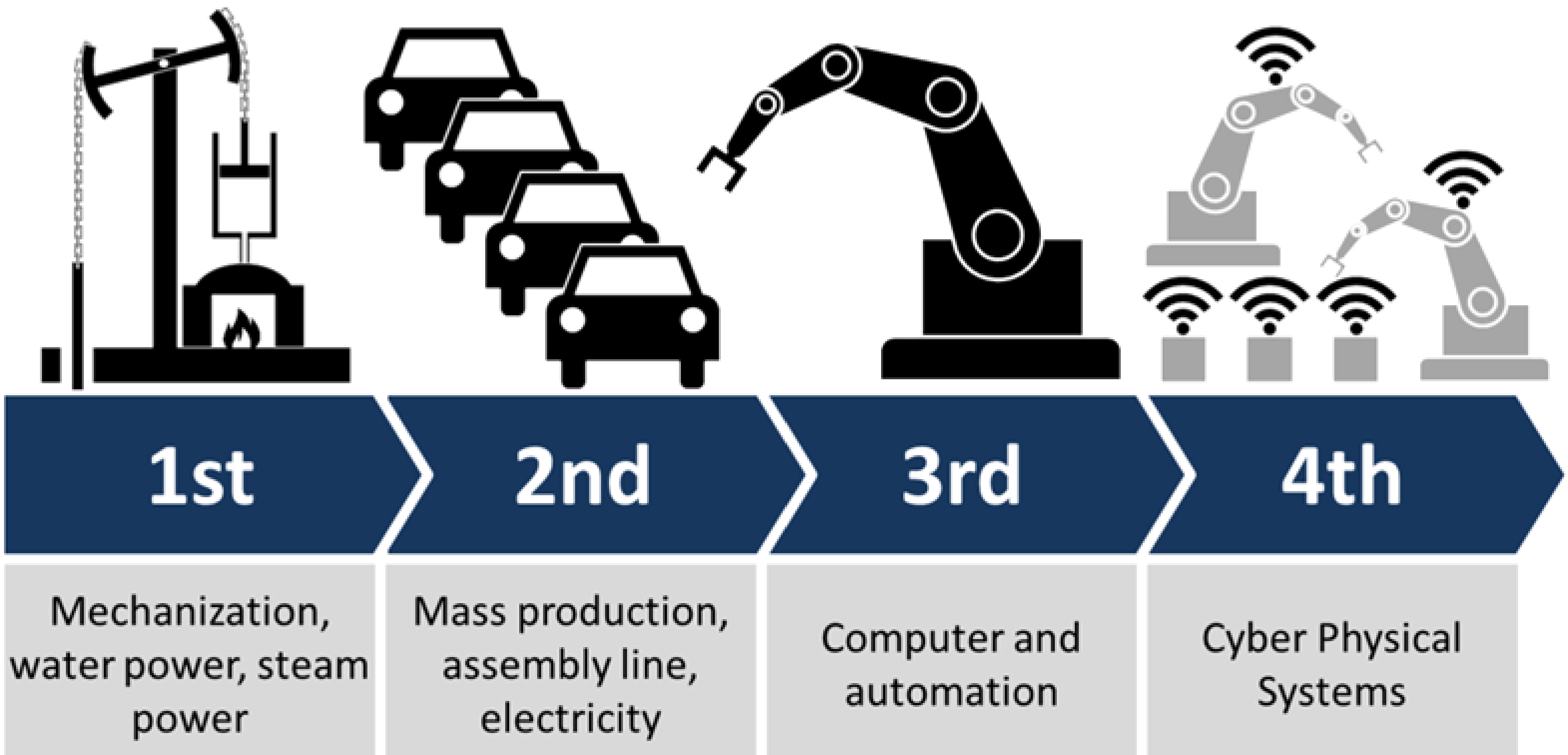

BECKHOFF
TWINCAT_HMI
11:05 am
Eventlogger
11:03 | Sawing station ready
11:03 | PLC start
11:03 | TwinCAT start
BECKHOFF

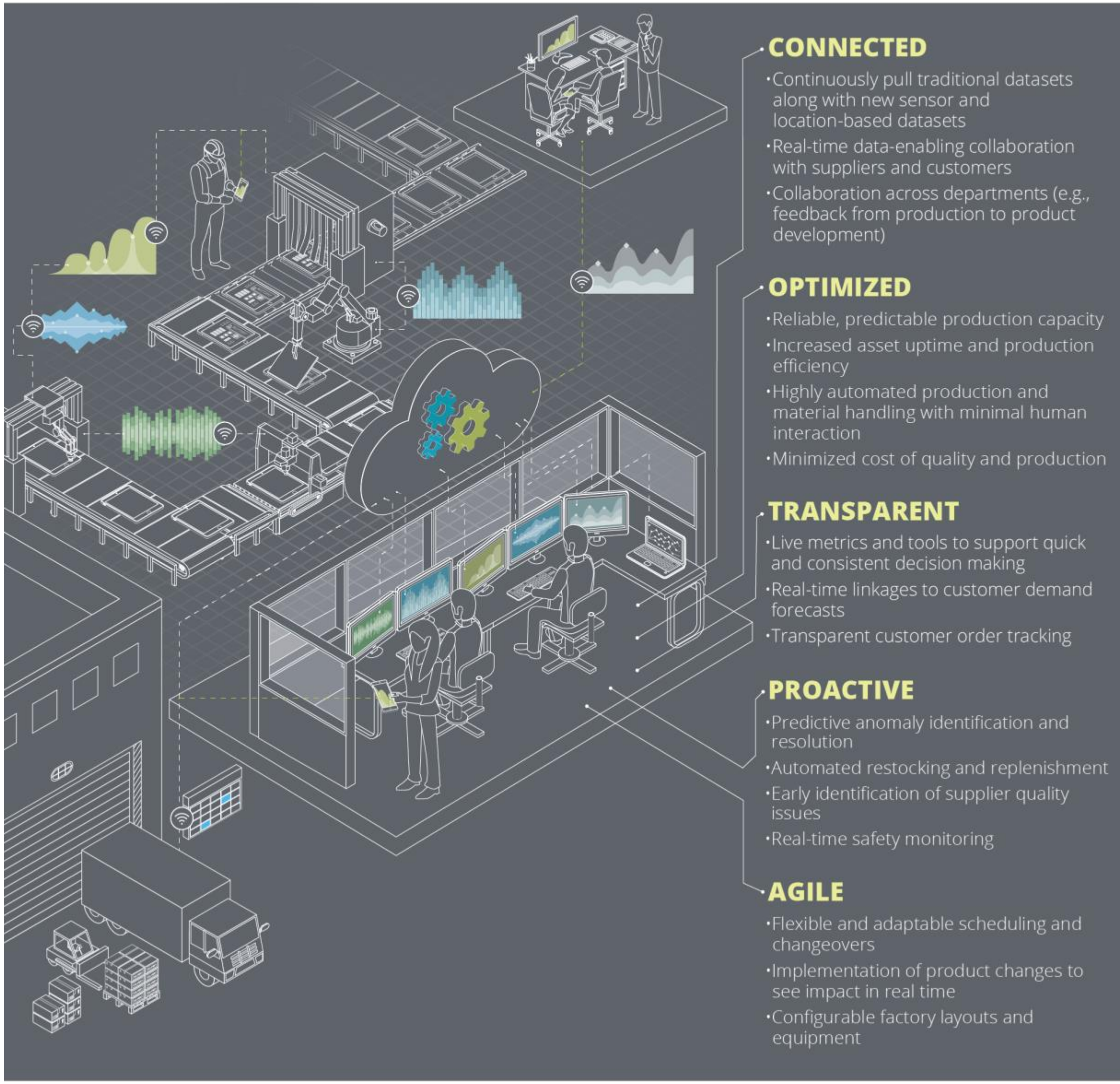
Motivation


1st
2nd
3rd
4th
Mechanization, water power, steam power
Mass production, assembly line, electricity
Computer and automation
Cyber Physical Systems

Industrie 4.0
Smart Factory

The smart factory represents a leap forward from more traditional automation to a fully connected and flexible system.

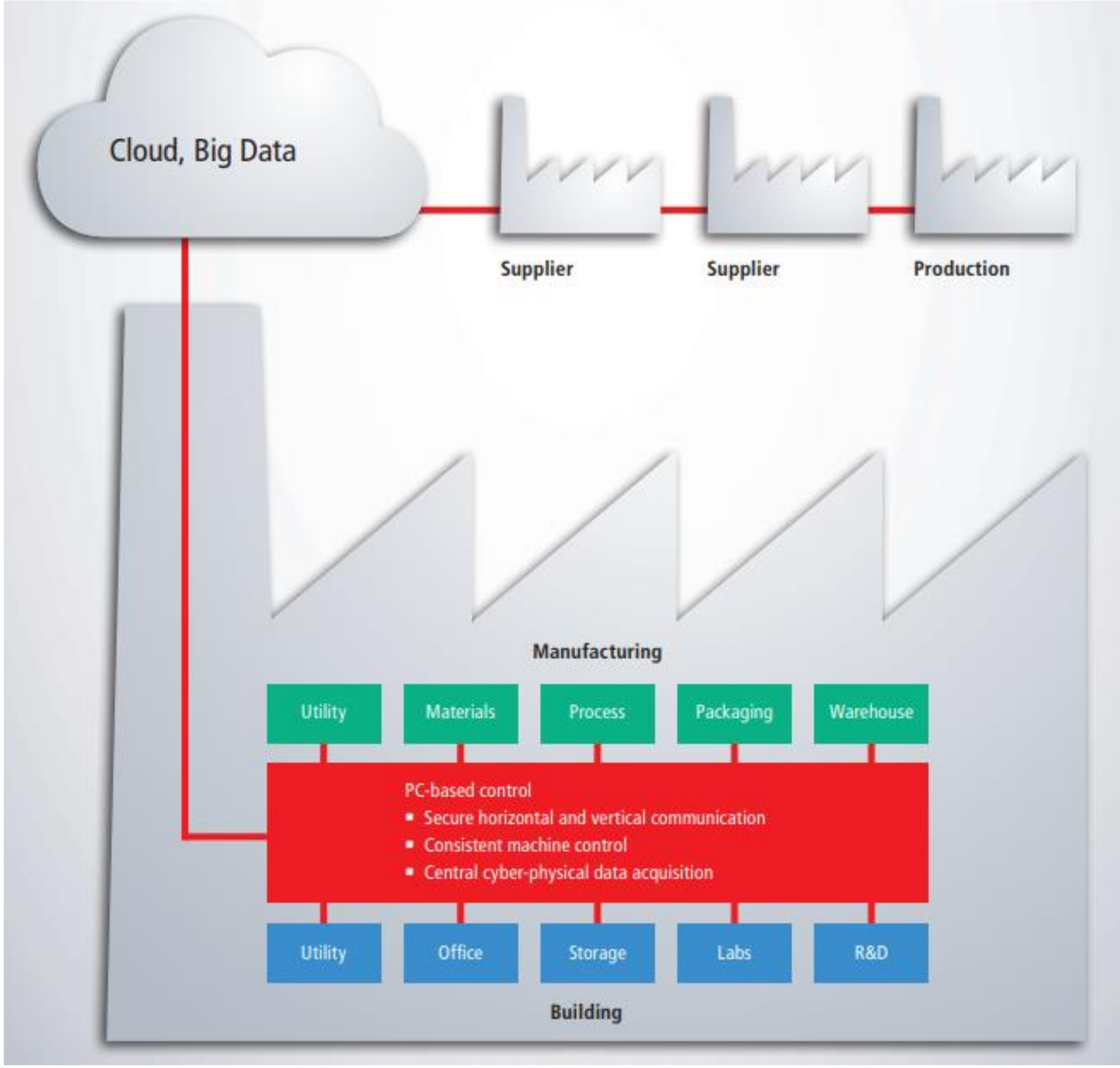
Figure 2. Five key characteristics of a smart factory



Source: Deloitte analysis.

Deloitte University Press | dupress.deloitte.com

Holistic approach to implement Industrie 4.0



/gas production

New Automation Technology
Beckhoff Automation

What can you do to optimise your production architecture for Industrie 4.0? With its New Automation Technology, Beckhoff enables you to benefit from all Smart Factory advantages with an integrated, interconnected process design – while XTS reduces your factory's floor and energy costs and optimises your footprint at the same time.

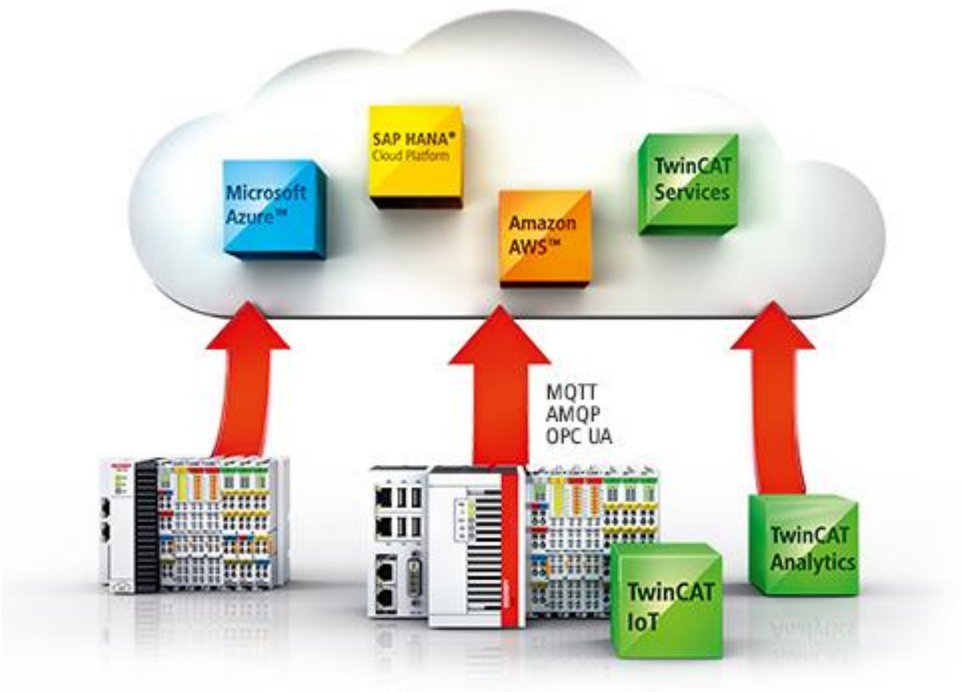
Benefits:

- Open control technology
- Improved efficiency and flexibility
- Reduced operational costs
- Lean automation architecture
- Modular, adaptive manufacturing systems
- Improved resource efficiency
- Reduced footprint

Motivation


Sales
Flexibility
Market share
Output
Efficiency
OEE
Profit
Energy consumption
COGS
Budgets
Resources
Training costs
Time to market
Labour costs
What you are expected to increase …
… and what to decrease at the same time.

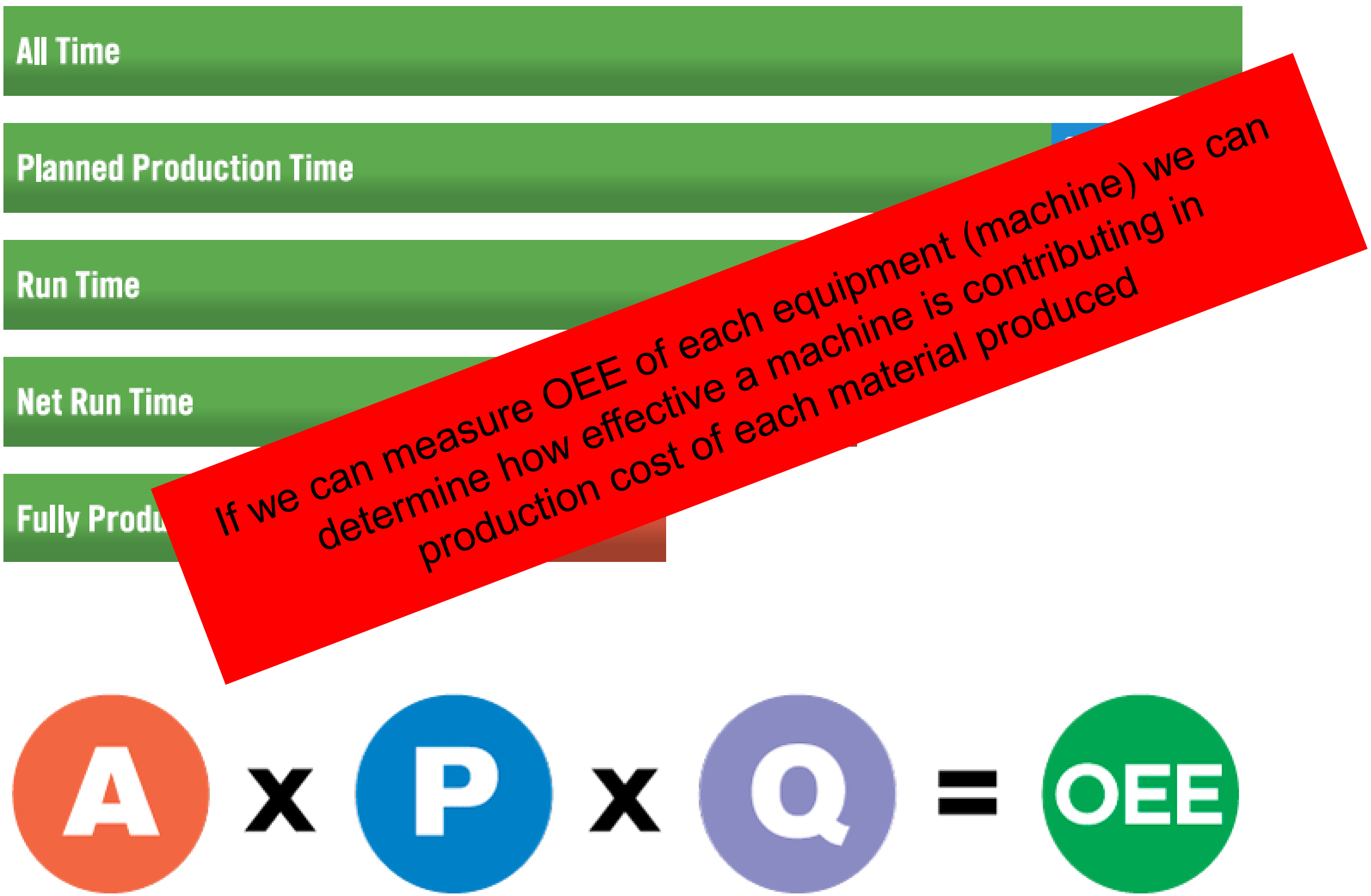
Creating added value: with IoT and data analytics



Measuring Productivity

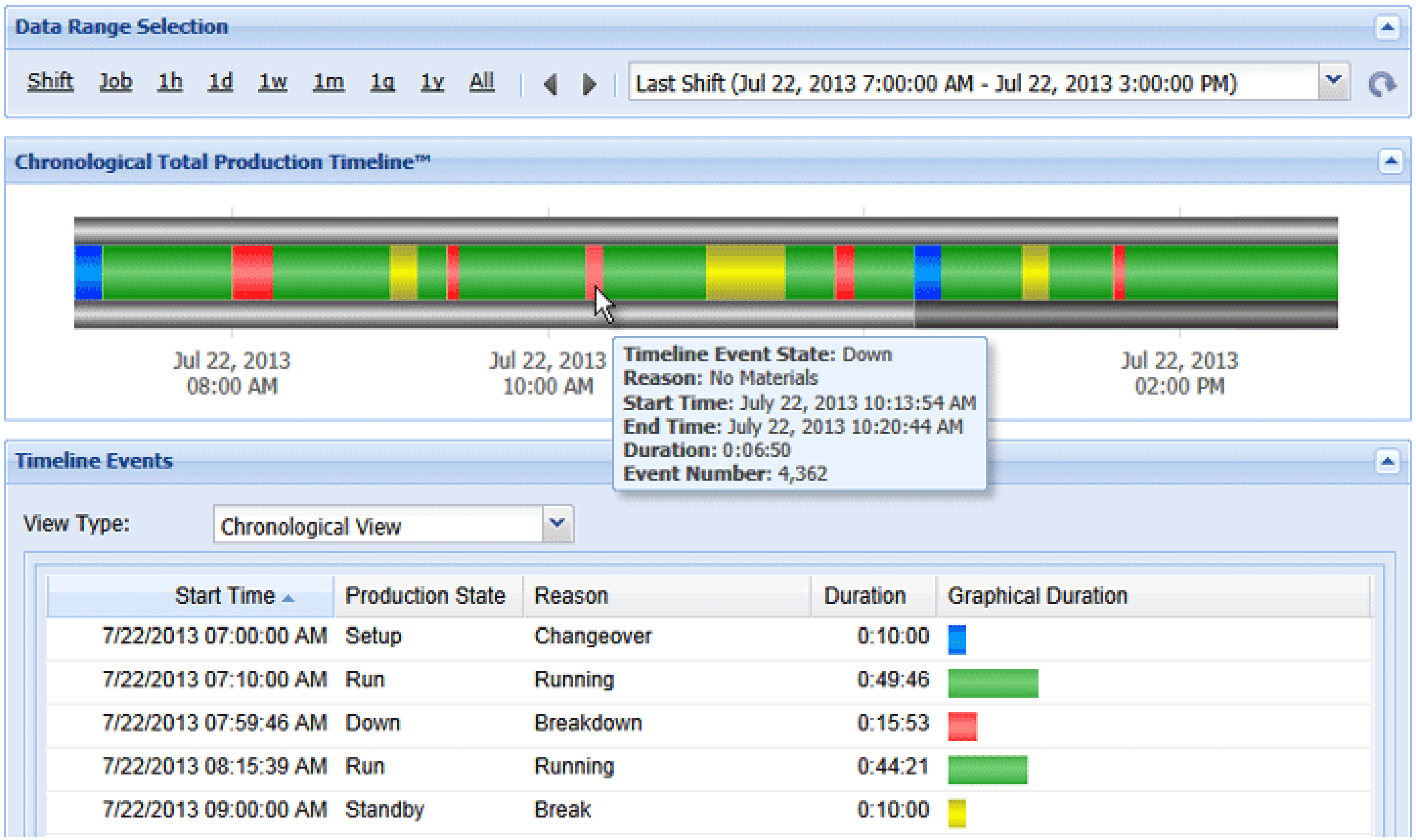
Measuring Productivity
Overall Equipment Effectiveness (OEE)

Measuring Productivity
Overall Equipment Effectiveness (OEE)

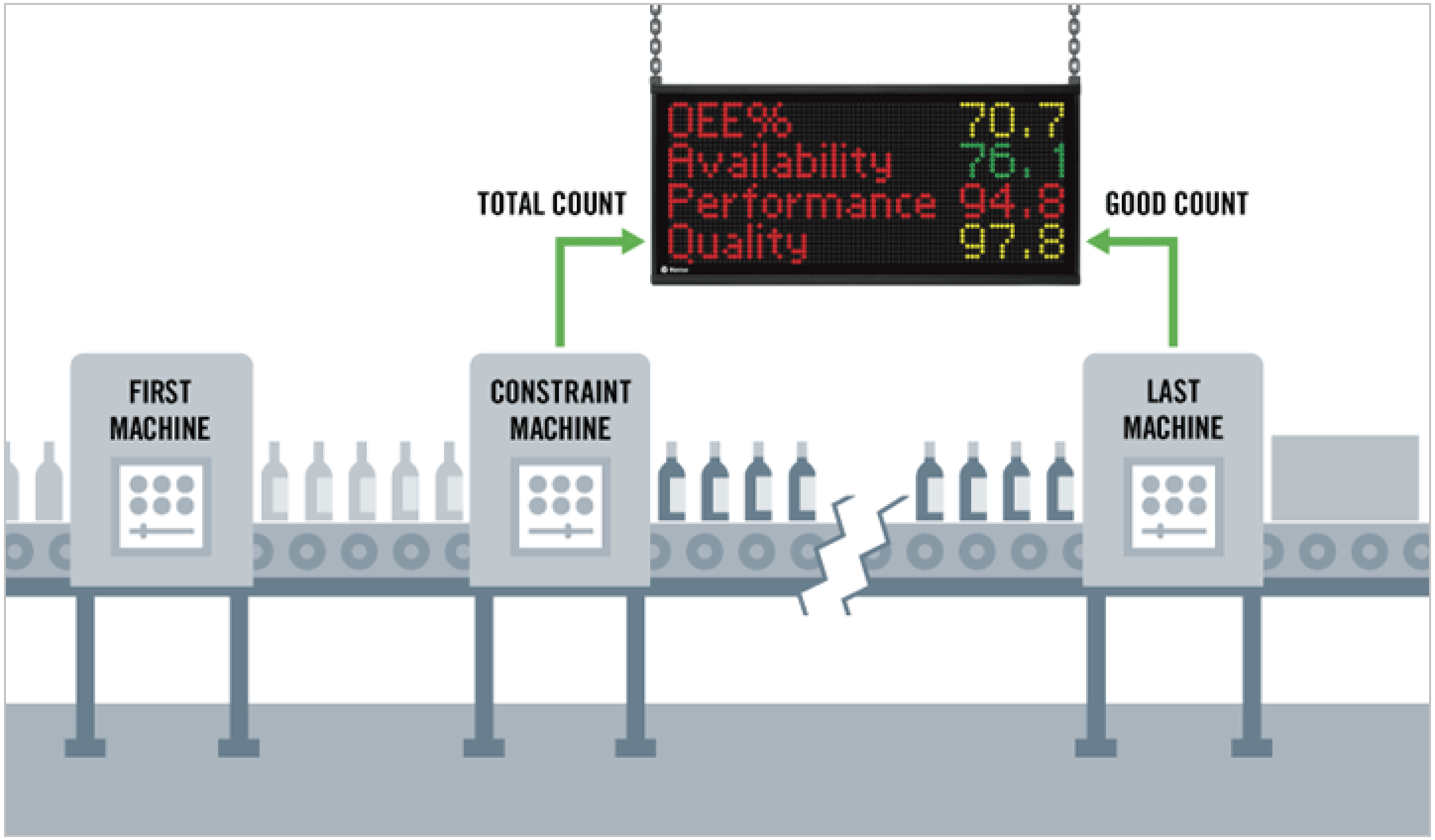


Availability

Performance



Quality


OEE% 70.7
Availability 76.1
Performance 94.8
Quality 97.8
TOTAL COUNT
GOOD COUNT
FIRST MACHINE
CONSTRAINT MACHINE
LAST MACHINE

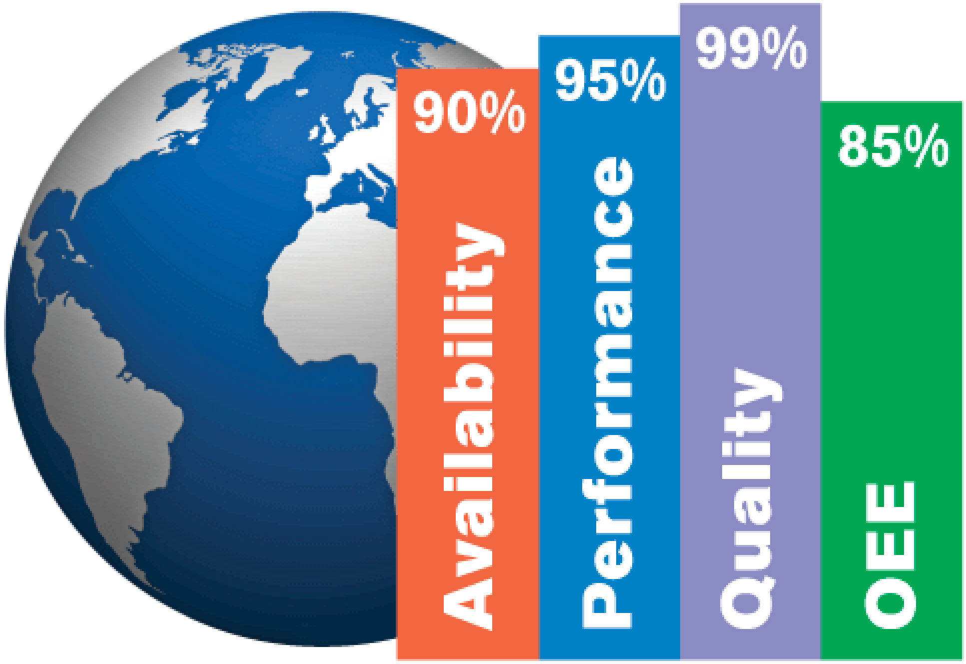
Measuring Productivity
Overall Equipment Effectiveness (OEE)

Overall Equipment Effectiveness	Recommended Six Big Losses	Traditional Six Big Losses
Availability Loss	Unplanned Stops	Equipment Failure
	Planned Stops	Setup and Adjustments
Performance Loss	Small Stops	Idling and Minor Stops
	Slow Cycles	Reduced Speed
Quality Loss	Production Rejects	Process Defects
	Startup Rejects	Reduced Yield
OEE	Fully Productive Time	Valuable Operating Time

Measuring Productivity
Overall Equipment Effectiveness (OEE)

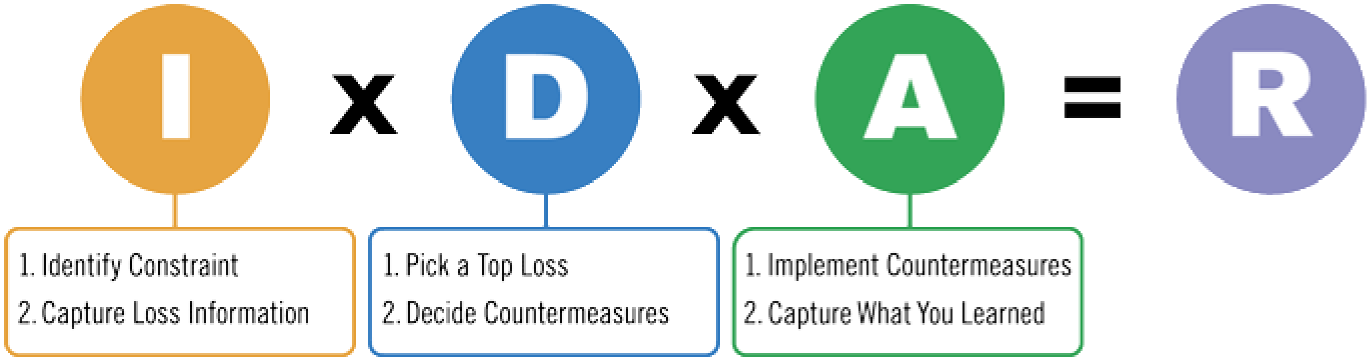
- **Unplanned stops:** equipment failures, starved stations or unplanned maintenance.
- **Planned stops:** changeovers, machine cleaning, tooling swap outs, etc.
- **Small stops:** minor or idling stops usually less than two minutes that could include things like a sensor obstruction, jams, feeds, etc.
- **Slow cycles:** anything slowing the production time from its maximum speed, like a worn out conveyor belt, poorly maintained equipment or an inexperienced machine operator.
- **Process defects:** defective parts produced during stable production due to equipment handling errors or incorrect equipment settings.
- **Reduced yield:** defective parts produced after an equipment failure until equipment has returned to a steady state.

Measuring Productivity
Overall Equipment Effectiveness (OEE)



It is often thought that a World-Class OEE score is 85%. Don't fixate on the absolute value of OEE, instead fixate on your ability to improve your OEE.

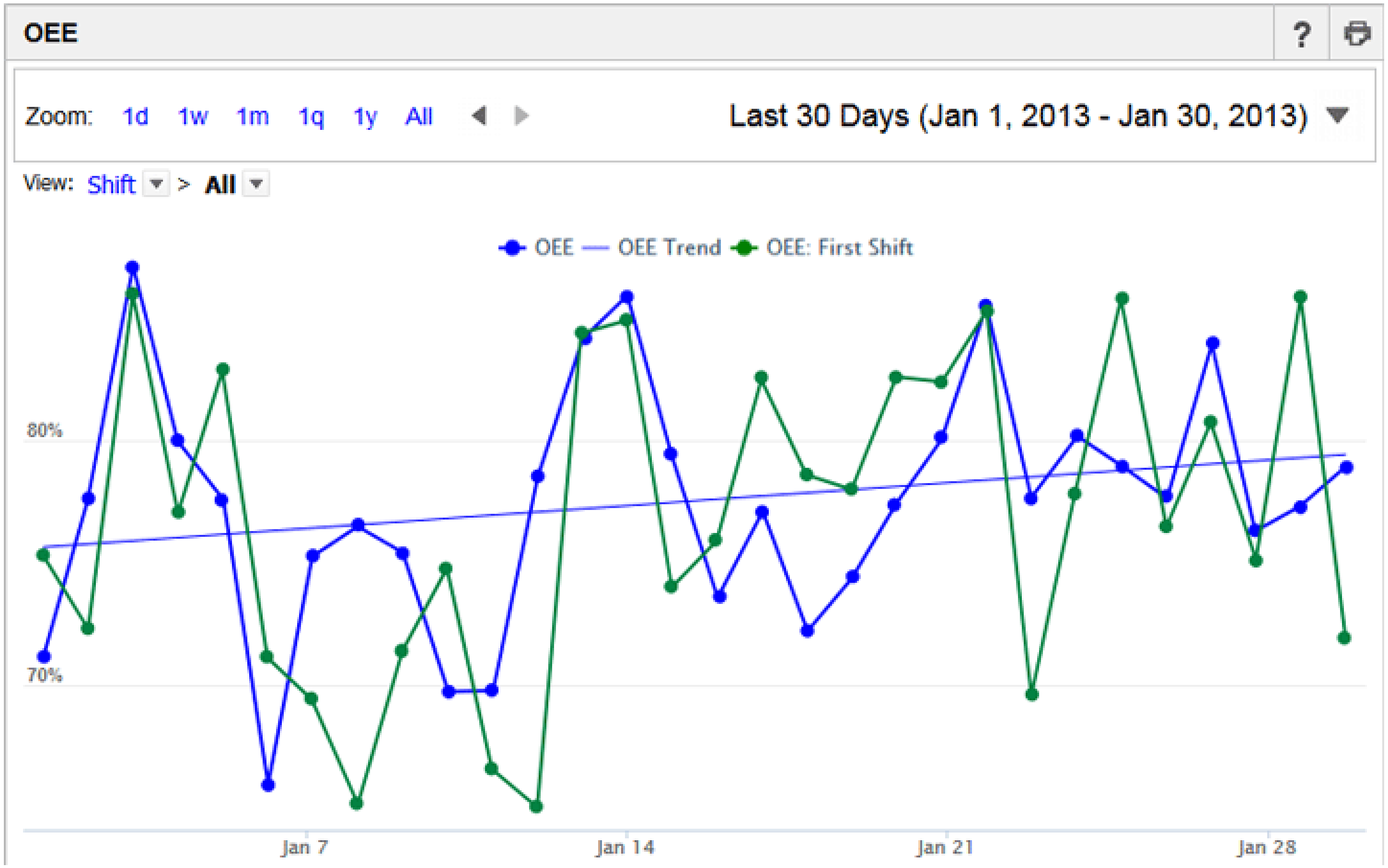
Measuring Productivity
Overall Equipment Effectiveness (OEE)



IDA (Information, Decision, Action) is a simple and highly effective process for improving productivity using information

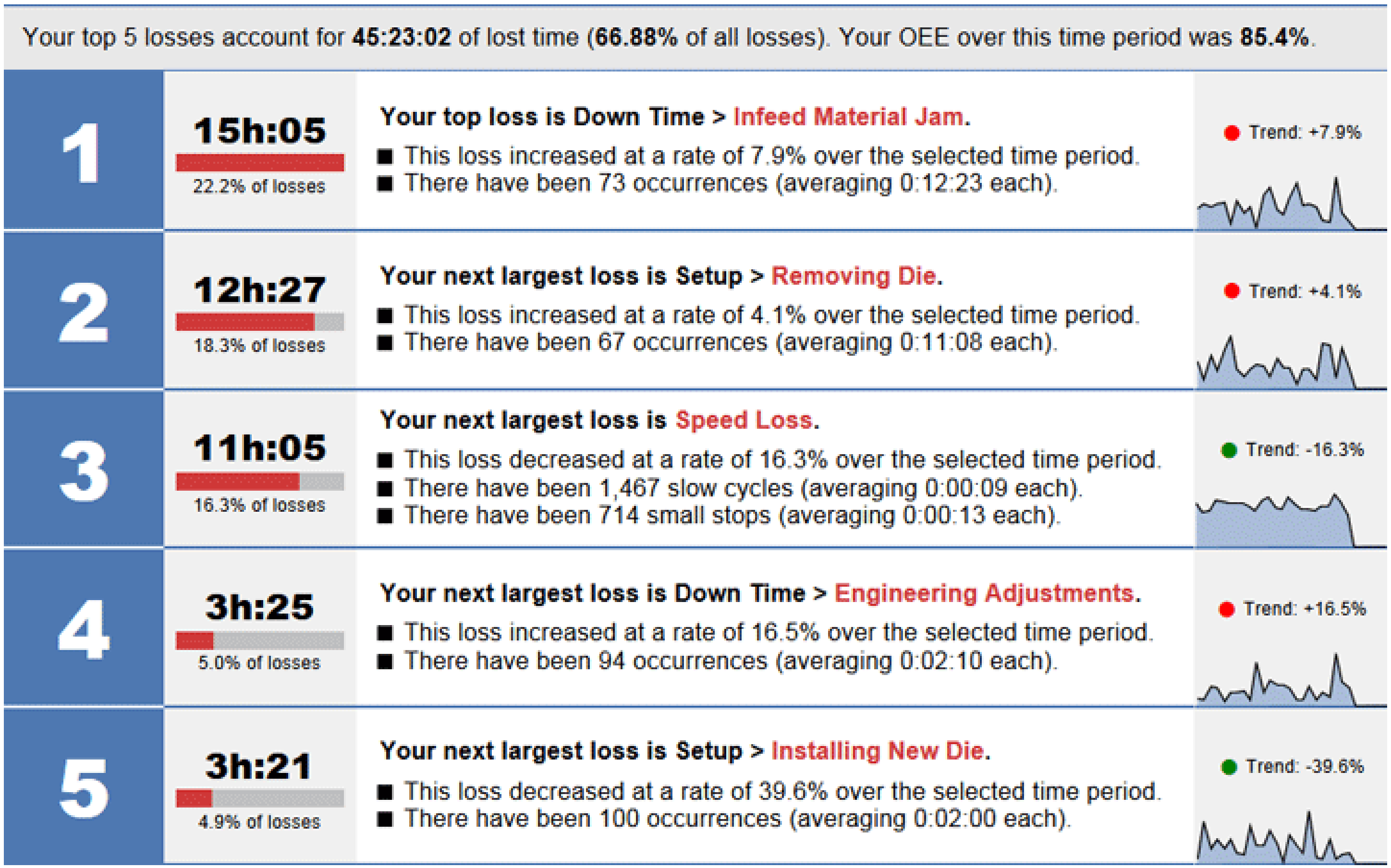
https://www.oee.com/

OEE trends

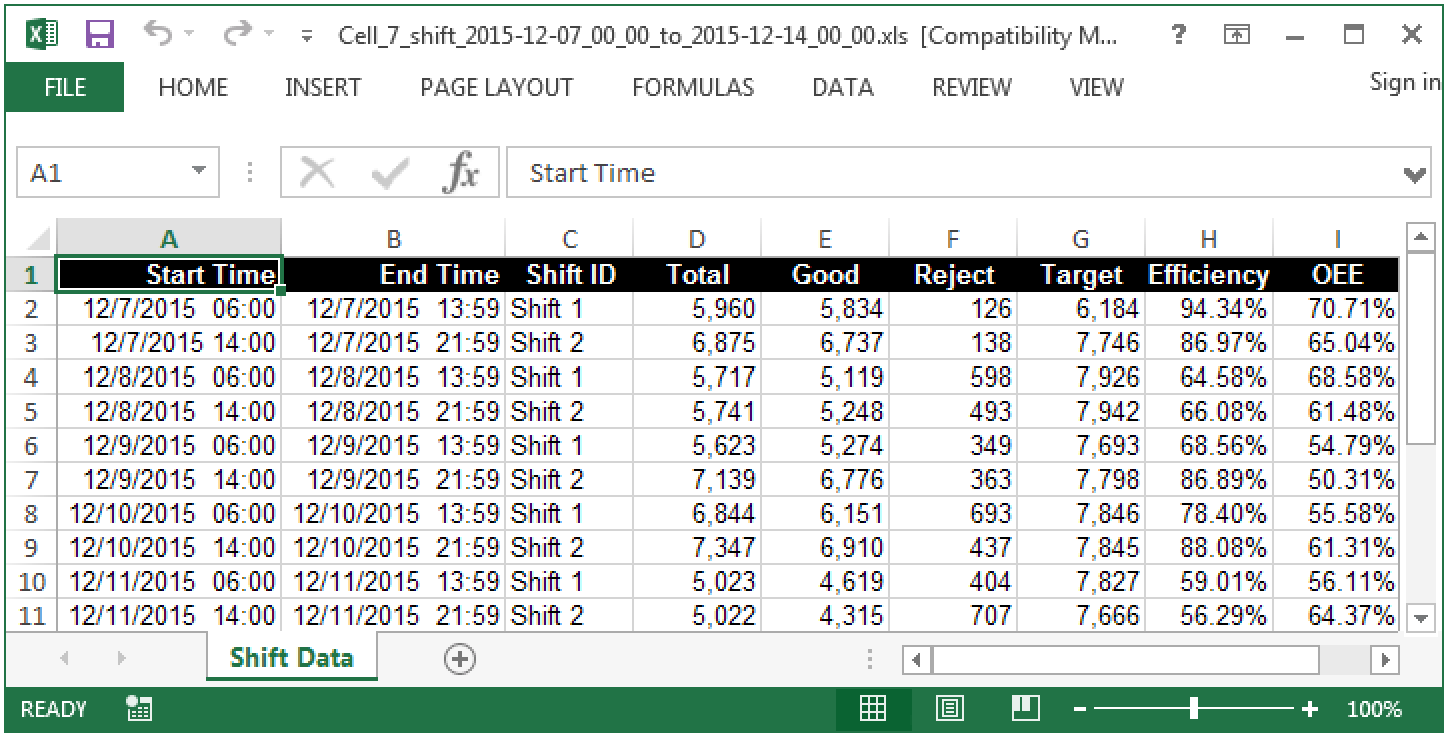


OEE
Zoom: 1d 1w 1m 1q 1y All
Last 30 Days (Jan 1, 2013 - Jan 30, 2013)
View: Shift > All
OEE
OEE Trend
OEE: First Shift
80%
70%
Jan 7
Jan 14
Jan 21
Jan 28

Observing top losses



Reporting.. for example in .xls/.csv format



Start Time	End Time	Shift ID	Total	Good	Reject	Target	Efficiency	OEE
12/7/2015 06:00	12/7/2015 13:59	Shift 1	5,960	5,834	126	6,184	94.34%	70.71%
12/7/2015 14:00	12/7/2015 21:59	Shift 2	6,875	6,737	138	7,746	86.97%	65.04%
12/8/2015 06:00	12/8/2015 13:59	Shift 1	5,717	5,119	598	7,926	64.58%	68.58%
12/8/2015 14:00	12/8/2015 21:59	Shift 2	5,741	5,248	493	7,942	66.08%	61.48%
12/9/2015 06:00	12/9/2015 13:59	Shift 1	5,623	5,274	349	7,693	68.56%	54.79%
12/9/2015 14:00	12/9/2015 21:59	Shift 2	7,139	6,776	363	7,798	86.89%	50.31%
12/10/2015 06:00	12/10/2015 13:59	Shift 1	6,844	6,151	693	7,846	78.40%	55.58%
12/10/2015 14:00	12/10/2015 21:59	Shift 2	7,347	6,910	437	7,845	88.08%	61.31%
12/11/2015 06:00	12/11/2015 13:59	Shift 1	5,023	4,619	404	7,827	59.01%	56.11%
12/11/2015 14:00	12/11/2015 21:59	Shift 2	5,022	4,315	707	7,666	56.29%	64.37%

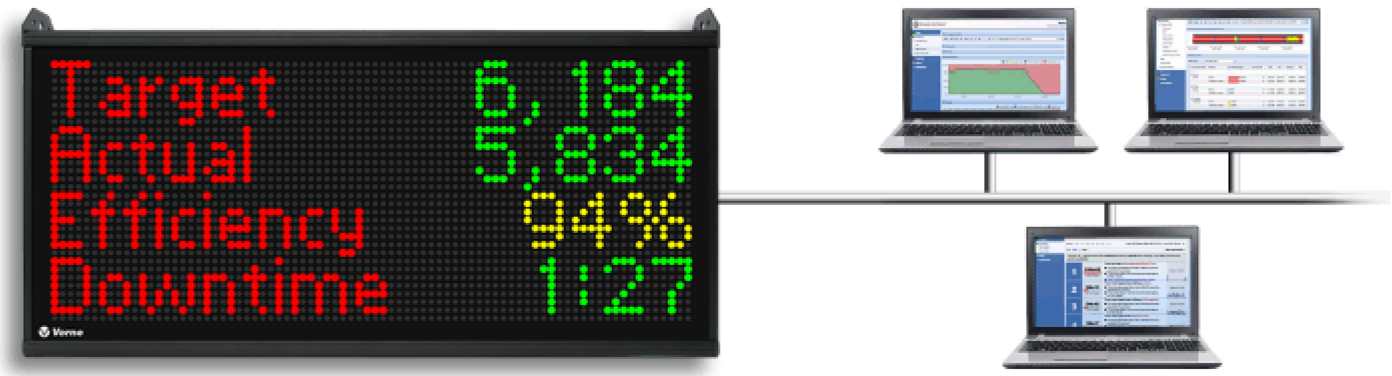
Multiple asset viewing

Multiple Asset View

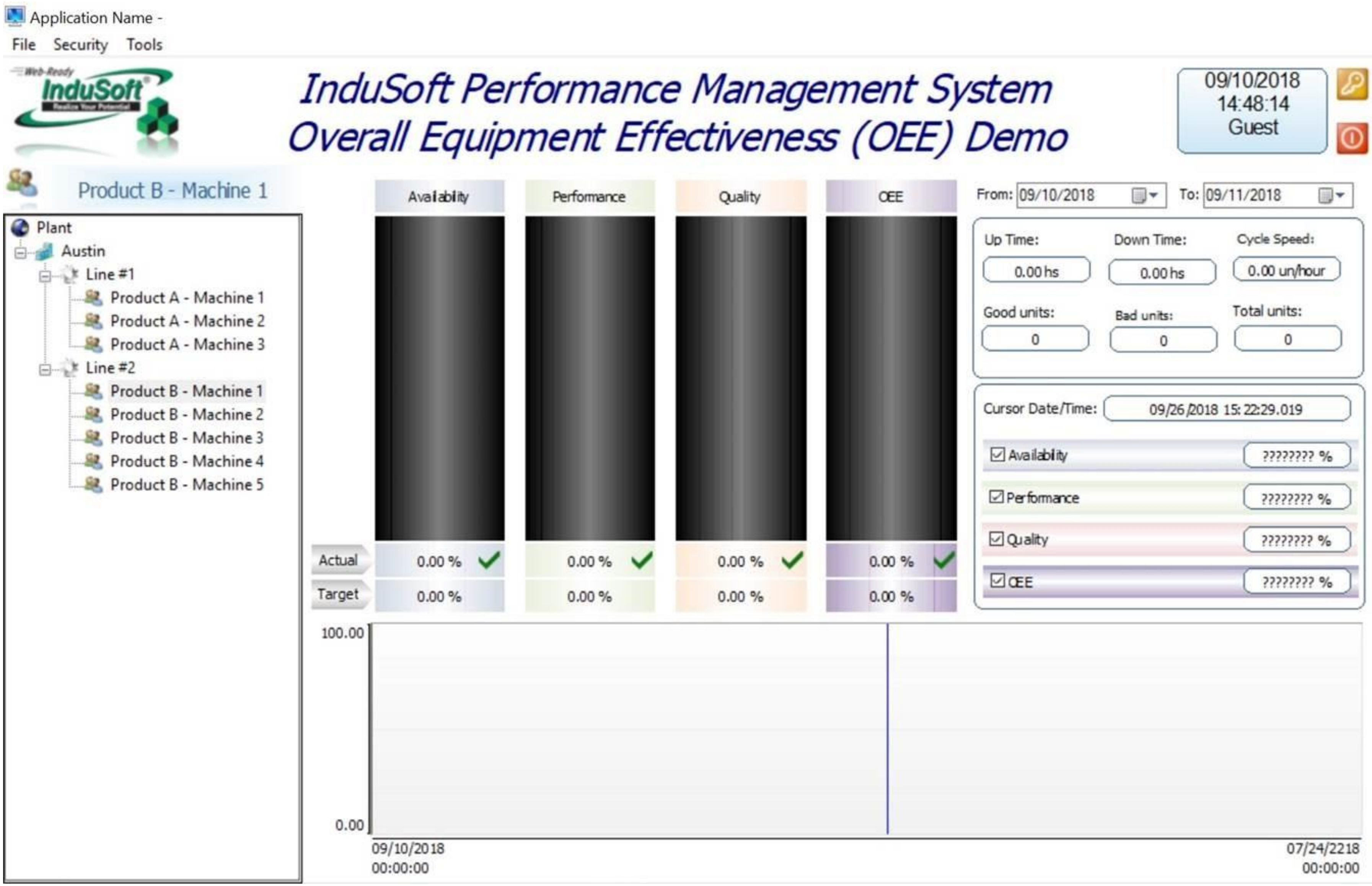
View as Hierarchy | Information to View: Shift TAED

Asset	Production State	Target Sum	Actual Sum	Efficiency Mean	Down Time Mean
Vorne Industries		30,324	23,295	76.02%	1:40:43
Itasca		15,193	12,335	80.16%	1:23:21
Stamping 1	Run	14,209	11,558	81.34%	1:18:22
Stamping 2	Standby	984	777	78.97%	1:28:20
Birmingham		15,131	10,960	71.89%	1:58:05
Assembly		9,291	6,904	74.32%	1:47:51
Cell 1	Run	4,568	3,414	74.74%	1:46:06
Cell 2	Down	4,723	3,490	73.90%	1:49:37
Finishing		5,840	4,056	69.45%	2:08:19
Paint Line	Run	5,840	4,056	69.45%	2:08:19

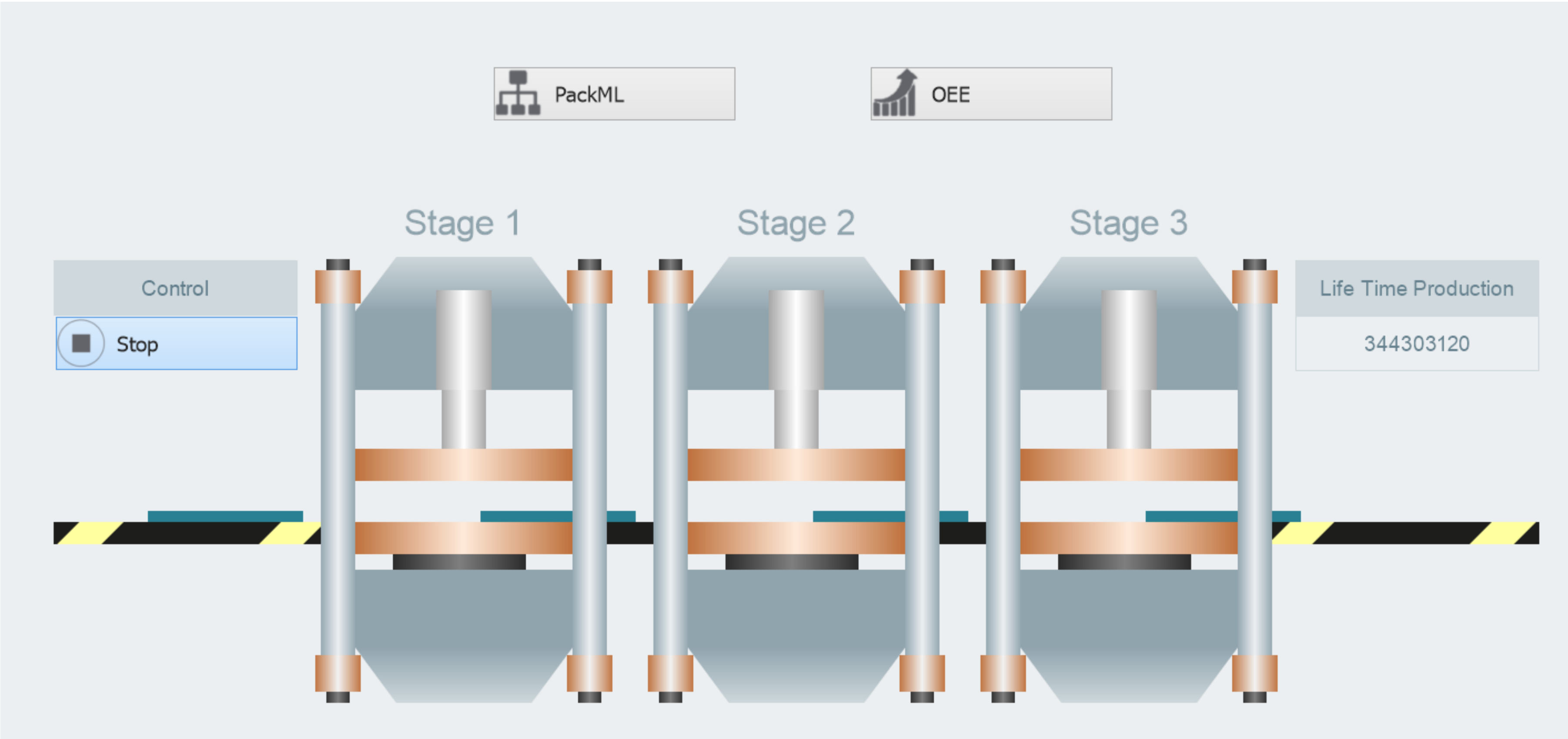
Multiple OEE viewing



OEE sample page

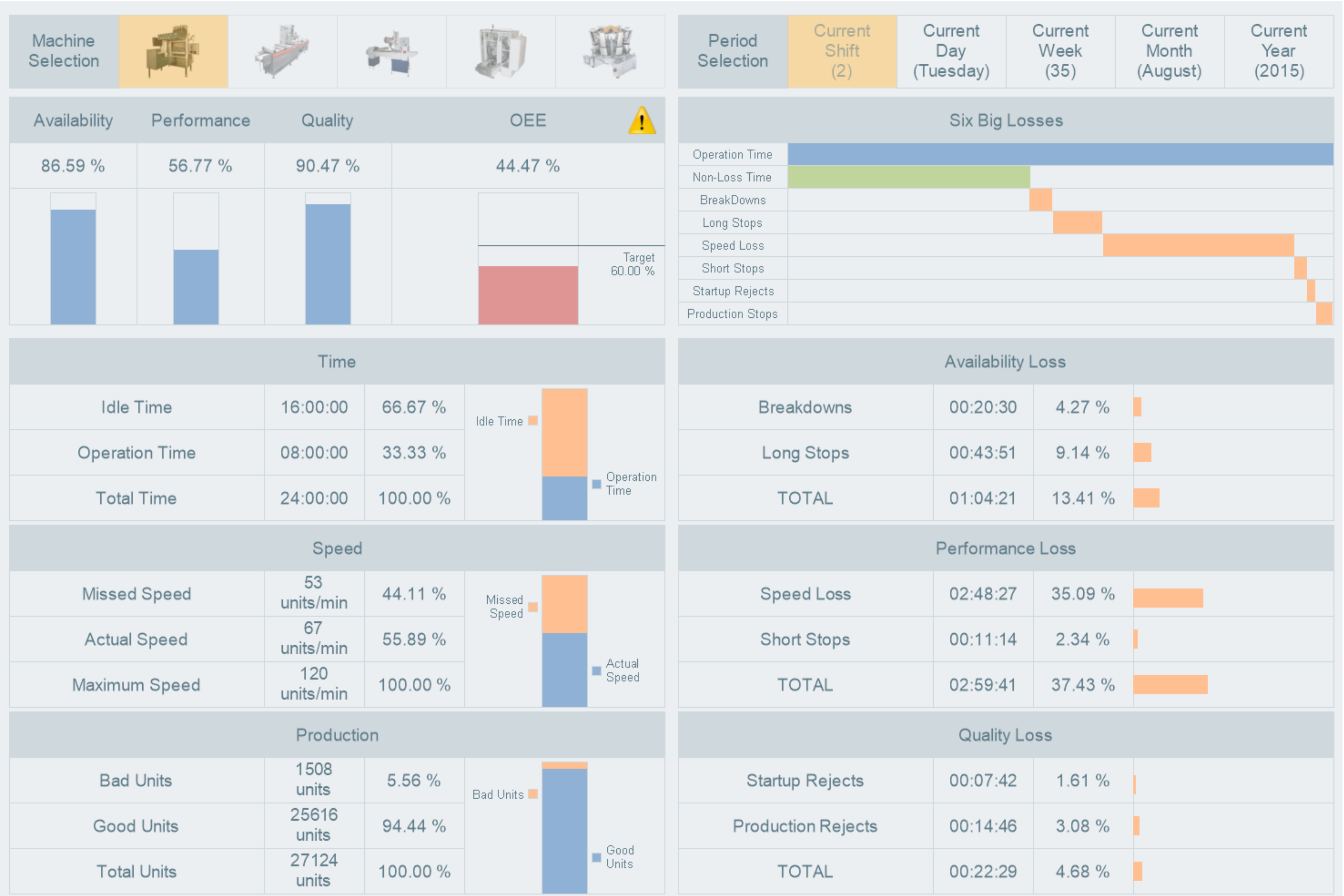


OEE sample page

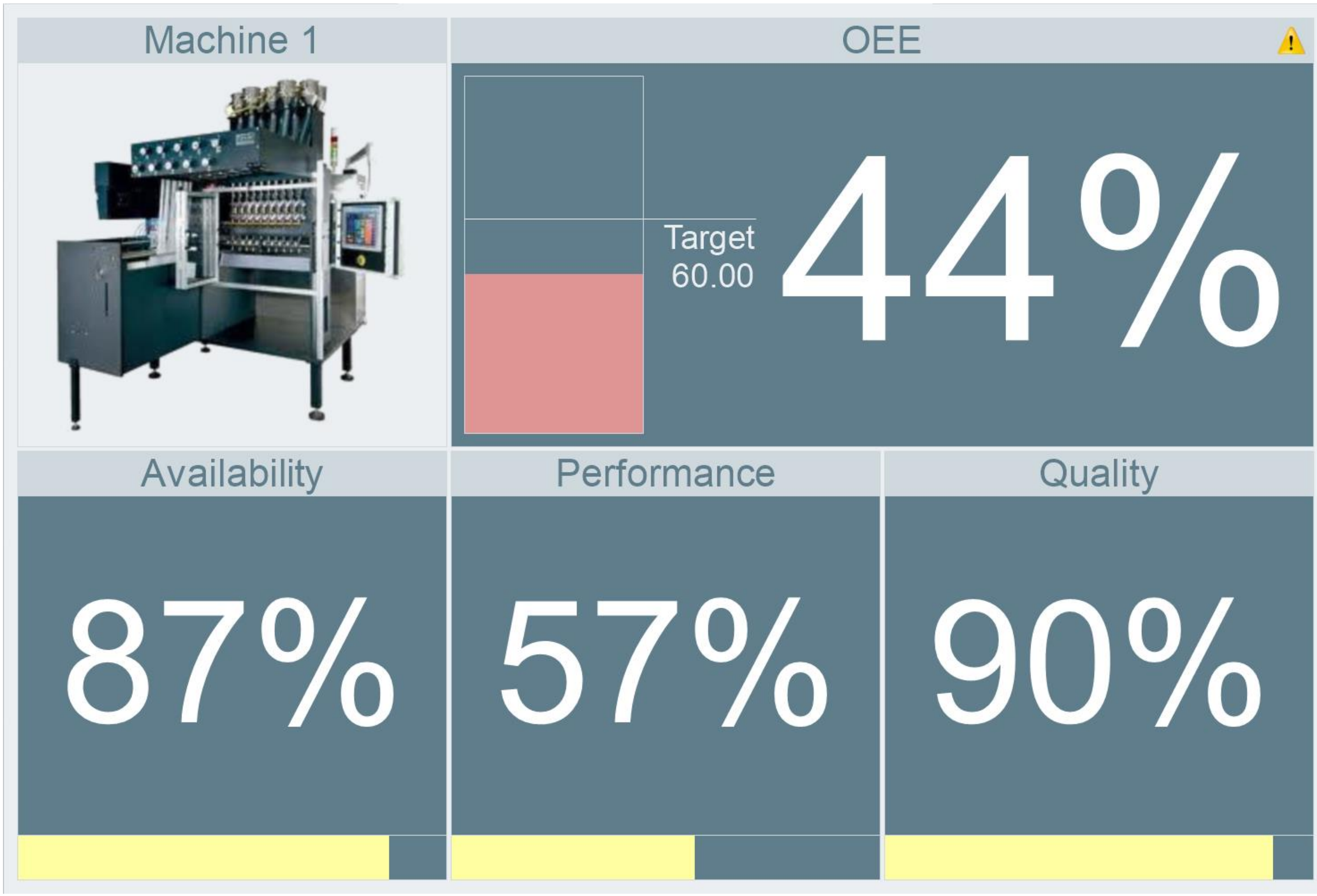


Progress Status Whitin Target	Job #11: Fender FL XYZ				
	Target	Actual	Remaining	Actual (%)	Progress
Parts	10	5	5	50 %	
Time	00:01:00	00:00:22	00:00:38	37 %	

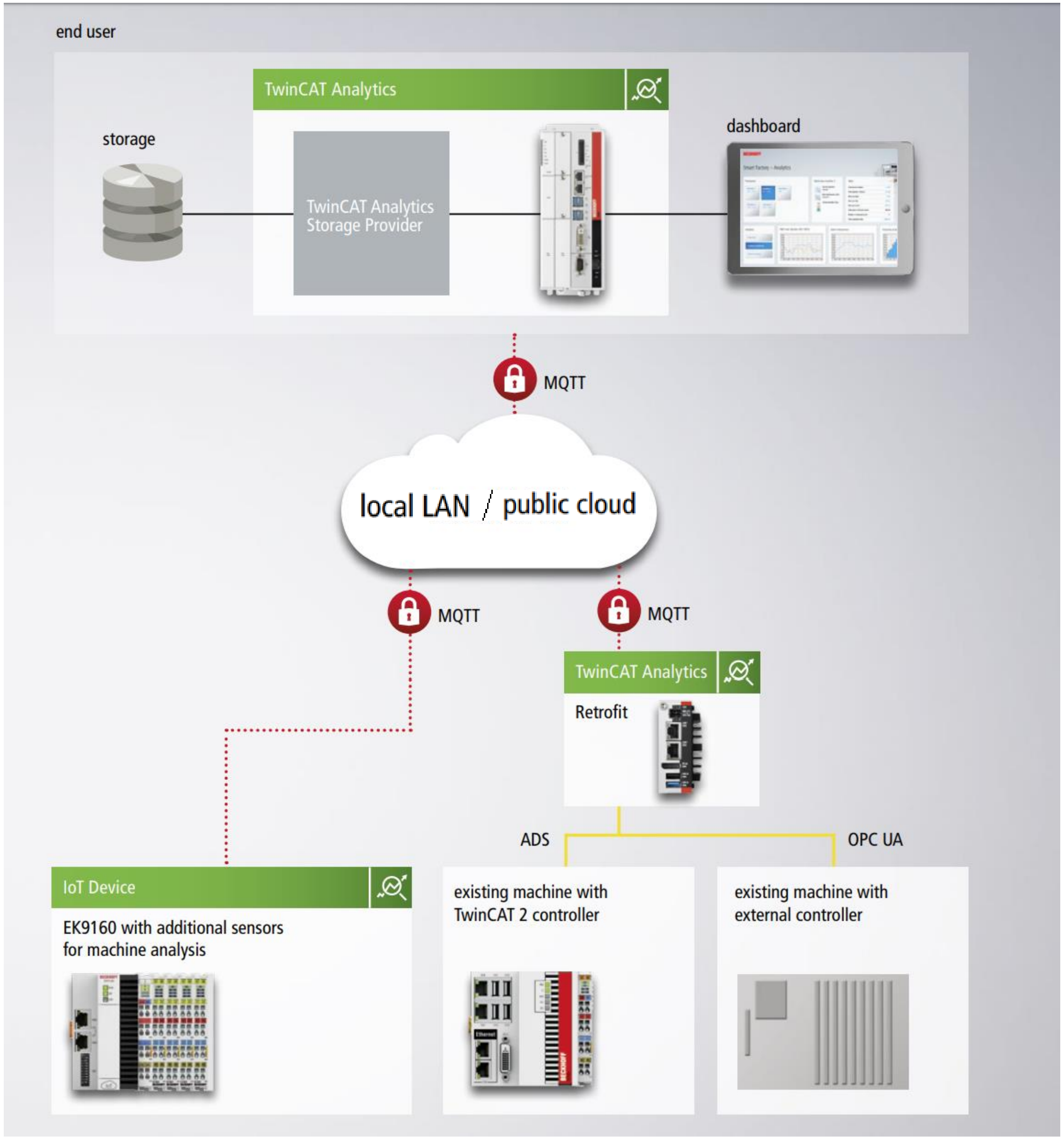
OEE sample page



Other term - ANDON



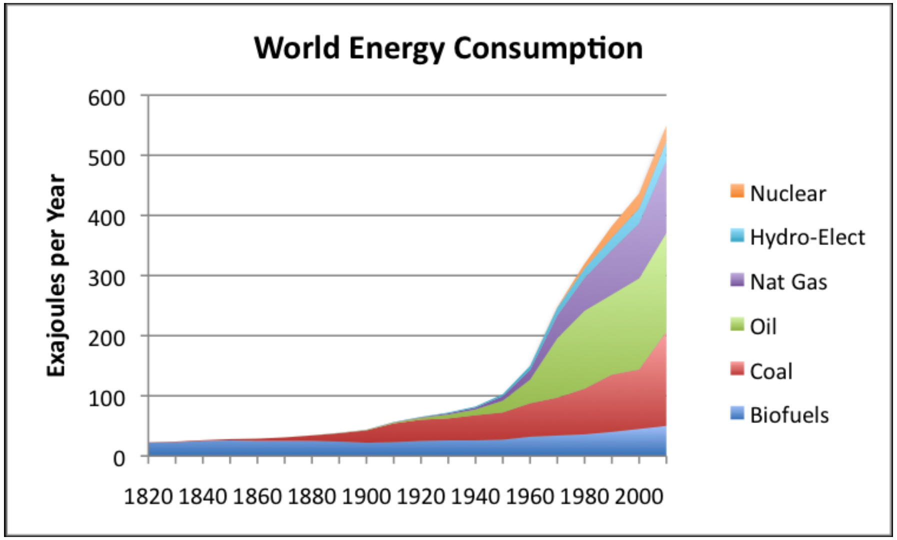
Leveraging your asset management
Analytics in use: 24/7 machine monitoring

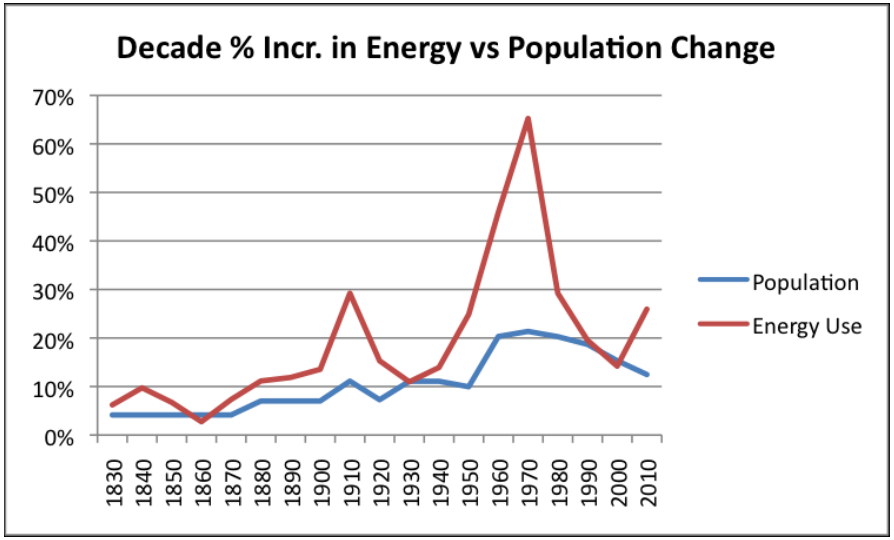


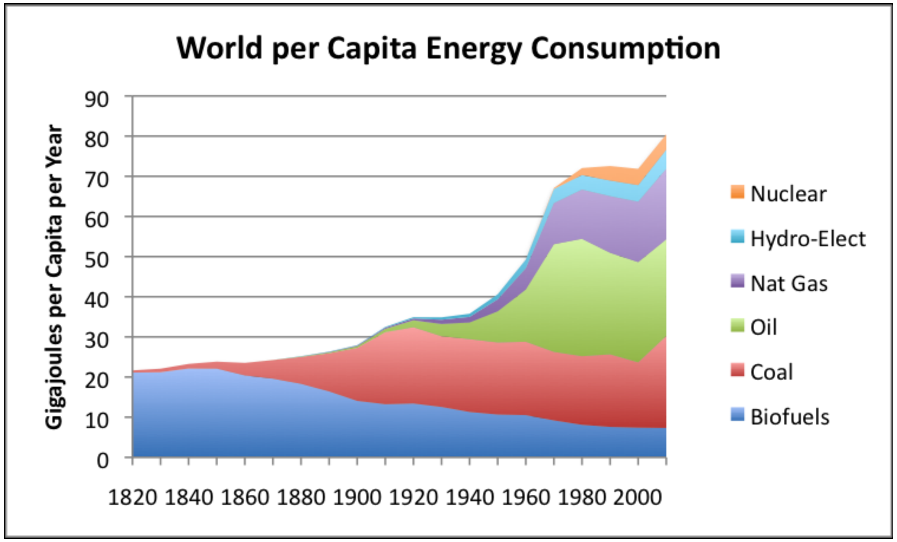
Energy and raw materials:
Discover your savings potential

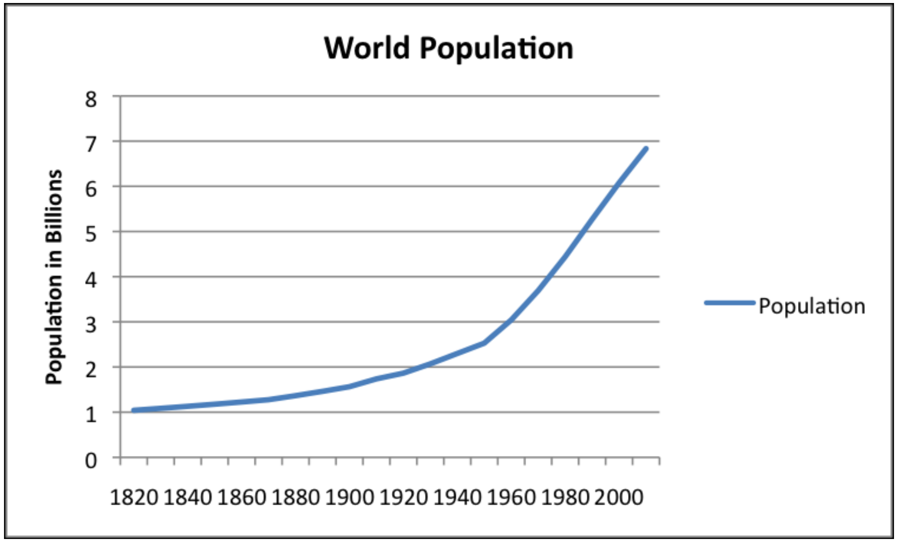
PC-based Control:
Cut Costs Using Comprehensive
Energy Data Management

Motivation


World Energy Consumption
Exajoules per Year
0
100
200
300
400
500
600
1820 1840 1860 1880 1900 1920 1940 1960 1980 2000
Nuclear
Hydro-Elect
Nat Gas
Oil
Coal
Biofuels


Decade % Incr. in Energy vs Population Change
0%
10%
20%
30%
40%
50%
60%
70%
1830 1840 1850 1860 1870 1880 1890 1900 1910 1920 1930 1940 1950 1960 1970 1980 1990 2000 2010
Population
Energy Use


World per Capita Energy Consumption
Gigajoules per Capita per Year
0
10
20
30
40
50
60
70
80
90
1820 1840 1860 1880 1900 1920 1940 1960 1980 2000
Nuclear
Hydro-Elect
Nat Gas
Oil
Coal
Biofuels


World Population
Population in Billions
0
1
2
3
4
5
6
7
8
1820 1840 1860 1880 1900 1920 1940 1960 1980 2000
Population

Integrated Energy Data Management

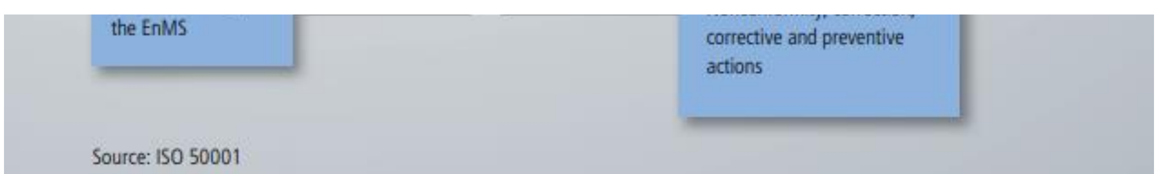
Integrated energy data management enables the implementation of ISO 50001…

ISO 50001:2018 – Energy Management System

ISO 50001 is based on the management system model of continual improvement also used for other well-known standards such as ISO 9001 or ISO 14001. This makes it easier for organizations to integrate energy management into their overall efforts to improve quality and environmental management.

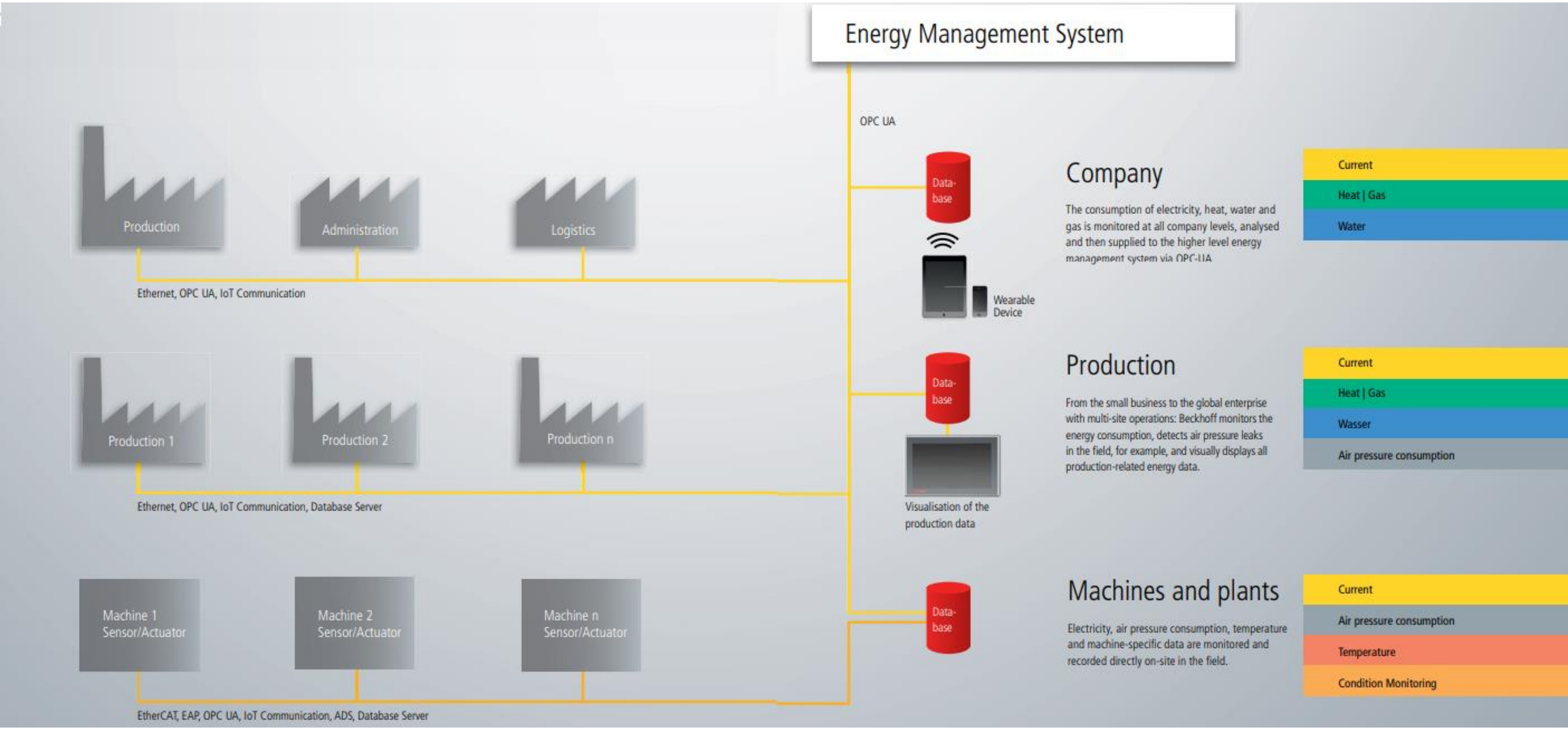
ISO 50001:2018 provides a framework of requirements for organizations to:

- Develop a policy for more efficient use of energy
- Fix targets and objectives to meet the policy
- Use data to better understand and make decisions about energy use
- Measure the results
- Review how well the policy works, and
- Continually improve energy management.



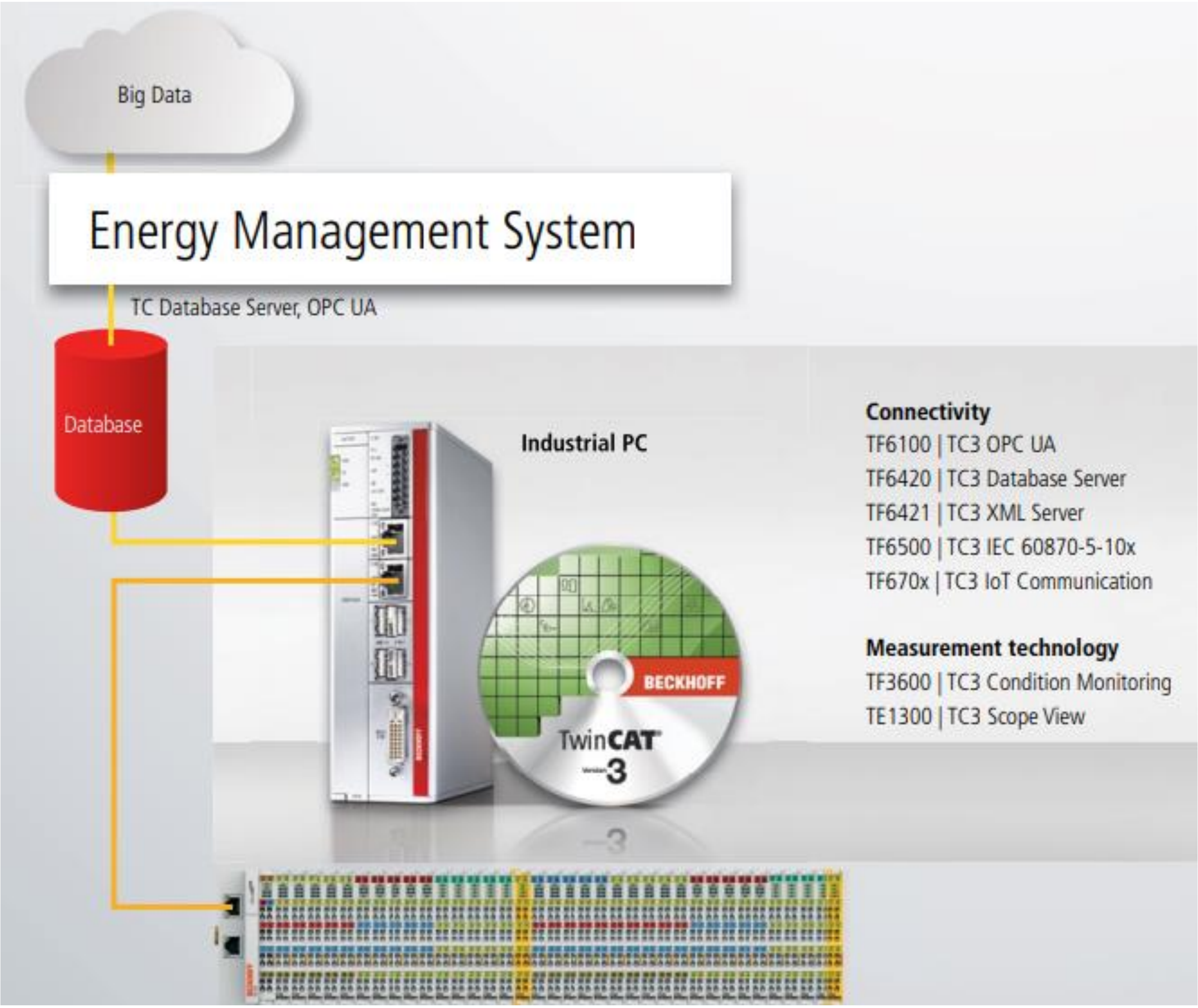
YOU CAN'T IMPROVE WHAT YOU DON'T MEASURE.

Integrated Energy Data Management



Oil/gas production

Integrated Energy Data Management



Measurement technology
System-integrated energy data management

Direct measurement
- EL3403 and KL3403 3-phase power measurement, 500 V AC
- EL3413 3-phase power measurement, 690 V AC
- EL3773 high-end power analysis

Current

Indirect measurement (meter)
- KL6401 LON Bus Terminal
- KL6781 M-Bus master terminal
- EL6224, KL6224 IO-Link master terminals
- EL1xxx/KL1xxx digital input terminals (acquisition of pulse outputs)

Heat | Gas

Indirect measurement (meter)
- KL6401 LON Bus Terminal
- KL6781 M-Bus master terminal

Water

Measurement technology
System-integrated energy data management

Direct measurement
- EP3744 pressure measurement box
- KM37xx and EM37xx pressure measurement terminals

Indirect measurement (analog)
- EL3xxx and KL3xxx analog input terminals
- EP3xxx analog input modules
- EL6224, KL6224 IO-Link master terminals

Air pressure consumption

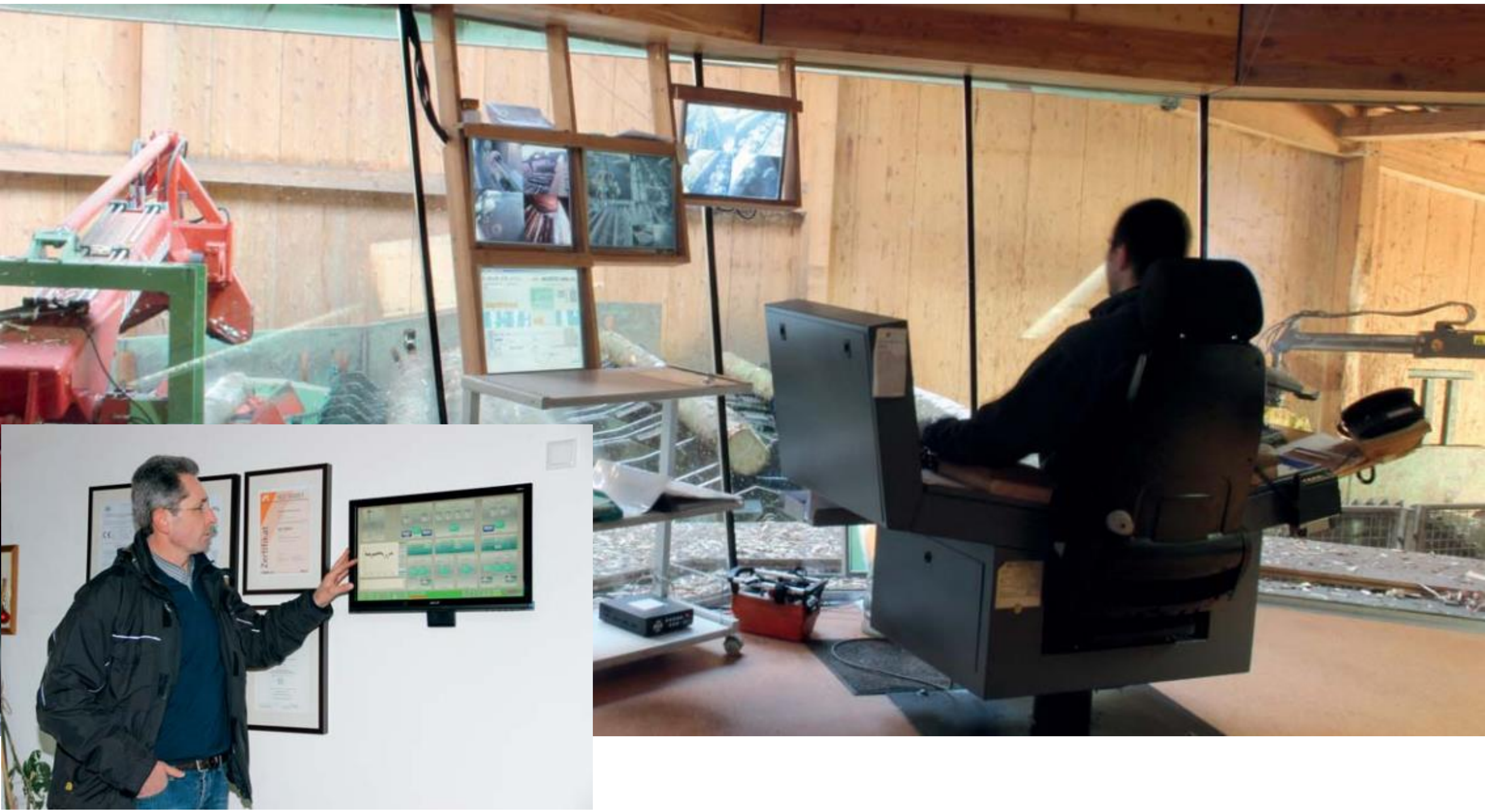
Direct measurement
- KL33xx, EL33xx and EP3314 thermocouple
- KL32xx, EL32xx and EP3204 resistance sensor RTD

Temperature

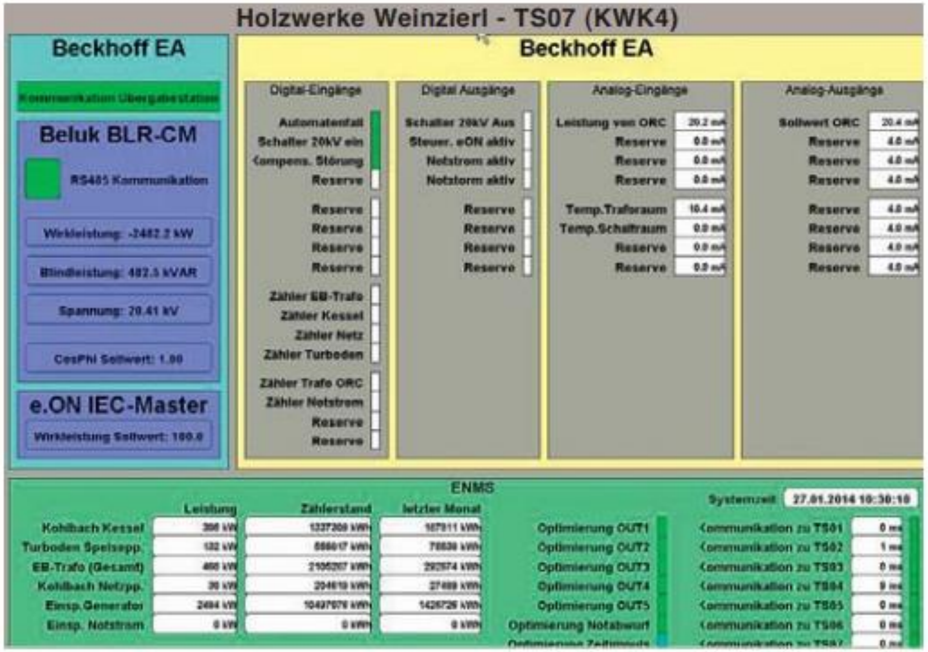
Direct measurement
- EL3632 CMS terminal (IEPE)

Condition Monitoring

Case study - Holzwerke Weinzierl GmbH
Energy management system for lumber mill



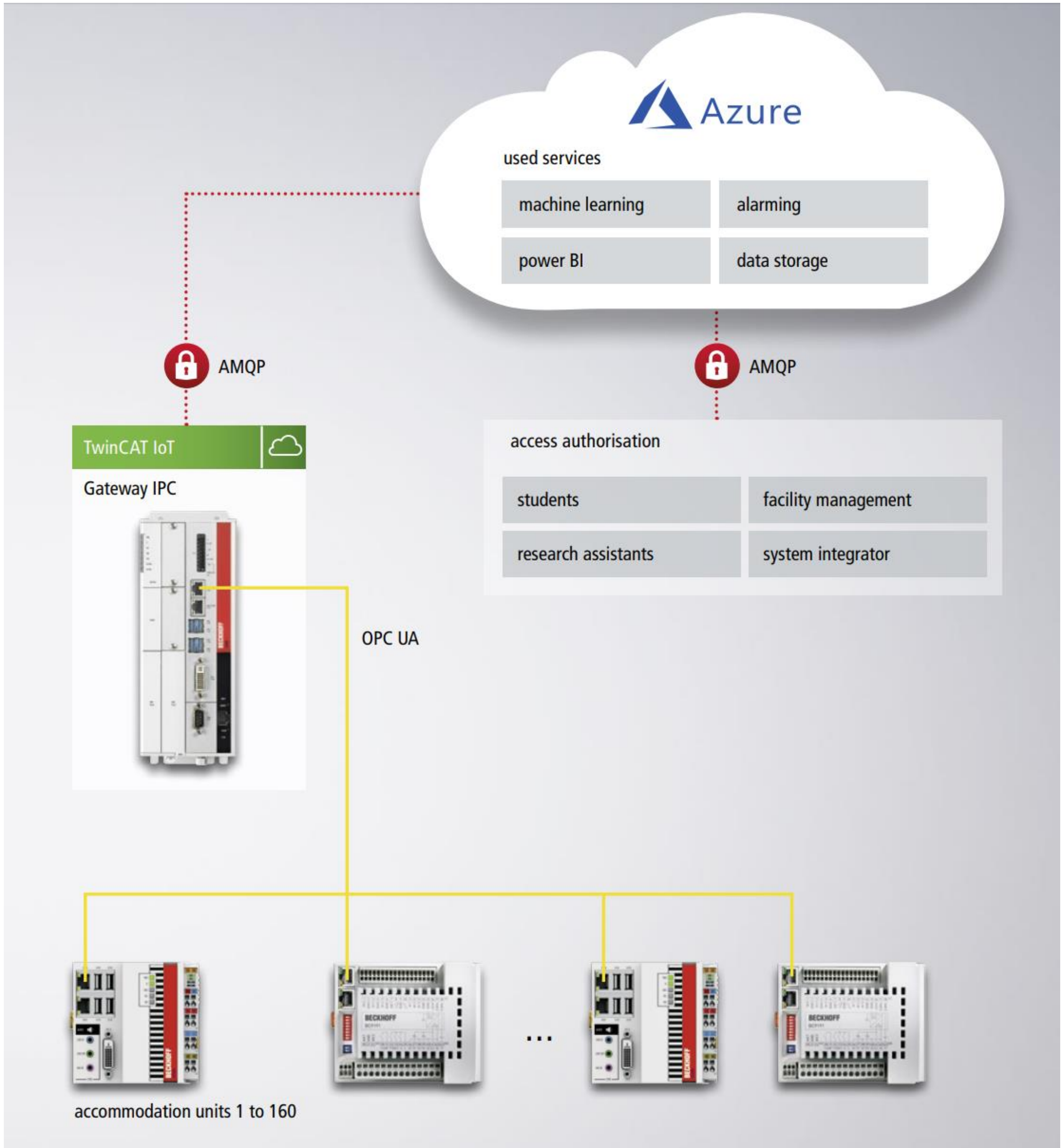
Case study - Holzwerke Weinzierl GmbH
Energy management system for lumber mill



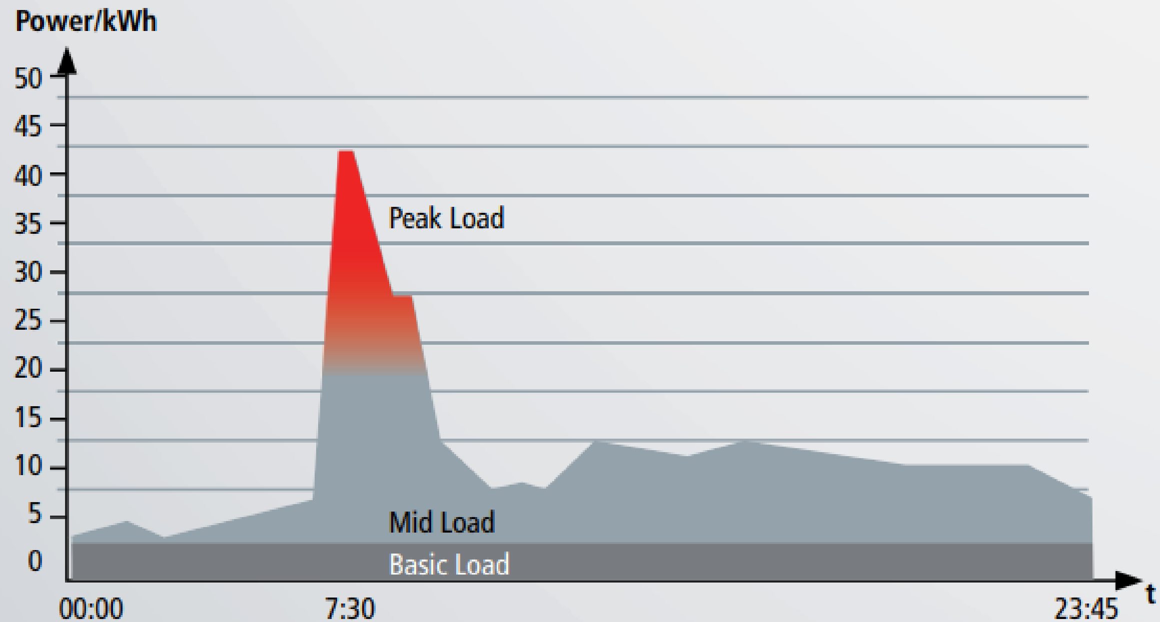
The web-based visualization system provides a rapid overview and diagnostic capabilities.

With several bio-mass boilers and solar power installations, Holzwerke Weinzierl generates "green" electricity that is CO_2-neutral.

IoT in use: 24/7 energy management



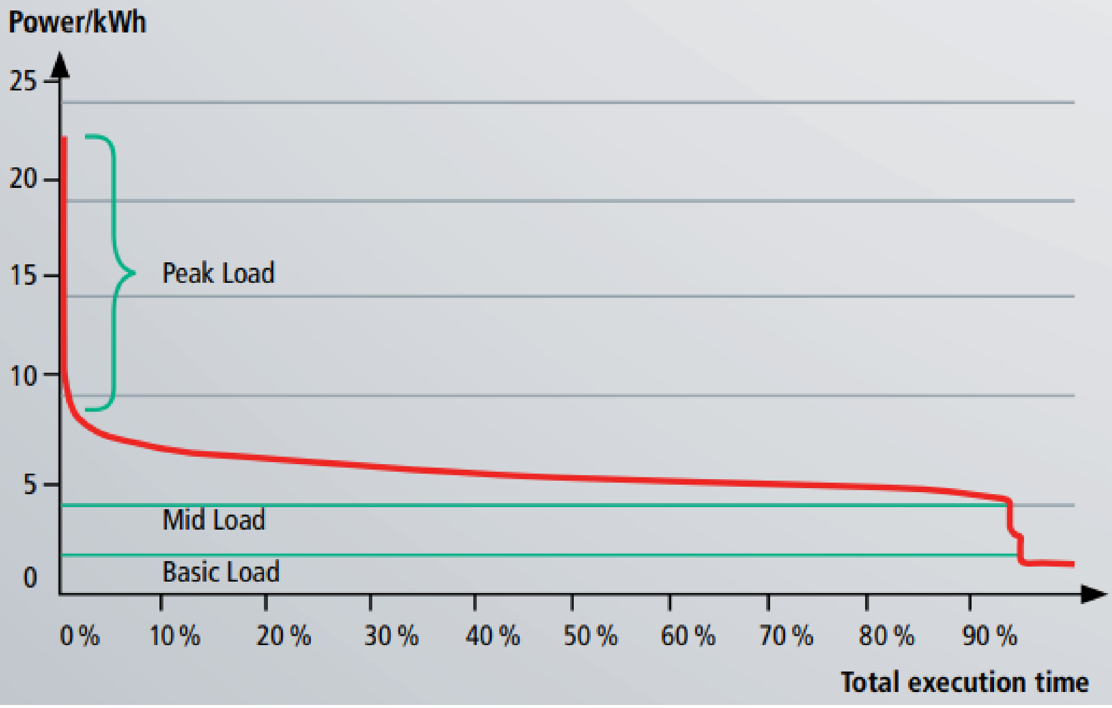
…creating the basis for extensive and actionable analyses



Load curve determination with PC-based control.

PC-based control supplies the data on the basis of which load curves are created, the peak loads are determined and peak load compensation is enabled.

…creating the basis for extensive and actionable analyses

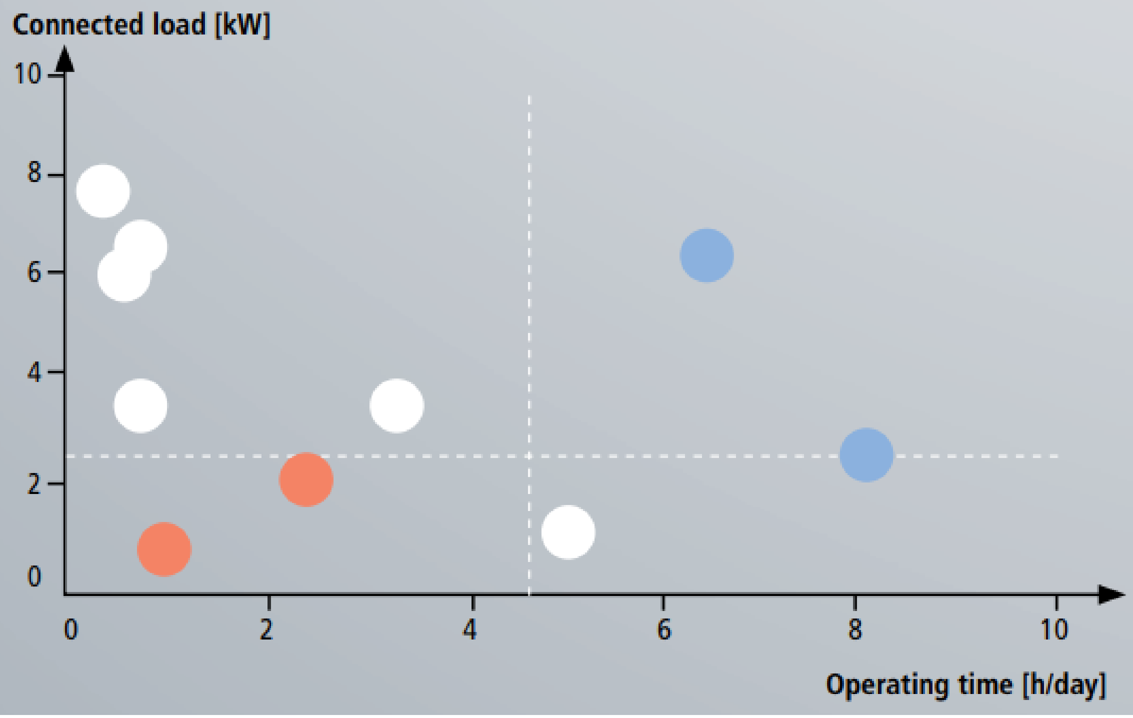


Operation during analysis with PC-based control.

PC-based control supplies data on the basis of how to best determine the percentage of total load attributable to each individual load as well as the basic and mean loads.

Energy consumption

…creating the basis for extensive and actionable analyses



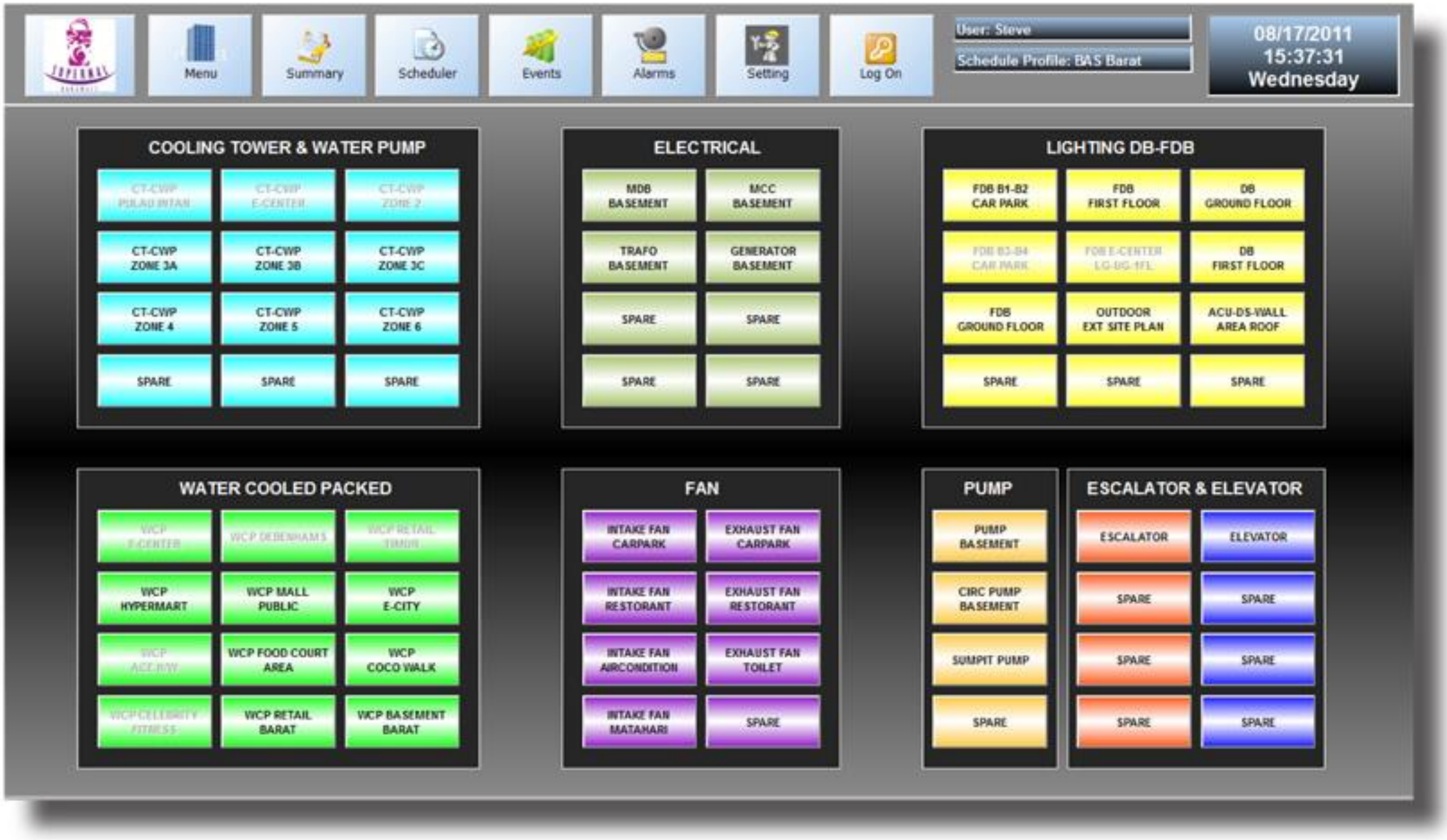
Portfolio comparison with PC-based control.

PC-based control can also help illustrate and compare the energy consumption data of individual machines in relation to other machines.

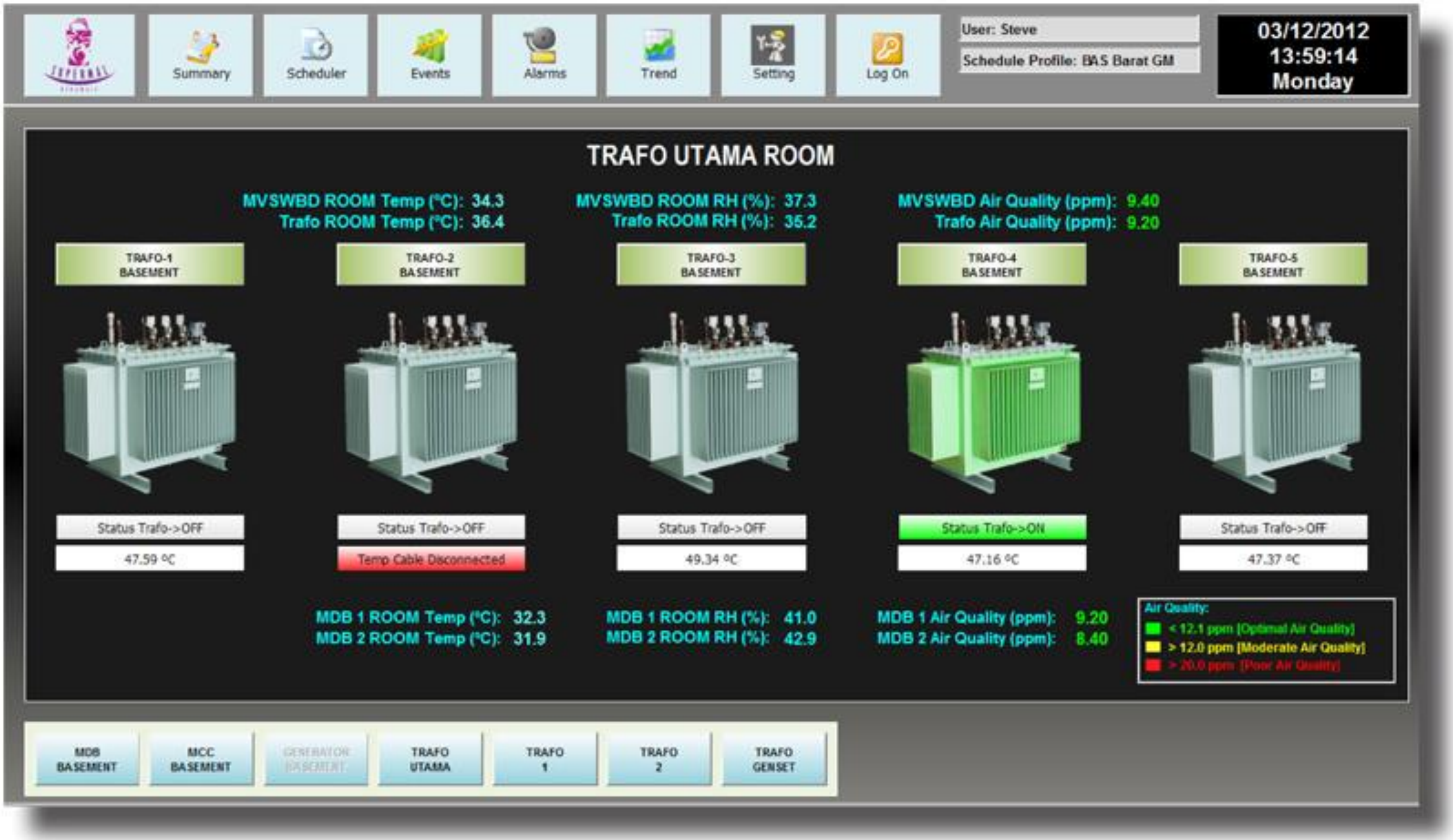
Energy monitoring sample page

Energy monitoring sample page

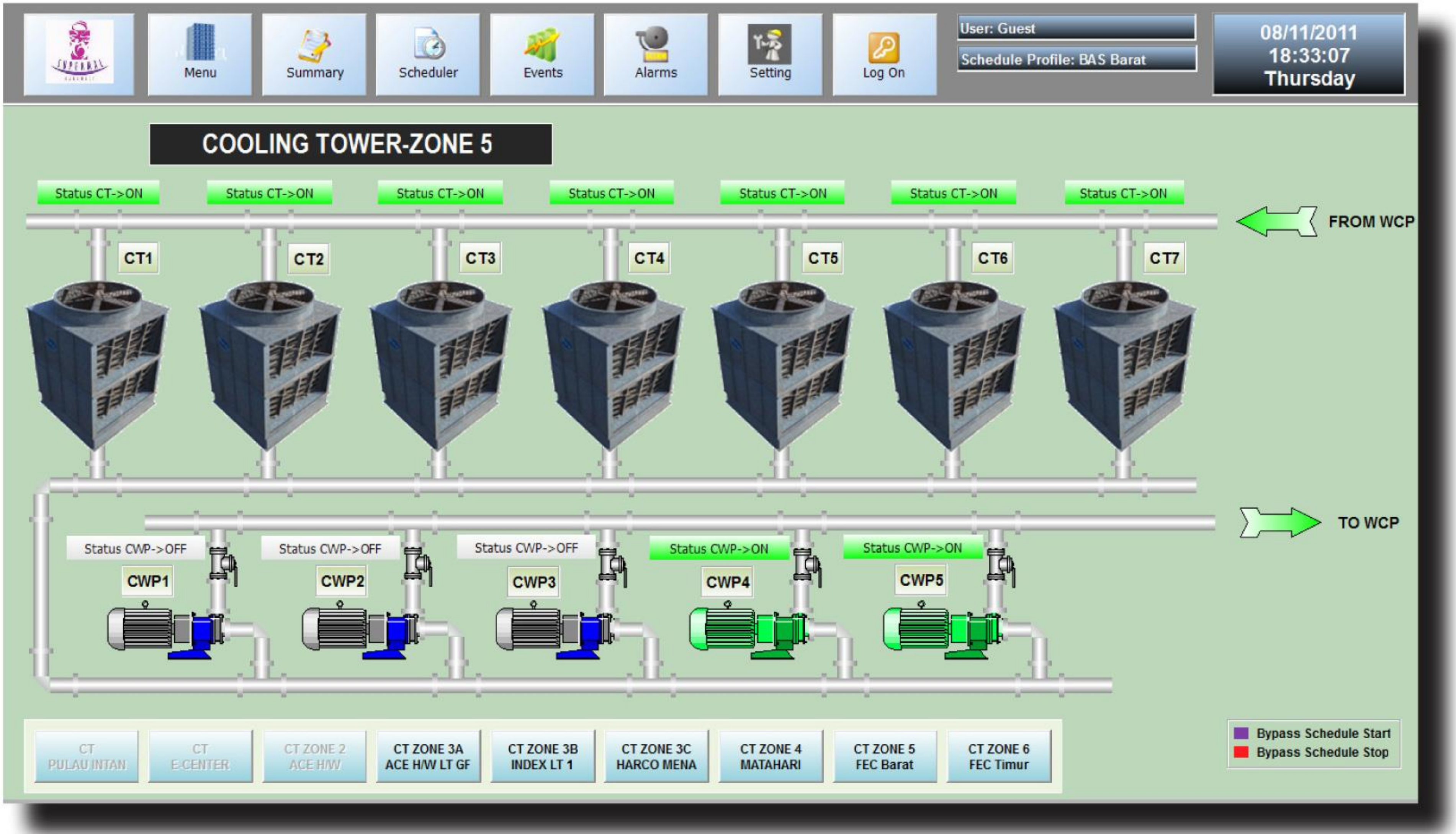
Energy monitoring sample page



Energy monitoring sample page

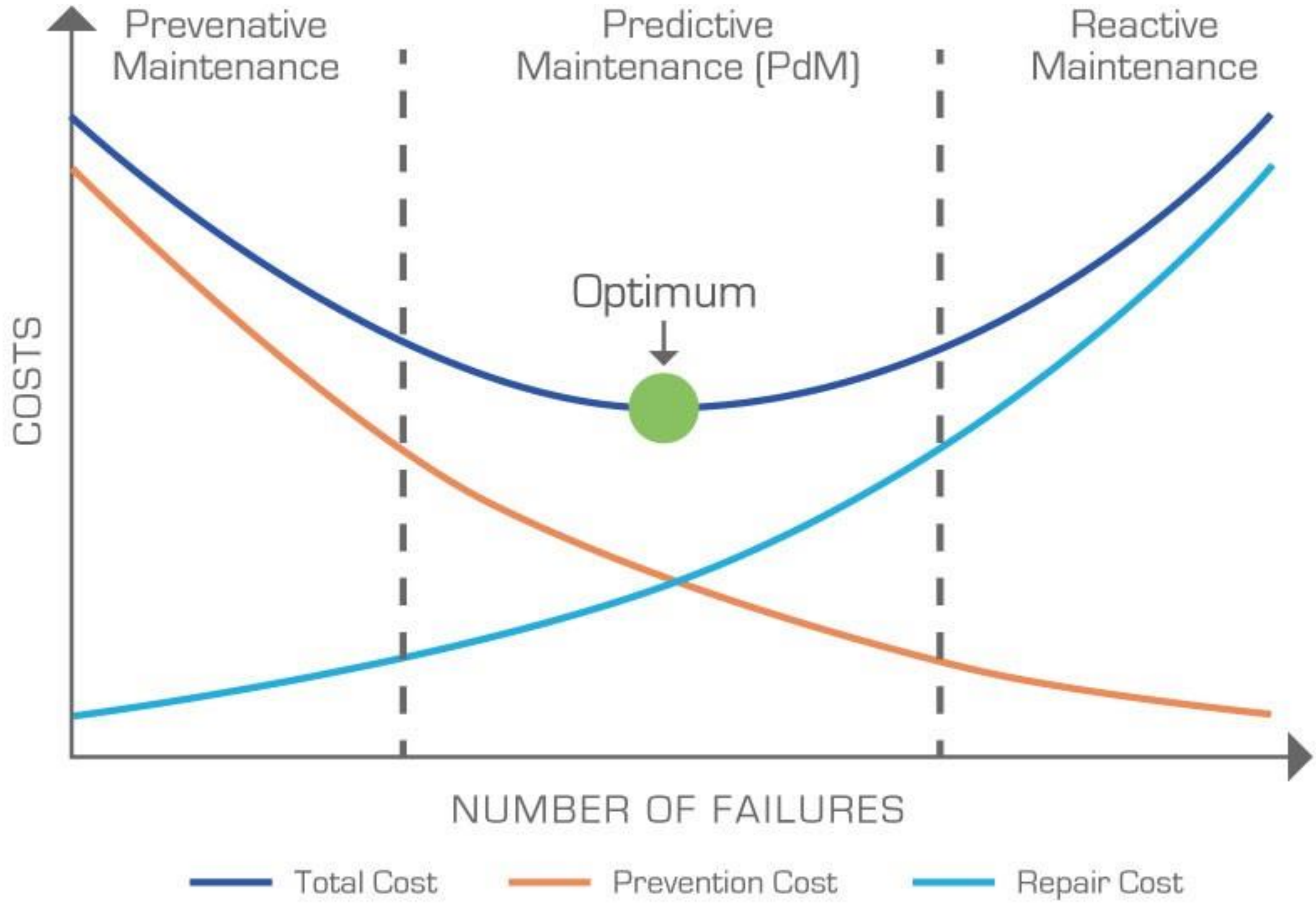


Energy monitoring sample page



PC-based Control:
Machine diagnostics and predictive maintenance

Motivation


Prevenative
Maintenance
Predictive
Maintenance (PdM)
Reactive
Maintenance
Optimum
COSTS
NUMBER OF FAILURES
Total Cost
Prevention Cost
Repair Cost

Predictive vs Preventive maintenance

Predictive vs. preventive maintenance

Though the best maintenance programs include a balance of both, preventive maintenance and predictive maintenance are different strategies. Preventive maintenance is determined using the average or expected life cycle of an asset, whereas predictive maintenance is identified based on the condition of equipment.

While predictive maintenance is more complex to establish than a preventive maintenance schedule based on manufacturer recommendations, it can be more effective for a business to save time and money. For example, taking vibration measurements on an electric engine at recommended intervals more accurately detects bearing wear and allows organizations to take action such as replacing a bearing before total failure occurs.

While the **investment** into a predictive maintenance program can be costly to install, it results in reduced maintenance costs and downtime and delivers 10 times the ROI for the oil and gas industry alone, according to research strategy consulting firm Roland Berger. For example, predictive maintenance is often used for wind turbines since wind farms often traditionally have high operational costs. And **field service** software can be used along with predictive maintenance tools to make sure your machinery keeps running efficiently.

Predictive Maintenance

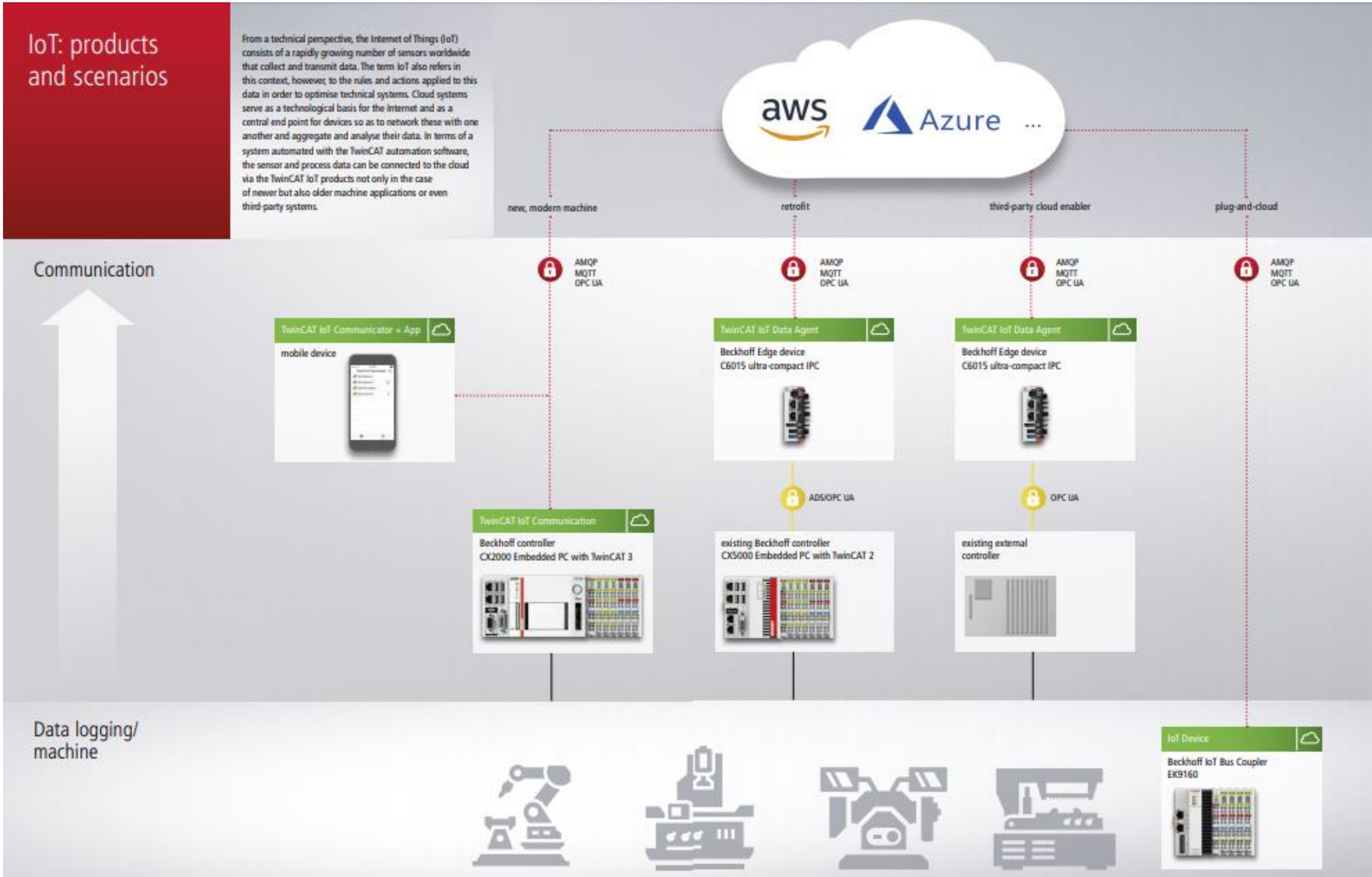
Predictive Maintenance and the Internet of Things

With the increased networking of machines and manufacturing facilities in the **Internet of Things**, predictive maintenance is becoming more and more important. Sensors facilitate the easy monitoring of machine conditions, cloud storage systems and data bases enable the long-time archiving and analysis of machine data for diagnostic and maintenance purposes.

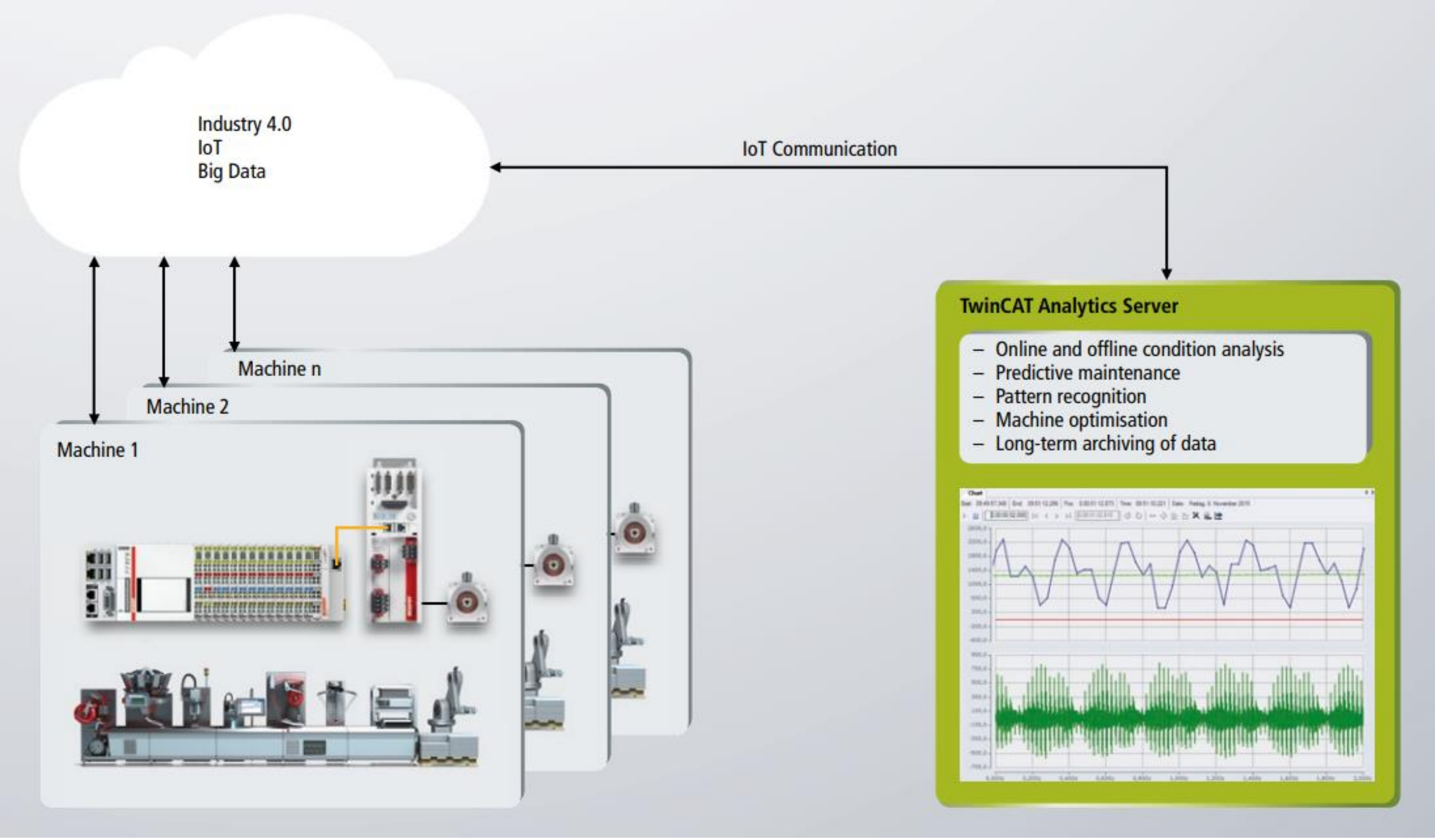
By means of real-time monitoring, a comprehensive data pool, and state-of-the-art analytical methods, machine-specific malfunctions can be predicted by 70 %. This enables field service technicians to intervene in time to effectively prevent failures as well as unnecessary maintenance measures, downtimes, and costs.

However, the benefits of the Internet of Things and predictive maintenance are not confined to new facilities. Older machines with life cycles of 50 or 60 years can also easily be integrated into predictive maintenance schemes by means of targeted retrofit measures.

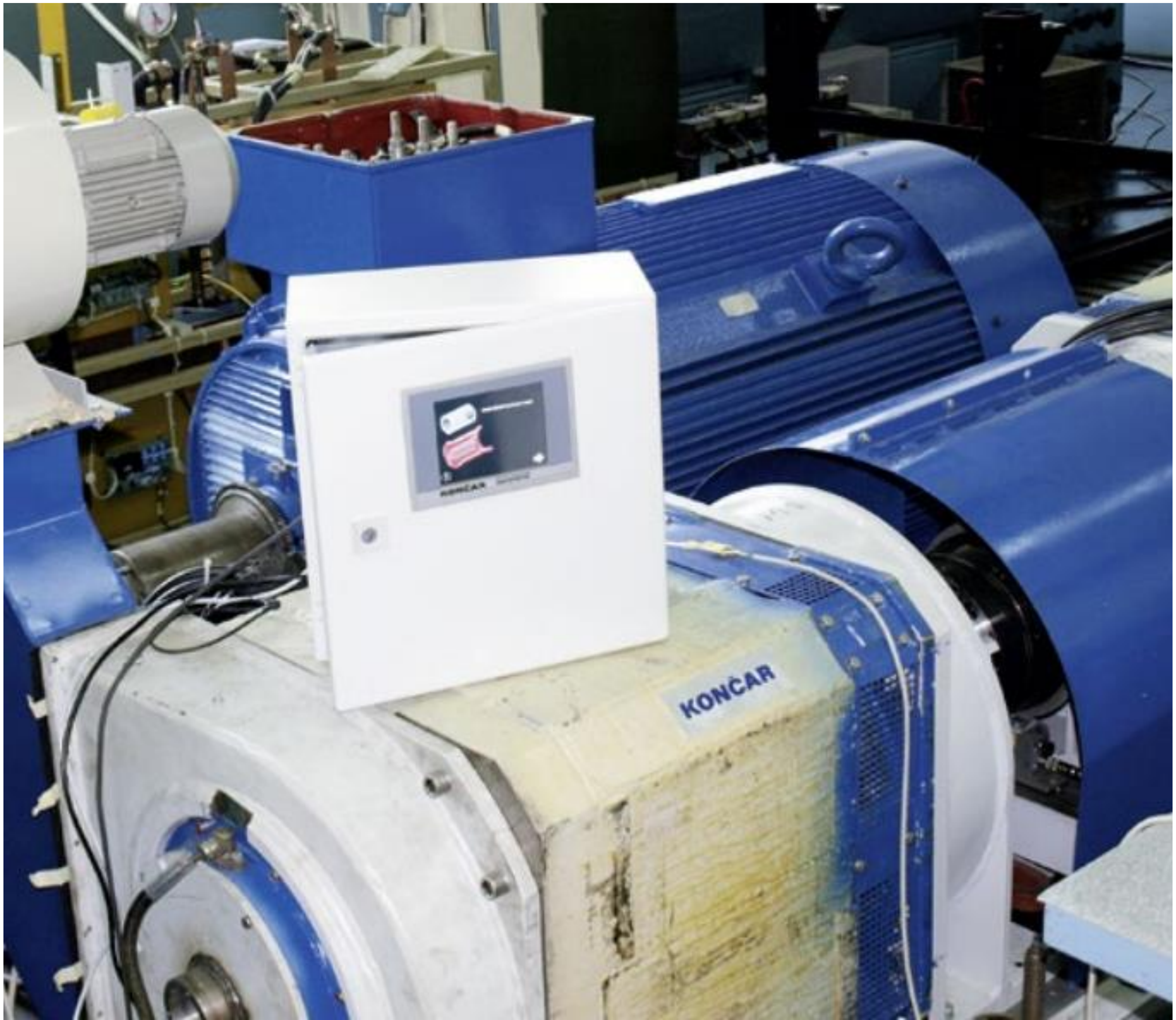
Data acquisition scenarios for predictive maintenance



Industrie 4.0 enables real time seamless data collection



Case study - The KONČAR – Electrical Engineering Institute, Inc
Expert Motor Condition Monitoring (EMCM) system



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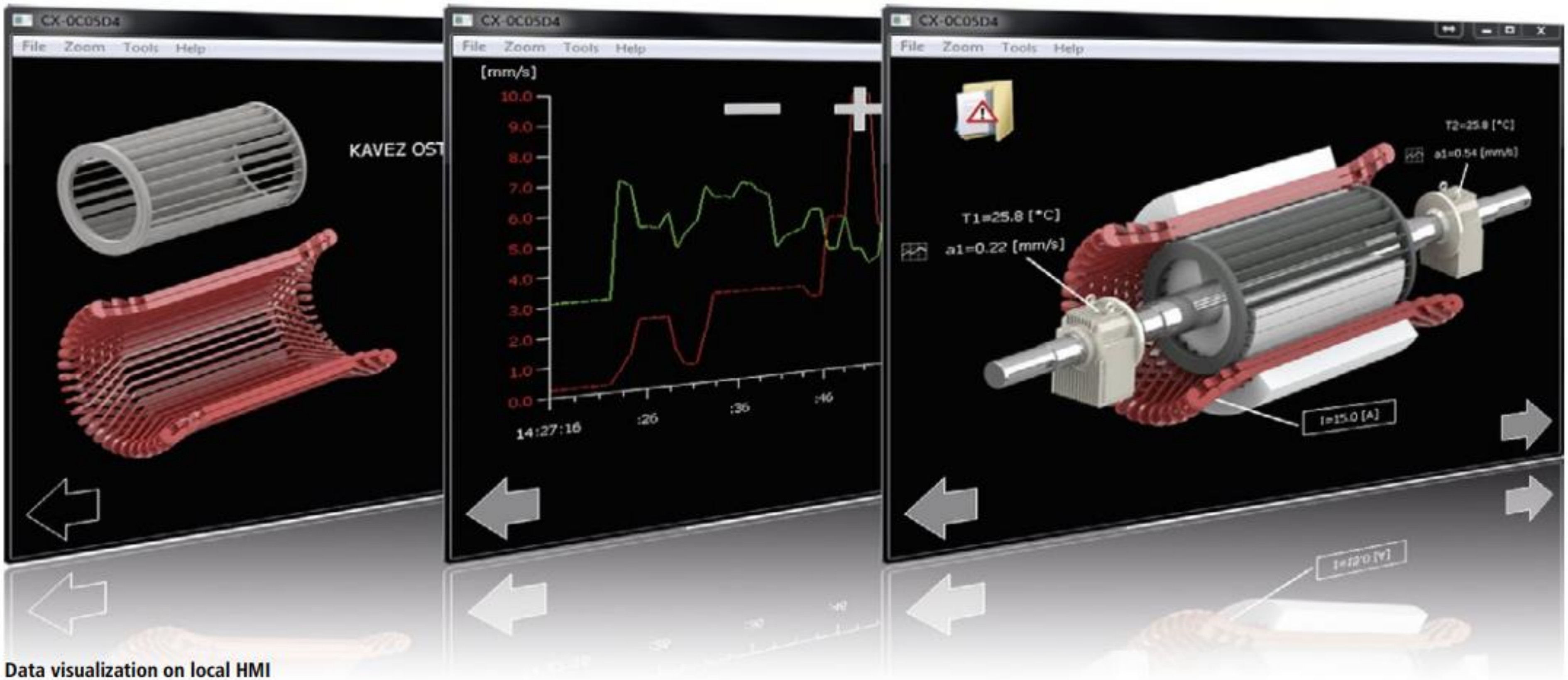
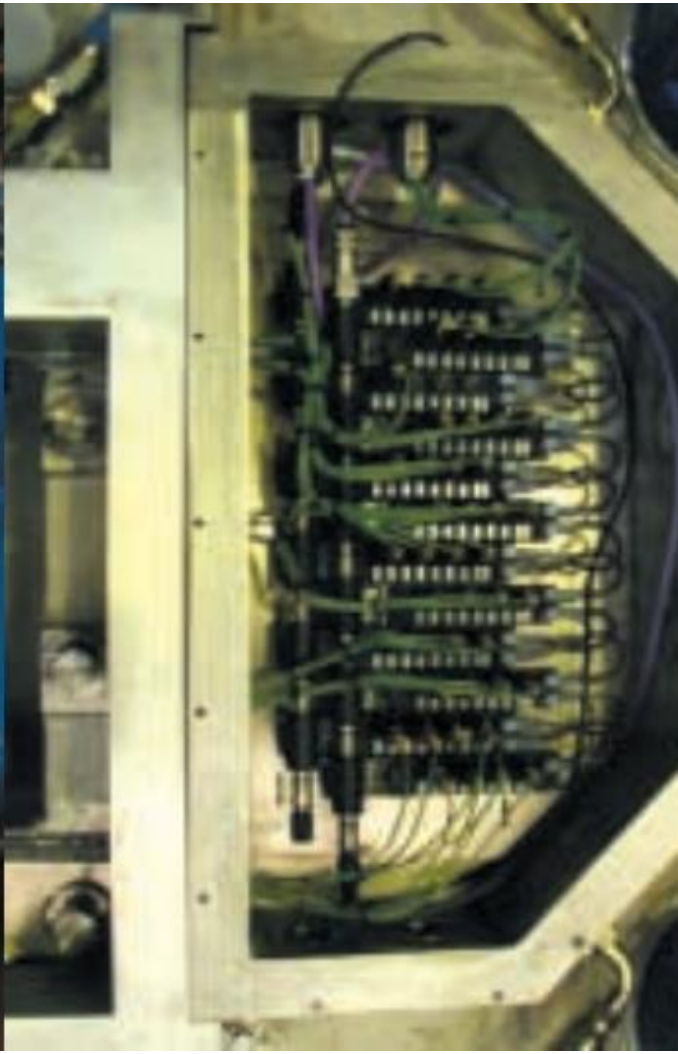


Data visualization on local HMI

Case study
SMS Demag – Breakout prediction systems



Case study
SMS Demag – Breakout prediction systems

Case study
TAR Automation – Condition Monitoring System (CMS)

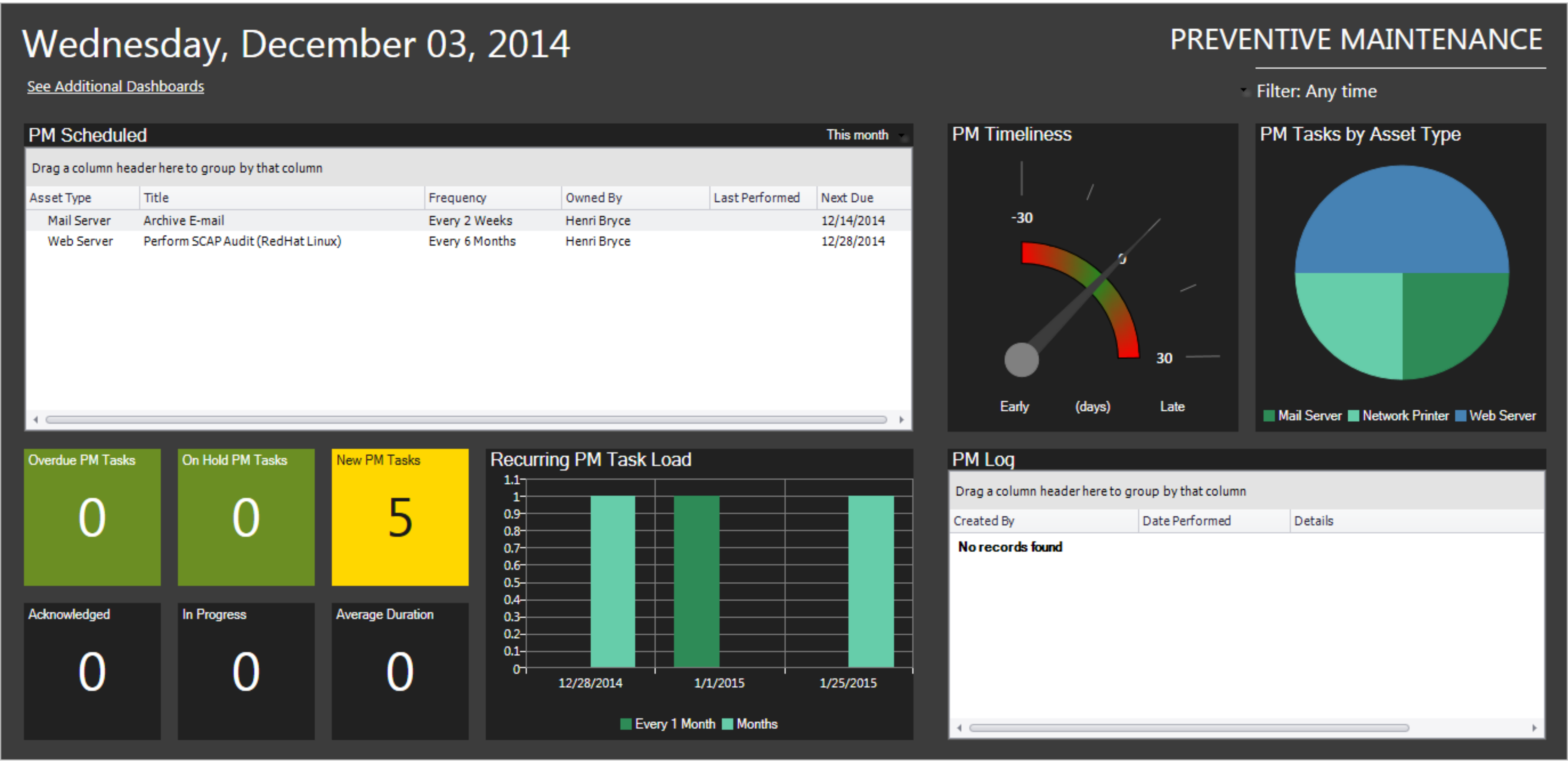
Case study
TAR Automation – Condition Monitoring System (CMS)

The condition monitoring system is supplied ready for operation, installed in a compact terminal box.

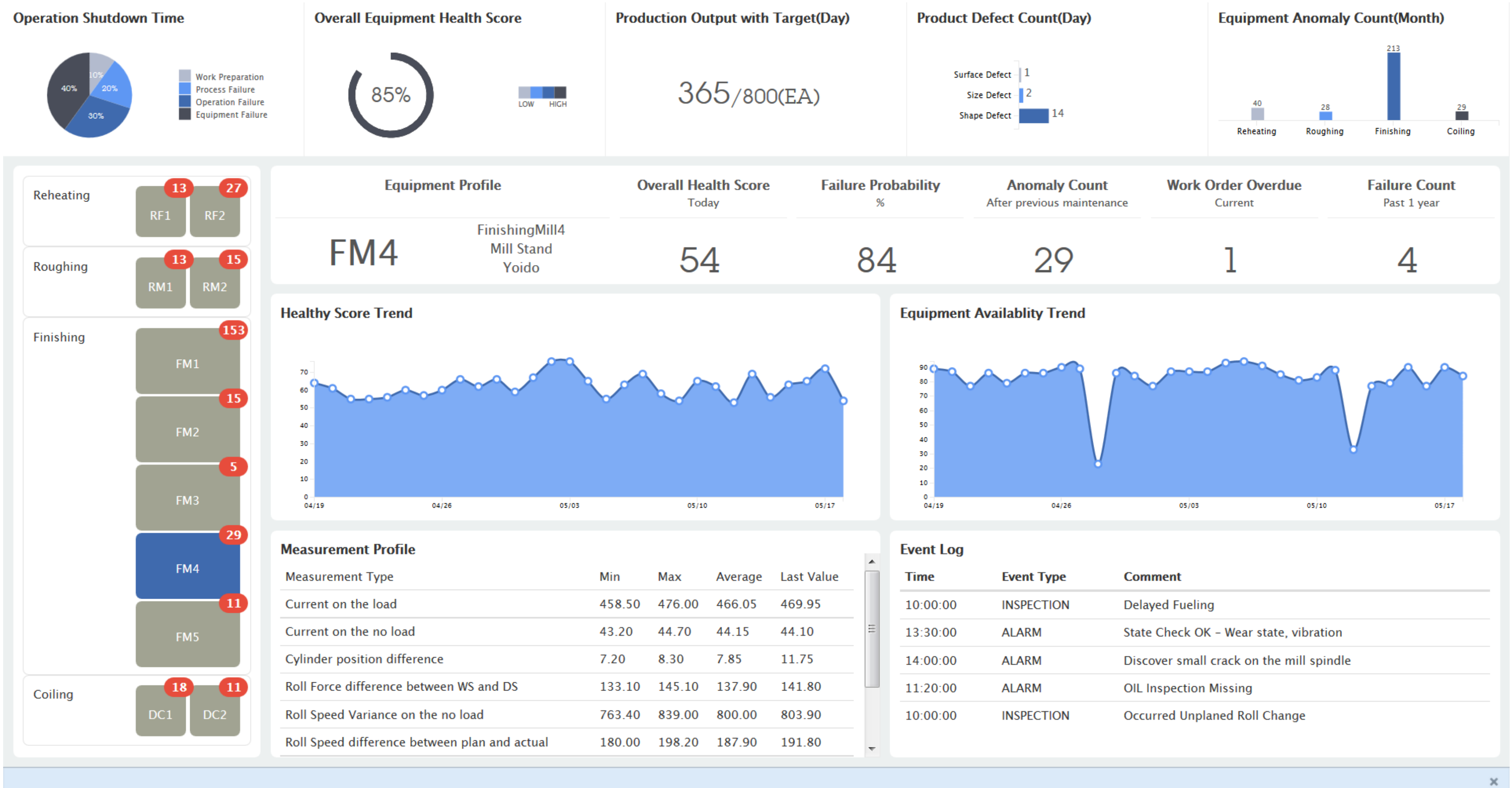
Industry 4.0: Communication standards for vertical and horizontal networking

The wide range of Embedded PCs are scalable in terms of performance and I/O configuration while offering diverse networking options. This offers many degrees of freedom when implementing control architectures and, as a result, optimum solutions for the tasks at hand. "Whether we are dealing with a small, stand-alone solution, networking of decentralized, intelligent controllers or a high-performance central solution – anything is possible," concludes TAR's Managing Director. "In combination with support for OPC UA as the universal standard for vertical networking, it is also possible to integrate ERP systems, both within a site and across sites."

Preventive Maintenance sample page



Predictive Maintenance sample page



Creating value:
IoT and Data Analytics from Beckhoff

The simple route from data recording to the dashboard

The Beckhoff principle is simplicity in itself: Beckhoff makes the route from data recording in the field to communication and historicisation through to data analysis in the framework of a user-specific HMI concept a comparatively simple one. IoT and data analytics scenarios can be integrated directly into existing tool landscapes and existing IT infrastructures. Sensors integrated directly with the control system are used to record data. Available fieldbuses can be used for communication, with standard protocols being used to exchange data with the cloud. Such simplicity pays off: costs, effort and training periods are reduced significantly.

Data logging

A number of different fieldbus systems can be used to record a machine's sensor data, with use of existing cabling and different topologies possible on the basis of EtherCAT.

Communication

The recorded sensor data can be communicated onward on the basis of communication standards, which can be integrated simply and securely into existing IT infrastructures.

Data historicisation

The entire communication data can be stored in a long-term archive. Thus, even subsequent analyses are possible.

Analysis

The user views data and configures his analyses in the TwinCAT Engineering. From this configuration, completed PLC code can be generated.

Industrie 4.0
From factory floor to your hand