process parameters
- Critical equipment exposed to thermal excursions

Quality of fuel

- Frequent changes in fuel energy value
- Controlling emission - NOx, SOx & CO

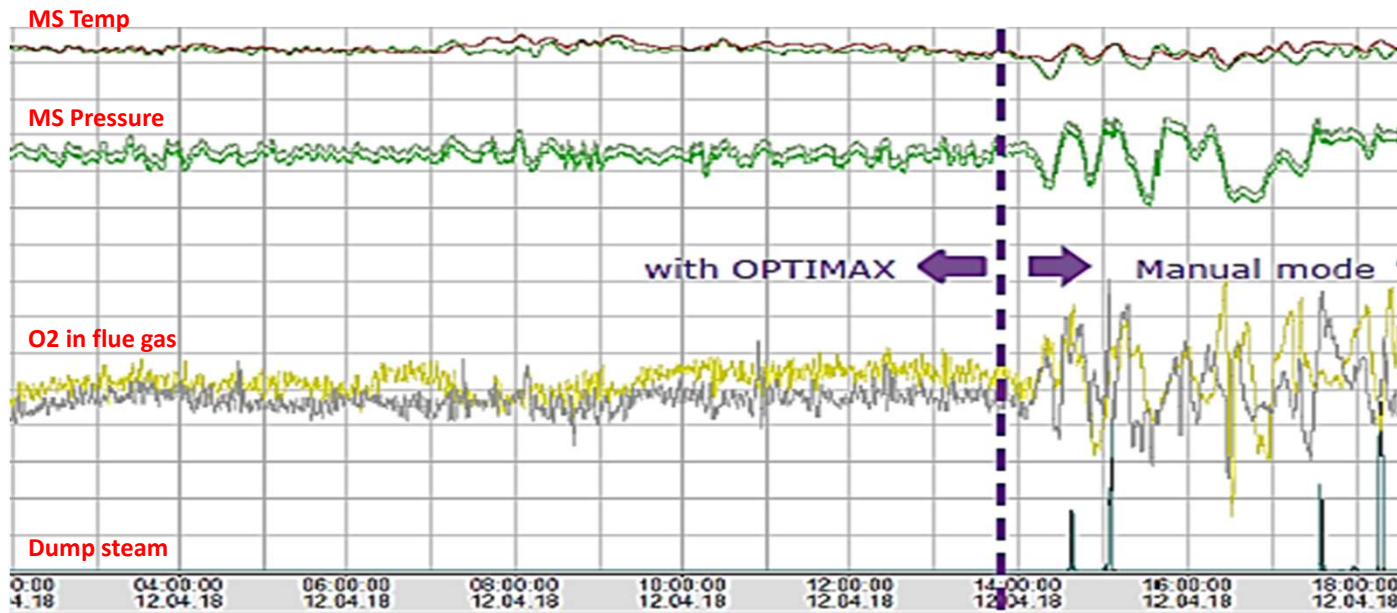**Manage demand variations**

- Load rejections in process
- Off-grid operations

Monitoring & Reporting

- Performance monitoring
- Performance reporting

OPTIMAX® Advance Process Control

MS Temp

MS Pressure

with OPTIMAX ← → Manual mode

O2 in flue gas

Dump steam

| 0:00 | 04:00:00 | 06:00:00 | 08:00:00 | 10:00:00 | 12:00:00 | 14:00:00 | 16:00:00 | 18:00:00 |

Reduce control variability, improve operation stability

Proven Track Record

Boiler type agnostic
- CFBC / AFBC
- Hot Cyclone/Cold Cyclone

Make agnostic
- Thermax / ThyssenKrupp / BHEL
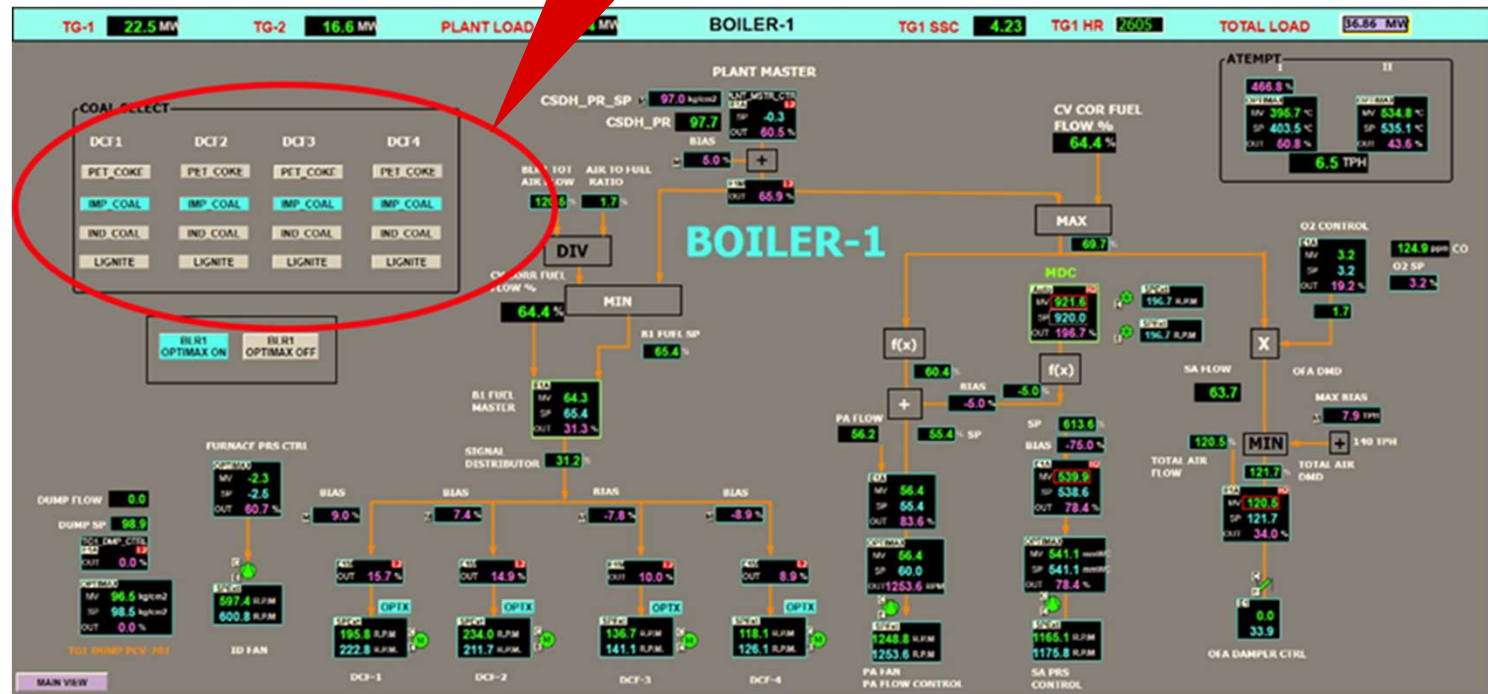- Chinese Make

Control system agnostic
- Siemens/Yokogawa/BHEL/…

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Operation View

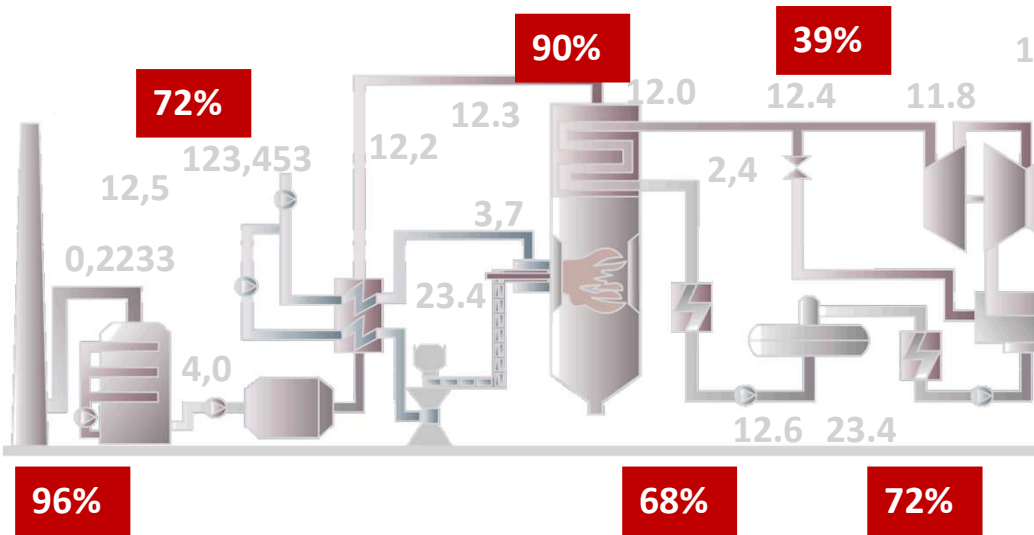Seamless environment for operators

Operation view

- Typical GCV ranges from 2000 kraal to 6500 kraal.

- Variable fuel types - plant uses 4 different types of fuels like Indian Coal, Indonesian Coal, Pet Coke, etc.

Operator selection of fuel types

Performance View
Insights at operator level

3

Energy transition - Priority

Challenges

Facing energy facilities

Minimizing unplanned downtime and blackouts: Plants needs a reliable energy supply and the ability to quickly act and restore power to minimize performance losses.

Enhancing safety: Blackouts and unreliable electricity increase safety risks. With improved power supply reliability, plants can limit exposure to unsafe situations and help keep their people and plant safe.

Margin Pressures: Increasing operational costs coupled with profitability challenges are forcing producers to become more energy efficient. Reliable energy supply is key to efficiency.
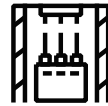
Managing multiple power sources: New energy assets within the plant or enterprise present increased management complexities and risks. Better process power management helps mitigate these risks.

Aging assets: Plants need to optimize the life of equipment with better asset utilization. This includes identifying which assets are more likely to interrupt stable energy supply.

ABB Ability™ Process Power Manager

A comprehensive solution for power management and control of electrical infrastructure

Integration…

with ABB System 800xA process and electrical control systems

Power balancing…

and predictive planning to avoid disturbances or blackouts

Increases uptime

Minimizes downtime…

Process power manager

Information servers — Systems 800xA — Dashboard

Instruments and flowmeters | Generator protection relay | Governor controller | Motor controllers | Governor controller | Controller | Controller | Generator protection relay | Generator protection relay | Automatic voltage regulator

Gas, steam, hydro-turbines, HRSG, diesel engines, wind, batteries and auxiliaries | Motors | Motors | Motors | Switchgear | Transformer | Generator

Engines | MV/LV drives motor starters | Protection and control IEDs

Process automation & engine | Electrical system

Dynamic network determination

200 load-shed priorities

Load shedding…

and recovery

Dynamic tripping…

of loads, which can be preconfigured or manually configured to a set of priorities

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Three challenges to energy management for industrial and commercial enterprises

Lack of visibility

Without visibility into operations, it's impossible to plan, predict, and comply with government green mandates that require control and reporting functions.

High energy costs

Inefficiencies in single or multi-site operations waste money and undercut the goal of sustainable practices.

Failure to maximize earnings

Not being able to participate in competitive wholesale energy markets means that selling excess energy at the most favorable rates is difficult.

OPTIMAX® for Industrials and Commercials

Value Proposition

1. Create Visibility
2. Automate Control
3. Optimize Operation

Benefit

- Save energy cost and site emissions
- Save time on reporting and documentation
- Increase revenues by participating in energy markets

For

- Sinlge sites
- Multiple sites

Remote services

- ABB collaborative support
- EaaS User Interface
- Enterprise level User interface
- Site User interface

ABB Ability Energy Management for Sites
OPTIMAX

| Forecasting | Optimization | Aggregation & trading |
| Monitoring and reporting | Data collection | Data analytics |

- Aggregator
- Energy markets
- Weather data
- Site planning

Site X – OPTIMAX Edge Gateway

Site 1 – OPTIMAX Edge Gateway[1]

On-site solution

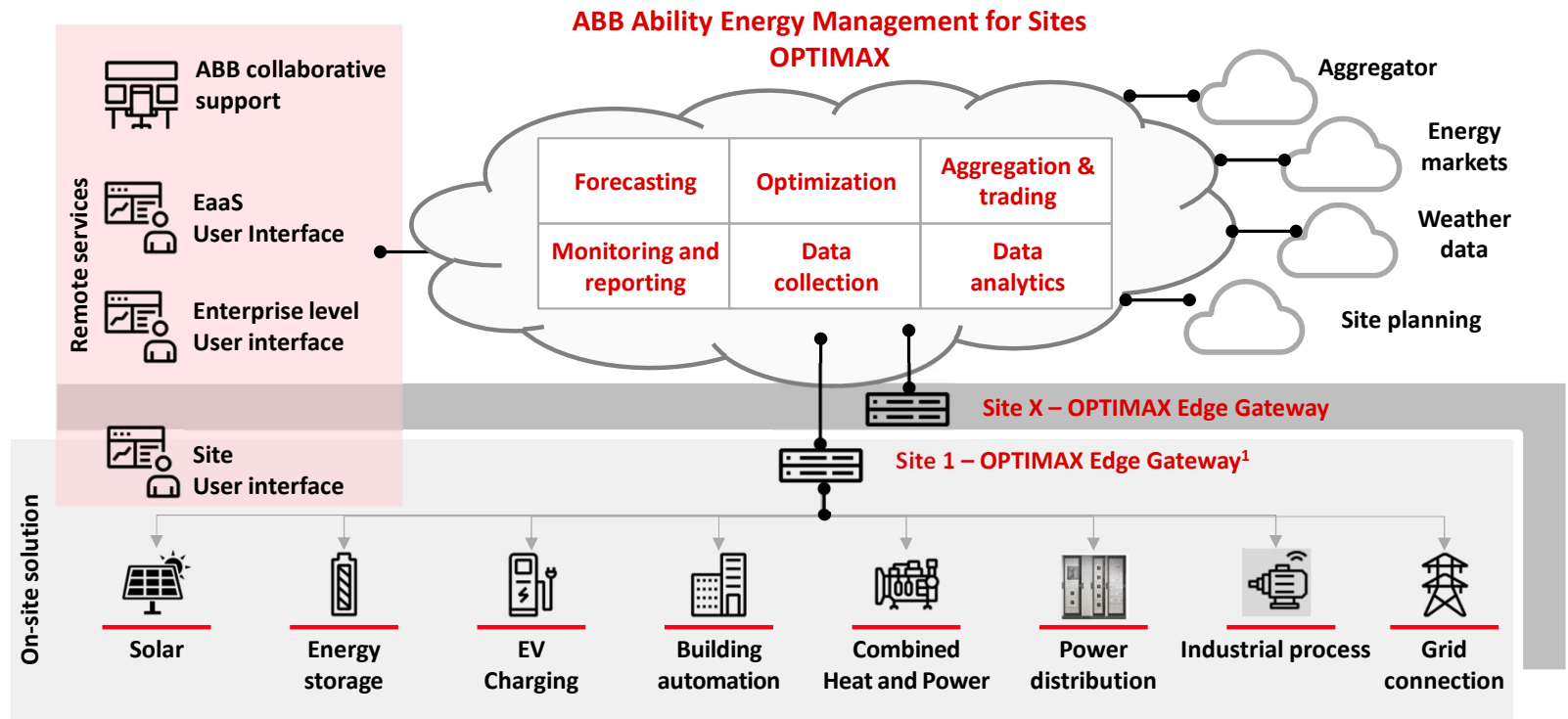| Solar | Energy storage | EV Charging | Building automation | Combined Heat and Power | Power distribution | Industrial process | Grid connection |

ABB Ability Energy Management with OPTIMAX®

OPTIMAX for Industrials & Commercials

Our solution **Option** **Option** **Option**

Monitoring & Reporting

- Enhanced user experience and visibility of your energy usage on-site
- PDF reports
- Excel export

Real Time Operation

- Real-time control and optimization
- Coordinated control at site level

Intra-Day- / Day-Ahead-Opt

- Intra-Day and Day-Ahead Optimization
- Optimal schedules based on forecasts, loads and prices + updated during day
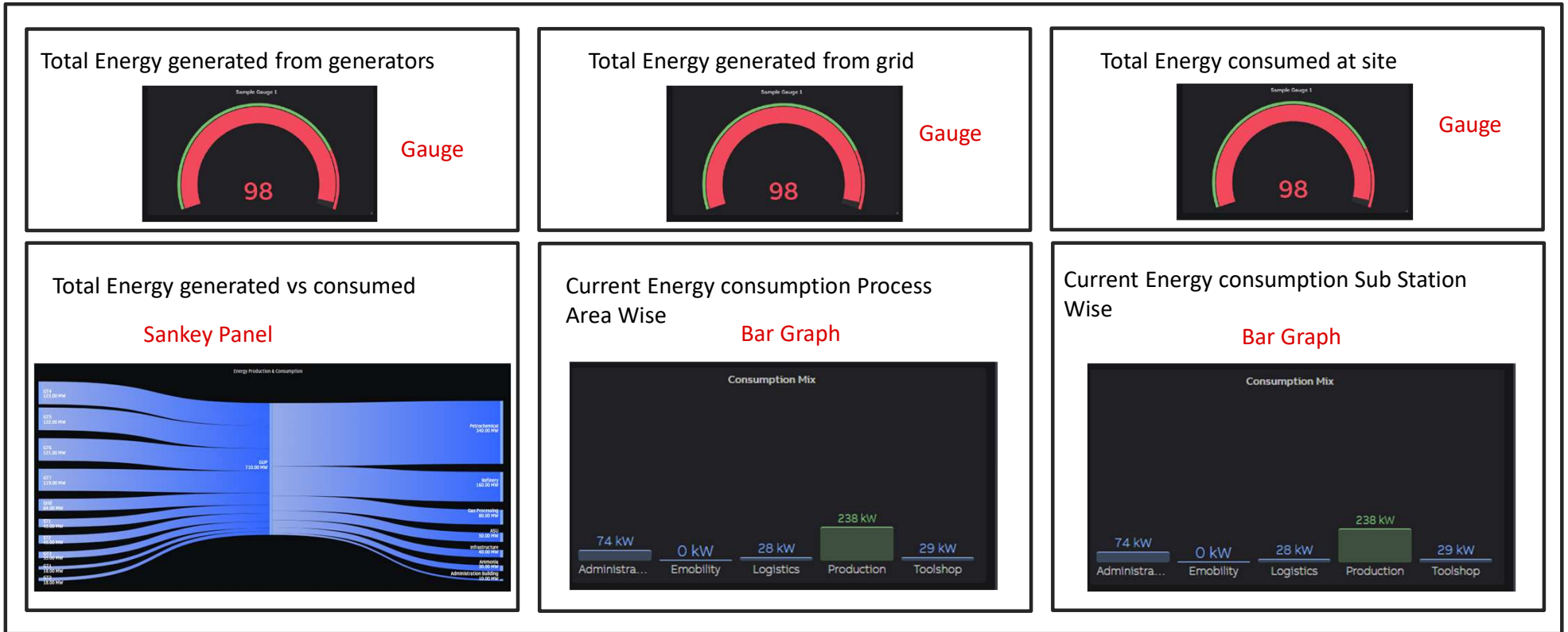
Forecasting & Simulation

- ML Forecasting
- AI Enhanced Forecasting
- Digital Twin
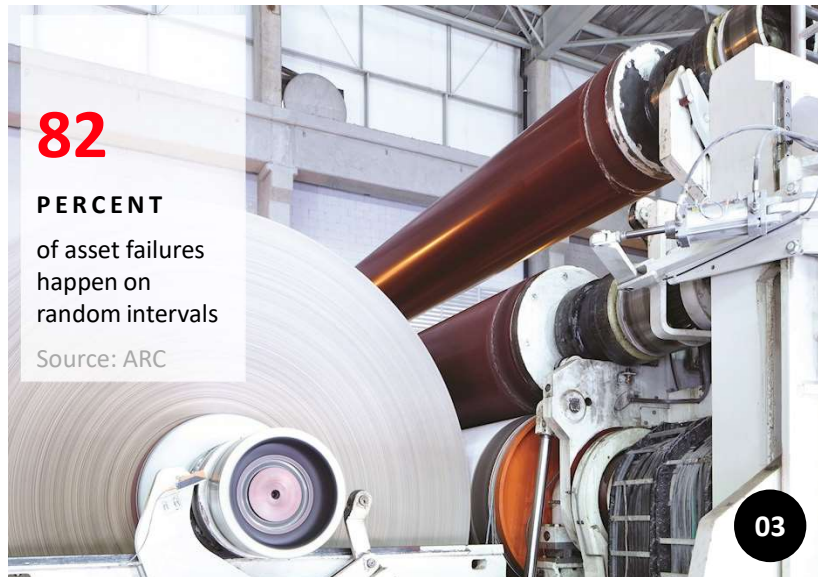- Steam and power

Multi-Site Operation

- Benchmarking sites
- Enterprise wide energy optimization

Continuous Energy Improvement

Total Energy generated from generators

Gauge

98

Total Energy generated from grid

Gauge

98

Total Energy consumed at site

Gauge

98

Total Energy generated vs consumed

Sankey Panel

Current Energy consumption Process Area Wise

Bar Graph

Consumption Mix

74 kW	0 kW	28 kW	238 kW	29 kW
Administra...	Emobility	Logistics	Production	Toolshop

Current Energy consumption Sub Station Wise

Bar Graph

Consumption Mix

74 kW	0 kW	28 kW	238 kW	29 kW
Administra...	Emobility	Logistics	Production	Toolshop

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Sustainable asset management

01. Energy efficiency

02. Reduced environmental footprint

03. Extension of asset life

04. Reduced CO2 emissions

05. Reduced impact of potential risks

40

PERCENT

"The use of condition-based maintenance provides savings of up to 40% over reactive maintenance and 12% over preventive maintenance, extending the life of the assets."

Source: US DOE

04

02

18

PERCENT

Of assets have age related degradation patterns

Source: ARC

01

82

PERCENT

of asset failures happen on random intervals

Source: ARC

03

05

NEXT GENERATION AI-BASED ASSET PERFORMANCE MANAGEMENT

ABB Ability™ Genix APM

Adding Condition Monitoring on the Edge into existing OT landscape becomes easier

Testing, training and deploying advanced predictive & prescriptive models becomes collaborative

A holistic view of asset performance, health, maintenance schedules, lifecycle cost becomes possible

Software support tool makes asset life assessment studies more accurate
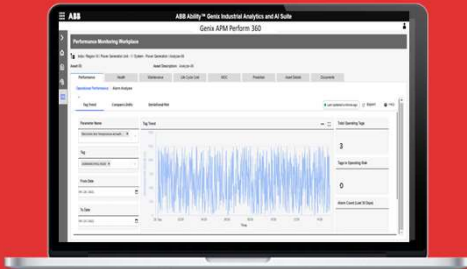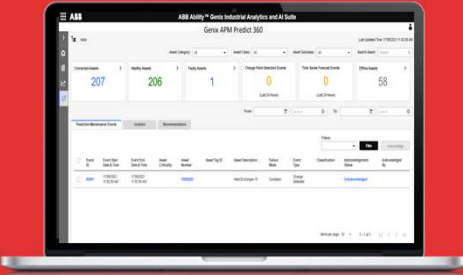
Start prioritizing maintenance activities based on data

Capture & codify the knowledge of experts to increase outcomes

Connect APM, work, operations management to realize more value

Find opportunities for optimum investment planning

PREDICT	PREDICT 360	PERFORM 360	ASSESS 360

PREDICT
- ✓ OT data / sensors
- ✓ Pre-built asset models to monitor known failure modes
- ✓ Maintenance workplace with detailed real-time information

PREDICT 360
- ✓ OT/IT/ET contextualized data + derived or predicted parameters
- ✓ Self-service fault modeling throughout asset life cycle, rule-based and AI/ML
- ✓ Library of configurable asset models with pre-built dominant failure modes
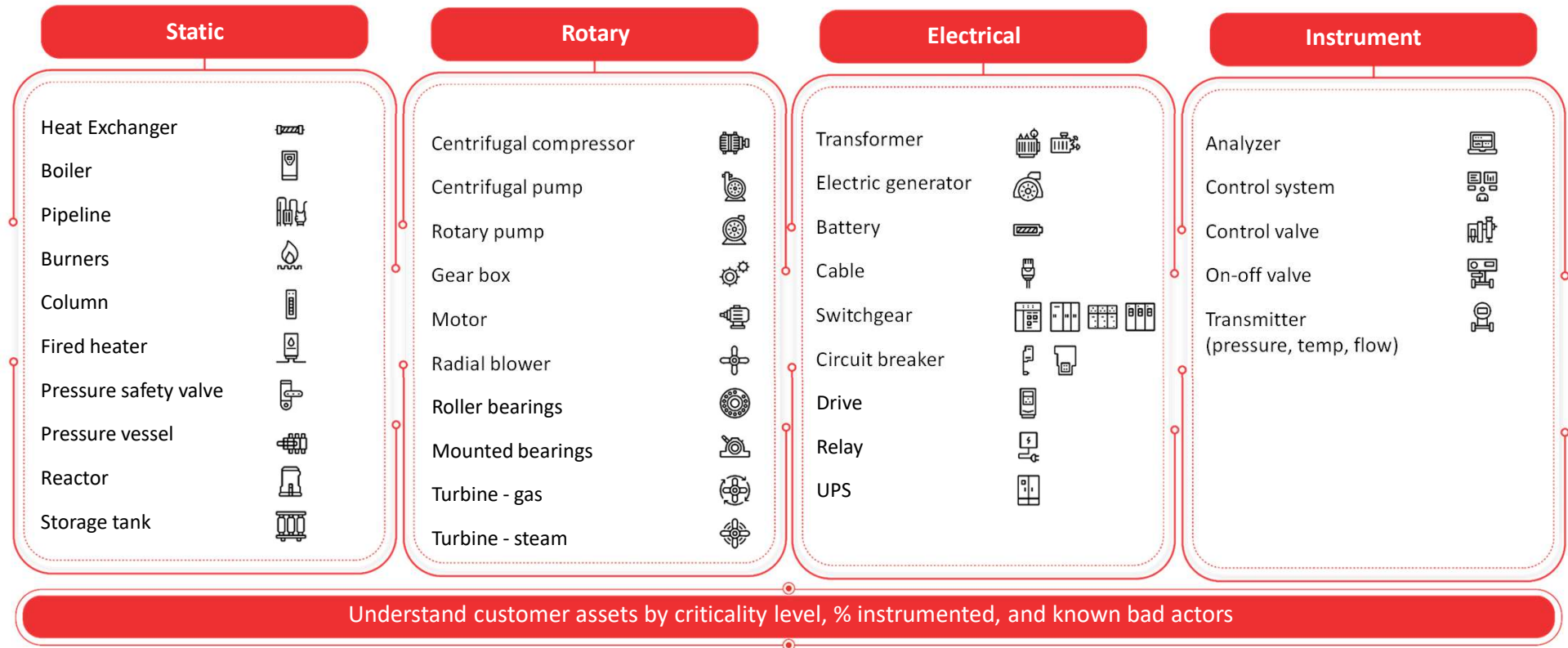- ✓ Events management, fault monitoring tools with recommendations

PERFORM 360
- ✓ OT/IT/ET contextualized data + derived or predicted parameters
- ✓ Parametrized asset templates 40+ pre-built performance models
- ✓ 360° view on Performance, Health, Maintenance, Life Cycle Cost, etc. to reveal correlations, change practices

ASSESS 360
- ✓ Pre-defined damage mechanisms, associated failure scenarios
- ✓ CAPEX profiling, manual data capture for integrity tracking
- ✓ Design history, operational & maintenance history

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Unified and Comprehensive APM Solution

Key industrial assets to start with

Static	Rotary	Electrical	Instrument
Heat Exchanger	Centrifugal compressor	Transformer	Analyzer
Boiler	Centrifugal pump	Electric generator	Control system
Pipeline	Rotary pump	Battery	Control valve
Burners	Gear box	Cable	On-off valve
Column	Motor	Switchgear	Transmitter (pressure, temp, flow)
Fired heater	Radial blower	Circuit breaker	
Pressure safety valve	Roller bearings	Drive	
Pressure vessel	Mounted bearings	Relay	
Reactor	Turbine - gas	UPS	
Storage tank	Turbine - steam		

Understand customer assets by criticality level, % instrumented, and known bad actors

ABB Ability™ Genix APM. Reveal the previously invisible

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Decarbonization – looking ahead in future

ABB OPTIMAX® Balance of Operations

Carbon Capture and Storage (CCS) Digital Twin: Features

- **End-to-end CCS solution:** The collaboration between our partner Pace CCS and ABB ensures safety, reliability, and efficiency from the emitters to the reservoirs and the full system lifecycle

- **Leading-Edge modelling of CO2 processes and impurities:** Combined expertise in complex thermodynamic fluid systems, including compositional tracking, enhancing our product's capabilities

- **Training, Simulation, and Scenario Analysis:** Facilitates understanding and application through exploratory scenarios and offline simulations.

- **AI-Enhanced Monitoring & Optimization:** Hybrid integration of AI and physical process optimization, enabling autonomous operations, enhanced by advanced monitoring and reporting. Our solution places a special focus on real-time (e.g. APC) as well as predictive optimization for
  - Efficient Compressor Control
  - Smart Heating and Cooling
  - Optimal injection into reservoirs or aquifers
  - Integrity supervision / management
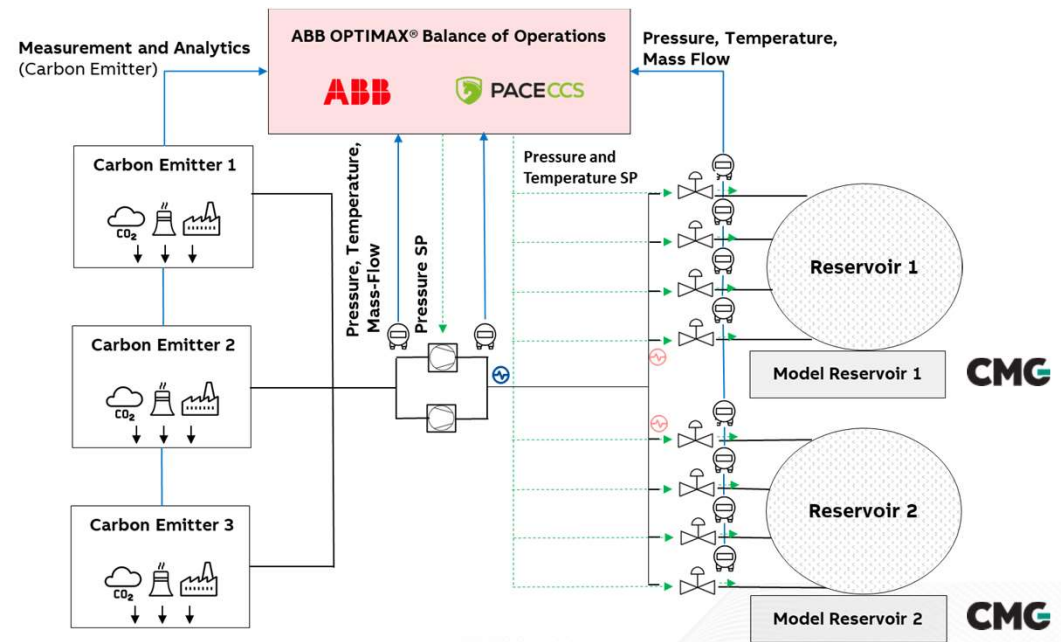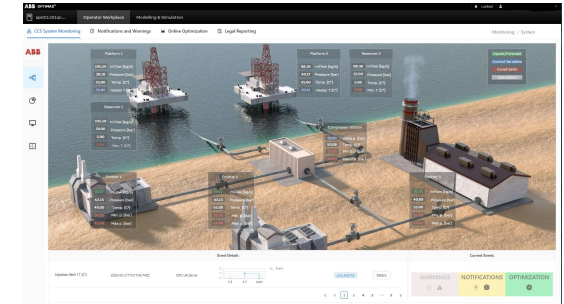
Maximize Availability and Efficiency

5

Case Studies

Case Study 1 – CFBC Boiler

2x25MW Thermal Power Plant
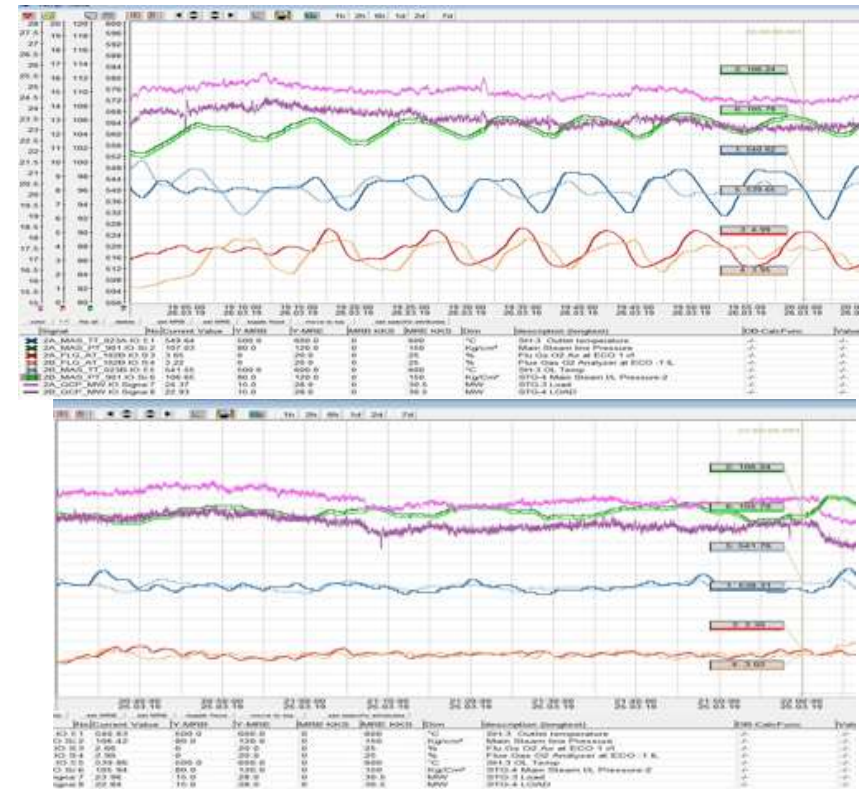
Customer requirements
- Ensure stable plant operations under continuous variation in load demand from cement plant
- Stable & reliable operations of thermal power plant in islanding mode
- Improve plant performance and process control

ABB solution
- APC using MPC, adaptive gain etc.
- Online monitoring of performance deviation & controllable losses

Customer benefits
- Improvement in unit heat rate 36 kCal
- Improvement in boiler efficiency up to 0.4%
- Increased life of critical equipment like boiler & turbine
- Reduced dump steam by > 90%
- Reduced emission with SOx reduction by 15% and CO reduction by 30%

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Case Study 3 – AFBC Boiler

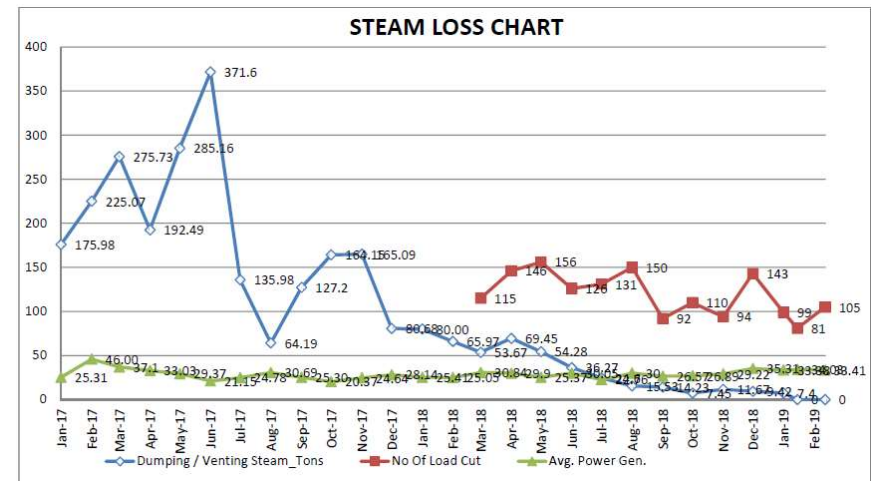## 1x40/20/6MW Thermal Power Plant

Customer requirements
- Ensure stable plant operations under continuous variation in load demand from cement plant
- Stable & reliable operations of thermal power plant in islanding mode
- Improve plant performance and process control

ABB solution
- APC using MPC, adaptive gain etc.
- Online monitoring of performance deviation & controllable losses

Customer benefits
- Reduce control variability by 2.x
- Improvement in combustion control ⬆
- Increased life of critical equipment like boiler & turbine ⬆
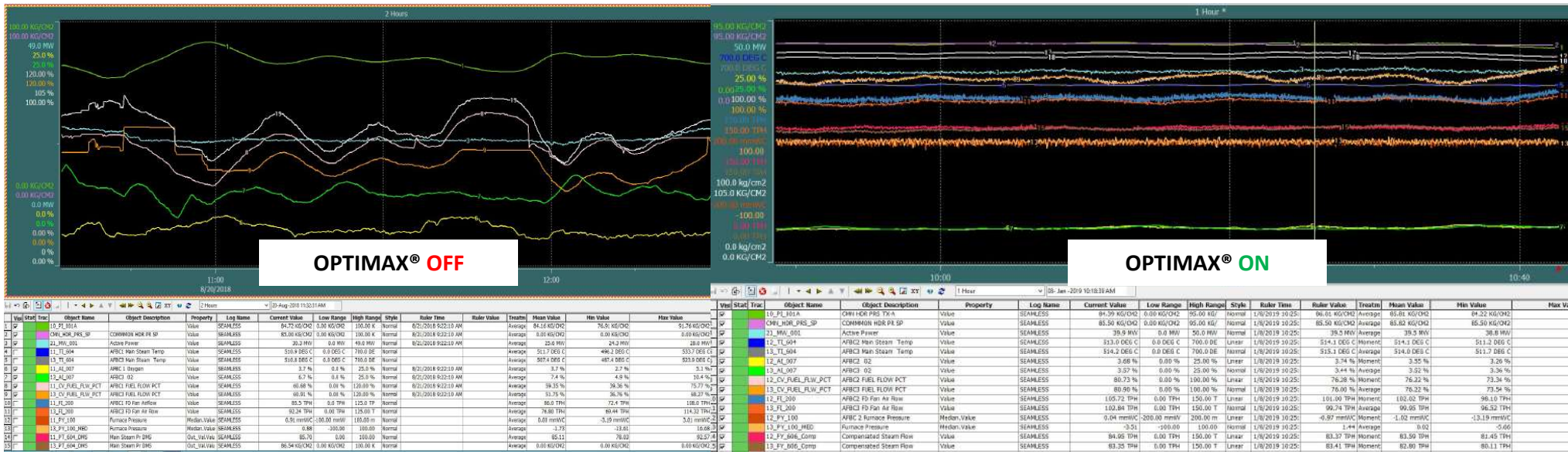- 100% Reduced dump steam ⬆

STEAM LOSS CHART

- Unit heat rate
- Boiler efficiency
- Life extension
- Cost of generation
- Emission

Case Study 4 – AFBC Boiler

1x40/20/6MW Thermal Power Plant

OPTIMAX® OFF

OPTIMAX® ON

Reduce control variability, improve operation stability without operator intervention

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What customers say about ABB Solution

E&I Head:

– *"Without OPTIMAX® solution, I don't think we could have operated the plant in the given conditions. We regained the confidence to operate without failures"*

Operation Head:

– *"ABB solution has taken away work stress inside the control room. I am able to send operators to supervise field jobs as well"*

Plant Head:

– *"The solution works like a magic. It has significantly reduced the deterioration and failure of critical equipment."*

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Case study 1: Gas Processing site in Abu Dhabi

ABB Ability™ Process Power Manager reduces energy costs

Customer needs

Power Management with IEC61850 GOOSE and MMS

- Avoid blackouts
- Expected GTG trips due to warm climate and high load
- Large plant with more than 20 substations
- More than 1900 Protection devices

Energy Industries, U.A.E.

ABB's solutions

Designing the load shedding and balancing of the gas plant

- Through efficient and fast load shedding avoid blackouts and prevent process interruptions or shutdowns.
- Active and reactive power control
- Overload shedding

Scope of delivery

- ABB Ability™ Process Power Manager

Customer benefits

Results

- 3X ROI in less than 1 year
- Fewer plant disruptions and reduced downtime
- 42 GTG trips and 4 load shedding events
- Reduced cost of signal cabling with network infrastructure
- Prepared for digital

Benefits

CapEx	OpEx	Availability
10%	39 MUSD	+5%

Case Study 2 – Large Petrochemical Complex in India

ABB Ability™ Process Power Manager increases uptime & reduces production losses

Plant Composition

>25 G/n s, 500+ Transformers, 6k+ Breakers, ~9k Numerical Relays, 6k Energy Meters, ~1k Motors, 3 Central Control Rooms, 14 MRS s (220/33 kV), 110 Substations (11/6.6 kV), 100,000 IO points

Complexity involved

Centralized Monitoring and Control of entire complex with Mega unified Load Shedding scheme with new & existing running refinery plant electrical network

Implemented Solution & Customer Benefits

ABB PMS provide centralized supervision & control of entire electrical generation & distribution network from 220 kV to 415 V

Mega Unified Load Shedding functionality looking at complete electrical network for uniform tripping of loads making it the largest single load shedding system installation in the world.

Avoiding Blackouts by ensuring uninterrupted power supply to critical loads, hence reducing production losses

Largest single load shedding installation in the world

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Predictive analytics deployed across 26 hydropower sites

- A global re-organization of maintenance processes to improve sustainability and lower costs

- Need to optimize performance, reliability and efficiency of hydro fleet to remain competitive with fossil fuels
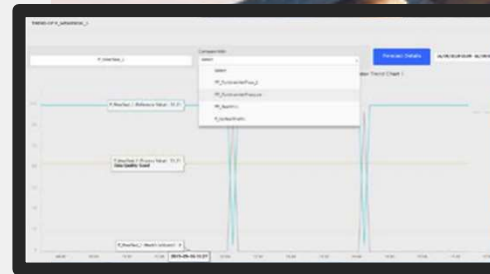
>600 assets — **Early notifications** Providing warning of critical failures and health diagnostics

10% — **Performance** Hydro specific performance efficiency KPIs, increased generation capability 10%

2% — **Maintenance costs** Assistance for more informed decisions resulting in fleet maintenance savings up to 2%

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