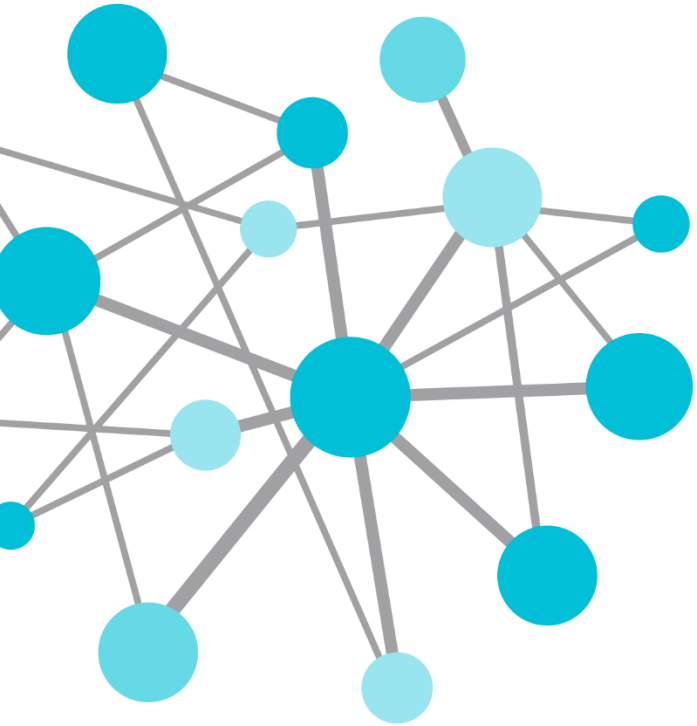
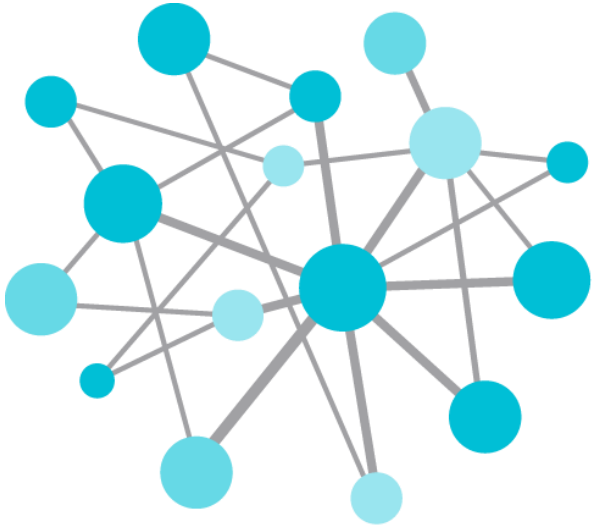


Power of Connection in Power industry

Presented by **Miguel Chavero**

EMEA Power & Utilities Industry Principal



OSIsoft.

REGIONAL SEMINAR 2014

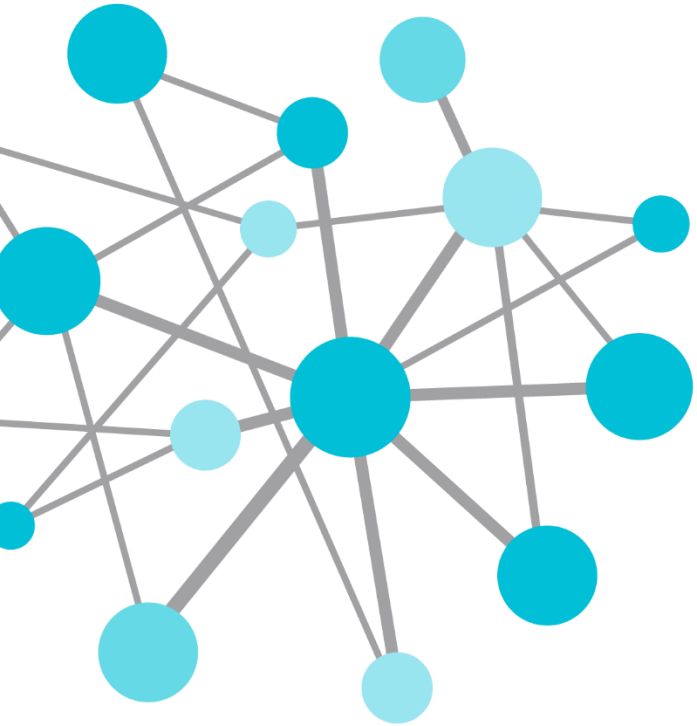
The Power of Data

E M E A

DECISION READY IN REAL-TIME

Agenda

- Introduction
- PowerGen Industry Pain Points
- PowerGen Industry Trends
- The Power of connection
- Showcases
- Q&A

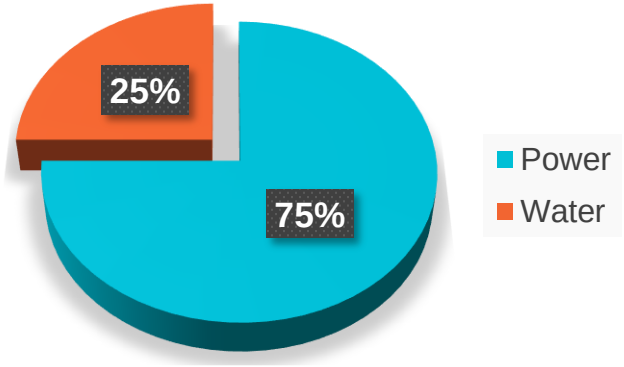


Introduction

Selected European PowerGen Customers

EMEA P&U Industry Principal

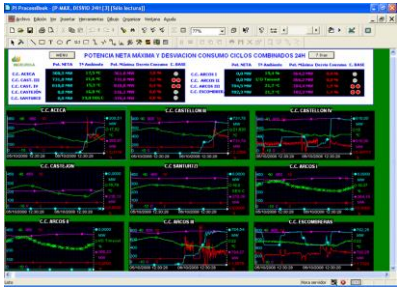
Experience (16 years)

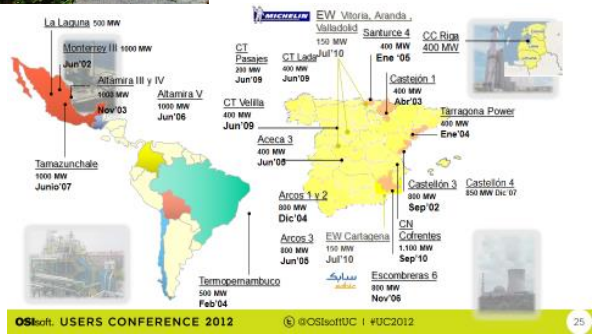


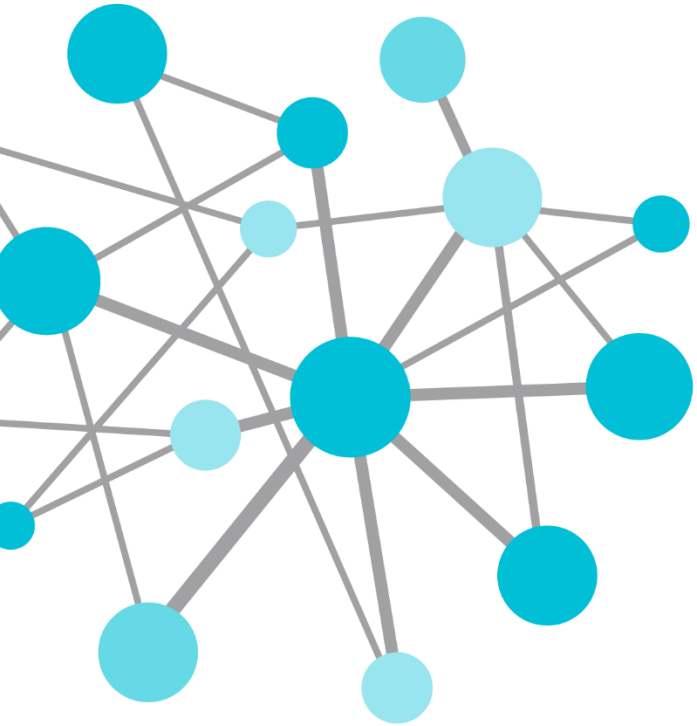
IBERDROLA

GRUPO AGUAS DE VALENCIA

CERTIFIED INFORMATION SYSTEMS SECURITY PROFESSIONAL CISSP







Industry Pain Points

PowerGen Industry Pain Points

Climate Change and environmental concerns

Growth in renewable generation and distributed resources

Aging asset performance with increased expectations on reliability

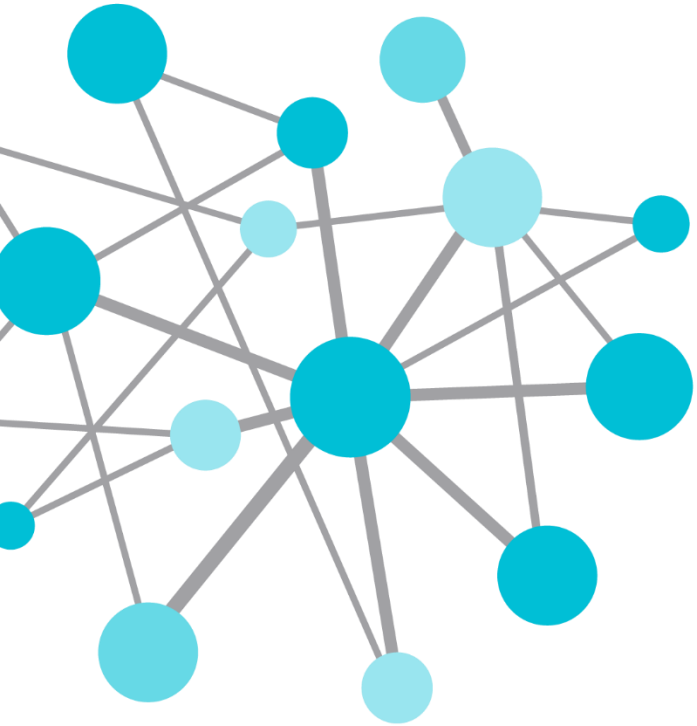
Increased pressure on operational efficiency and workforce productivity

Demand reducing due to Global Crisis

Fuel costs keep rising

PowerGen Industry Pain Points

CCGT	COAL	HYDRO	NUCLEAR	RENEWABLE
• Low production landscape • A lot of start-up and shutdown just for some generation hours (even twice per day) • Gas costs still rising • Last technology on the market pool	• Aging asset landscape • Low carbon initiatives across EU countries • Lack of automation in some systems / processes • Human resources reluctant to new technologies	• Aging asset landscape • No new projects due to market collapse or investments constraints • New “Green taxes” reduce margin • New environmental regulations impact • Hydro resources management	• FUKUSIMA disaster constrained or even stopped new developments and also forced new investments on existing ones • Safety, Safety and Safety • Compliance	• Margin narrowing in some countries • Not homogenous regulation across EU • Rapidly growth impacts on grid stability • Large number and distributed assets difficult operations



Industry Trends

PowerGen Industry Trends

PowerGen Industry Trends

CCGT

- From Base Load towards two-shifting operational mode (high impact on asset Lifecycle)
- Real-time training simulators
- Availability and Efficiency is a must
- In some countries planning to shutdown or hibernate power stations

COAL

- Reducing CO2 emissions projects (FGD, CO2 capture,…)
- New automation projects to reduce operational costs
- Controllable losses initiatives to maximize incomings

HYDRO

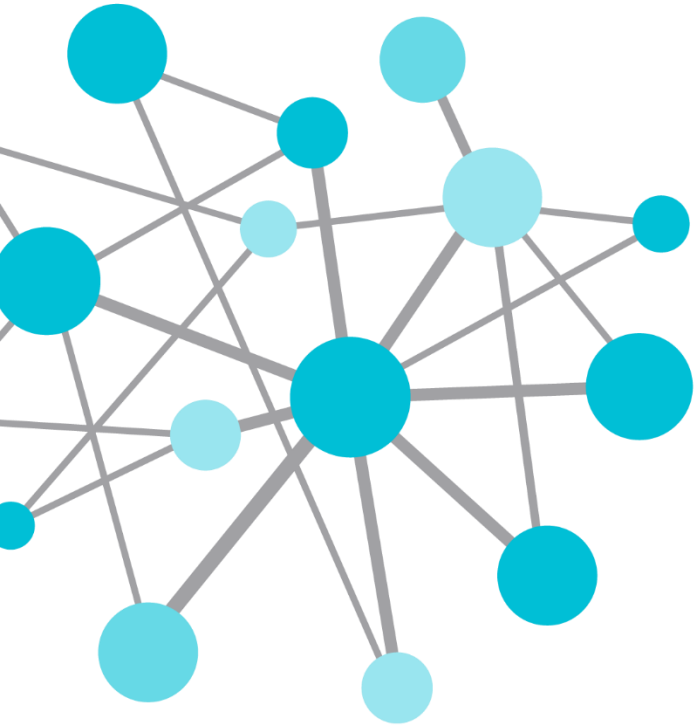
- New Pump Storage projects for balancing the system (peak mode)
- Environmental compliance being critical
- Dam monitoring refurbishment projects
- New systems deployment for Emergency response

NUCLEAR

- New refurbishment projects after FUKUSIMA disaster
- Moving from analog to digital systems. Cybersecurity is a must
- Operational and reliability excellence programs
- Emergency preparedness and response programs

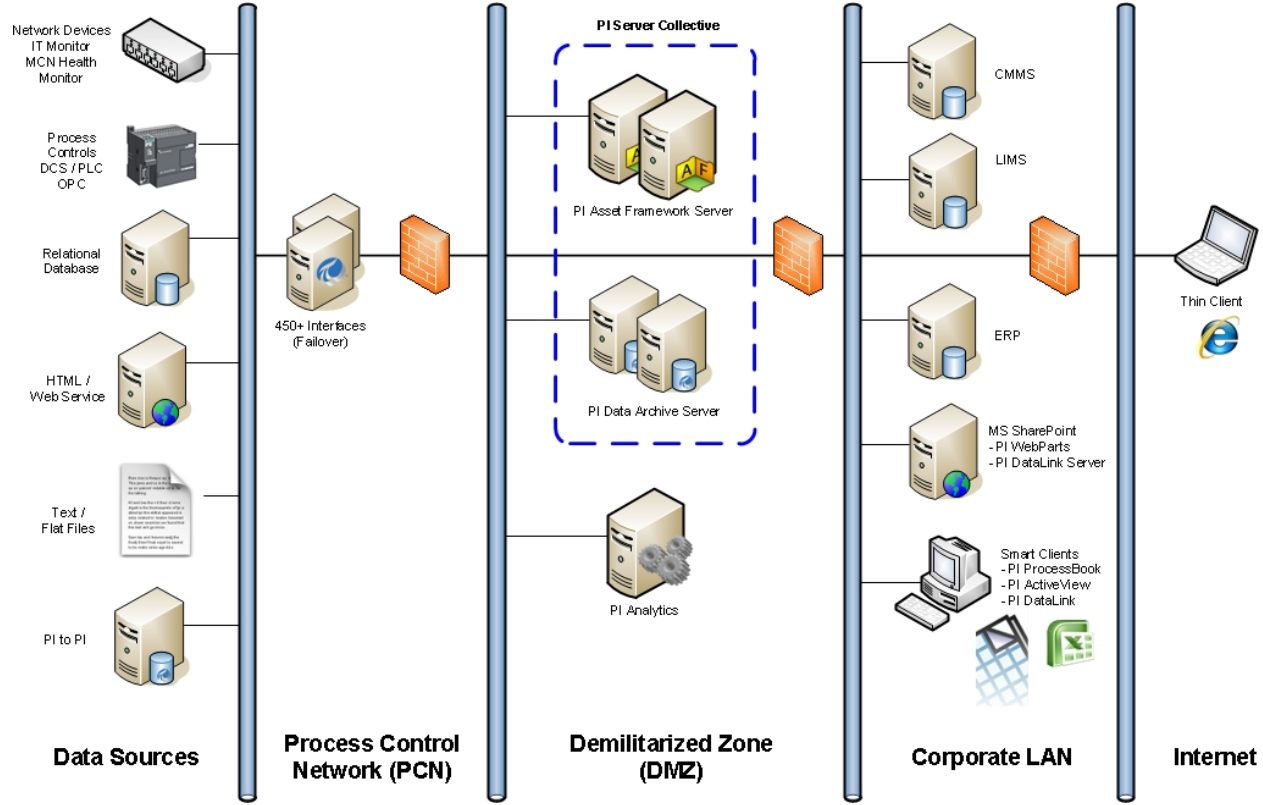
RENEWABLE

- New Off-shore deployments
- CBM programs across worldwide fleet
- New curtailment strategies for maximizing revenues
- Predictive analytics become critical (Production forecasting)
- GIS integration initiatives

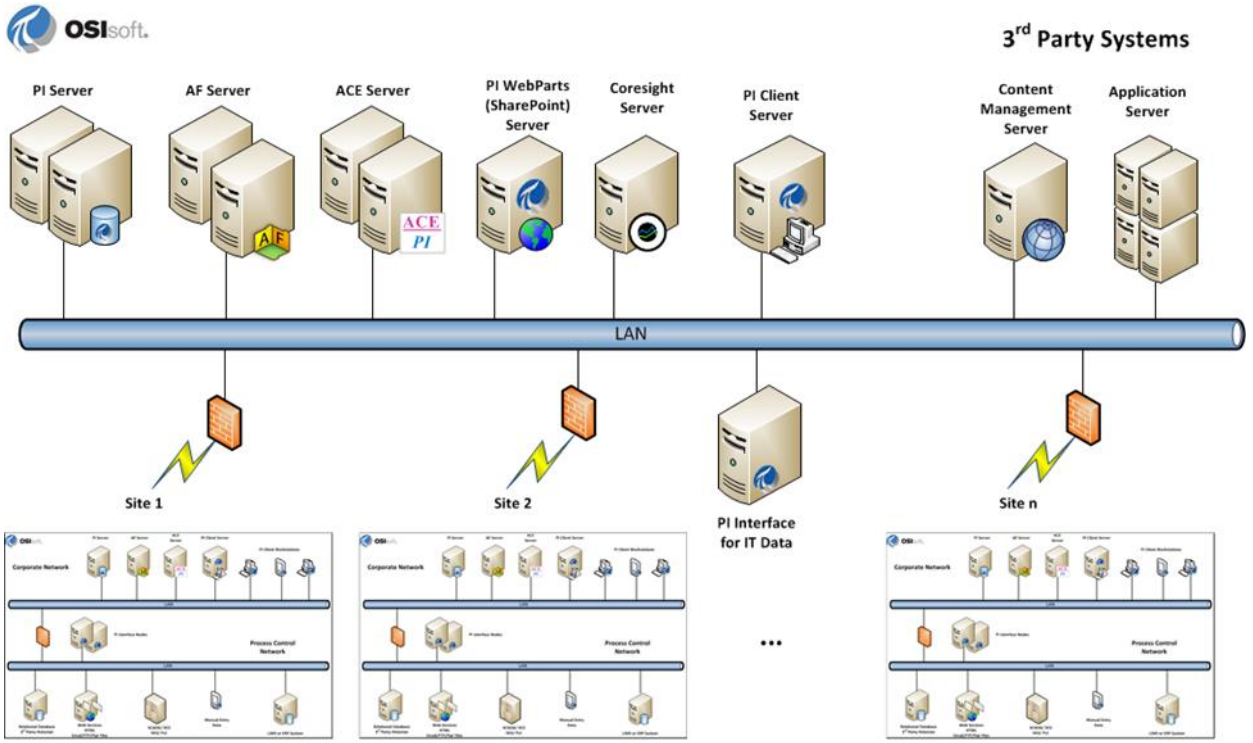


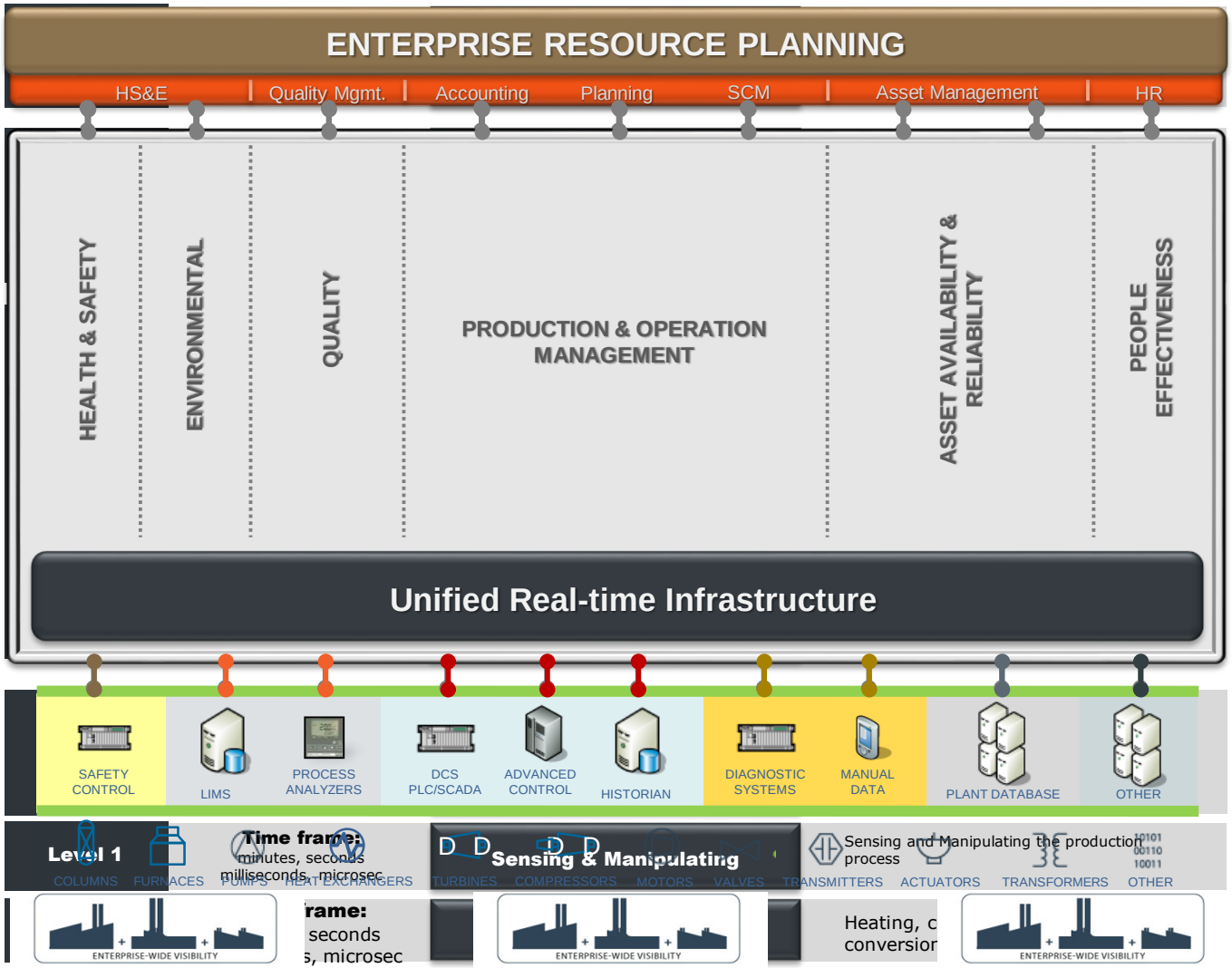
The Power of Connection

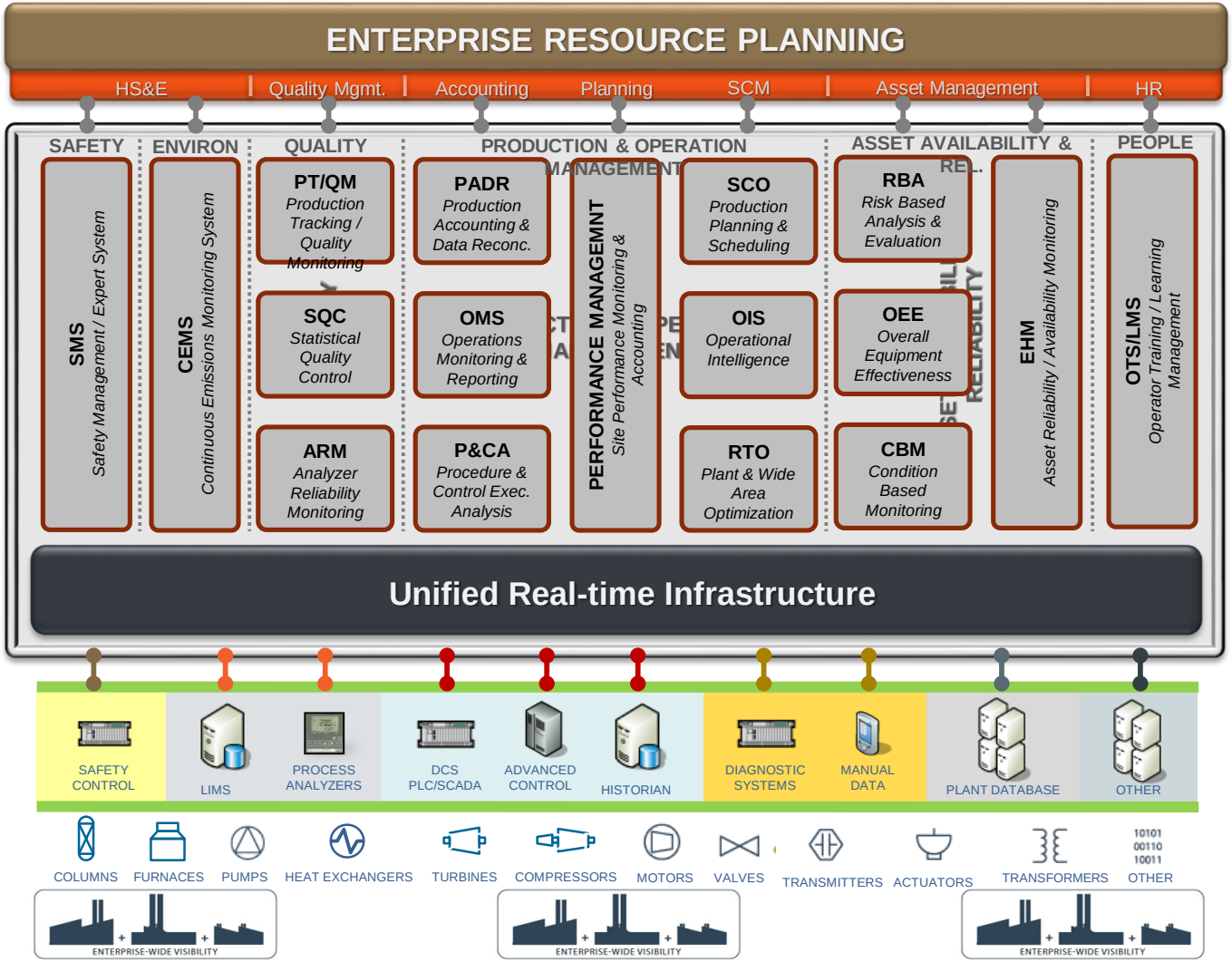
The Power of Connection



The Power of Connection




ENTERPRISE RESOURCE PLANNING
HS&E
Quality Mgmt.
Accounting
Planning
SCM
Asset Management
HR
HEALTH & SAFETY
ENVIRONMENTAL
QUALITY
PRODUCTION & OPERATION MANAGEMENT
ASSET AVAILABILITY & RELIABILITY
PEOPLE EFFECTIVENESS
Unified Real-time Infrastructure
SAFETY CONTROL
LIMS
PROCESS ANALYZERS
DCS PLC/SCADA
ADVANCED CONTROL
HISTORIAN
DIAGNOSTIC SYSTEMS
MANUAL DATA
PLANT DATABASE
OTHER
Level 1
Time frame:
minutes, seconds
milliseconds, microsec
Sensing & Manipulating
Sensing and Manipulating the production process
COLUMNS
FURNACES
PUMPS
HEAT EXCHANGERS
TURBINES
COMPRESSORS
MOTORS
VALVES
TRANSMITTERS
ACTUATORS
TRANSFORMERS
OTHER
ENTERPRISE-WIDE VISIBILITY
ENTERPRISE-WIDE VISIBILITY
ENTERPRISE-WIDE VISIBILITY


ENTERPRISE RESOURCE PLANNING
HS&E
Quality Mgmt.
Accounting
Planning
SCM
Asset Management
HR
SAFETY
ENVIRON
QUALITY
PRODUCTION & OPERATION MANAGEMENT
ASSET AVAILABILITY & RE..
PEOPLE
SMS
Safety Management / Expert System
CEMS
Continuous Emissions Monitoring System
PT/QM
Production Tracking / Quality Monitoring
SQC
Statistical Quality Control
ARM
Analyzer Reliability Monitoring
PADR
Production Accounting & Data Reconc.
OMS
Operations Monitoring & Reporting
P&CA
Procedure & Control Exec. Analysis
PERFORMANCE MANAGEMNT
Site Performance Monitoring & Accounting
SCO
Production Planning & Scheduling
OIS
Operational Intelligence
RTO
Plant & Wide Area Optimization
RBA
Risk Based Analysis & Evaluation
OEE
Overall Equipment Effectiveness
CBM
Condition Based Monitoring
EHM
Asset Reliability / Availability Monitoring
OTS/LMS
Operator Training / Learning Management
Unified Real-time Infrastructure
SAFETY CONTROL
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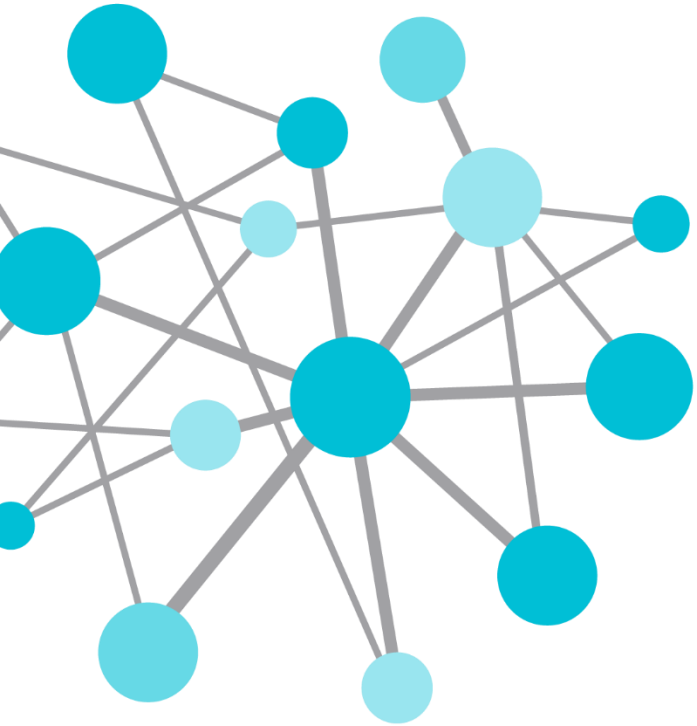
ACTUATORS
TRANSFORMERS
OTHER
ENTERPRISE-WIDE VISIBILITY
ENTERPRISE-WIDE VISIBILITY
ENTERPRISE-WIDE VISIBILITY

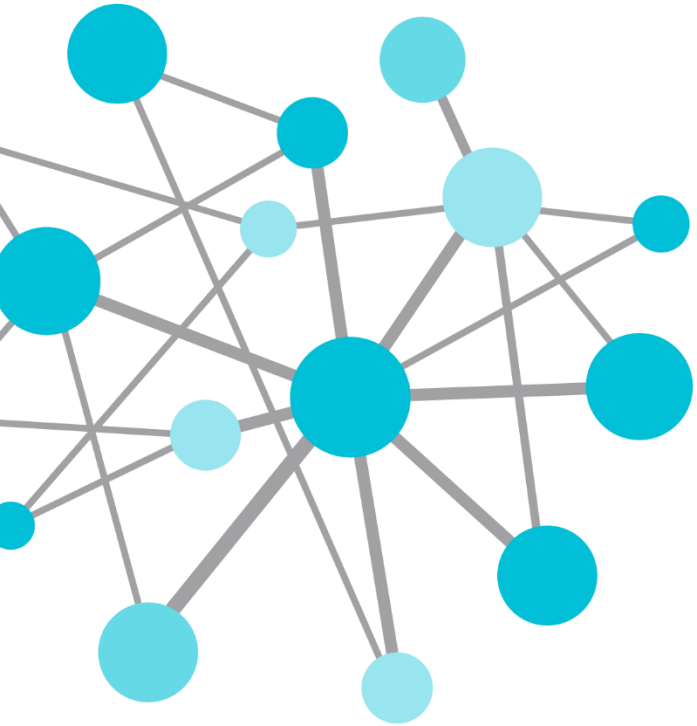
Addressing the Industry Challenges

PI System Supports Generation Core Processes

- Proactive and Condition Based Maintenance
- Operations (extend DCS beyond the Control Room)
- Controllable Losses
- Start Up / Shut Down
- Root Cause Analysis (RCA)
- Outage Planning (plan and spend on the right things)
- Vendor Performance (Pre and Post work review)
- Equipment / Manufacture Performance
- Plant System Performance & Efficiency
- Environmental (Compliance, emissions, limits, reporting)
- Water Chemistry monitoring (Steam-Water Cycle)
- Enterprise core metrics and KPIs
- Security- Passive access to Plant information
- Scheduling, Ancillary Services (AGC, regulation, voltage..), and Dispatch Optimization



Showcases



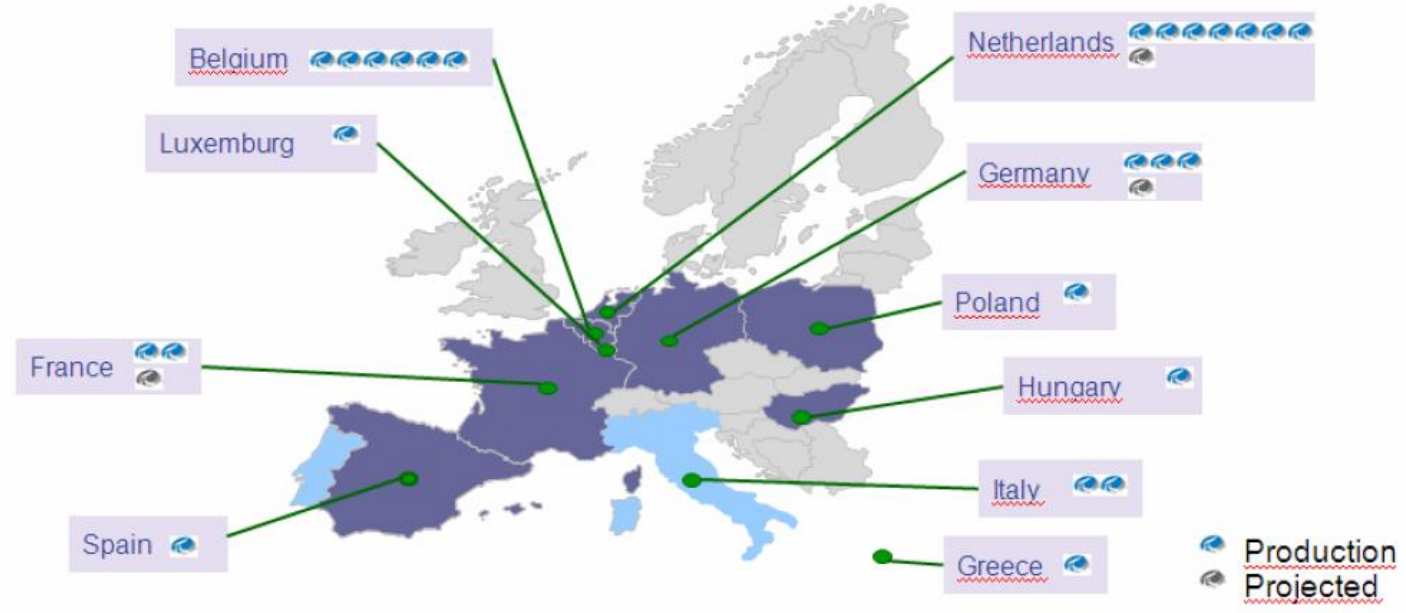
Enterprise Approach

Showcases

GDF SUEZ

GDF Approach

European PI Systems



GDF Approach

Information & Application platforms

EGENOSS

- **E**nergy
- **Gen**eric
- **O**perational
- **S**upport
- **S**ystem

PIMS

- **P**rocess (Plant)
- **I**nformation
- **M**anagement
- **S**ystem

KWIS

- **K**raft**W**erk
- **I**nformation
- **S**ystem

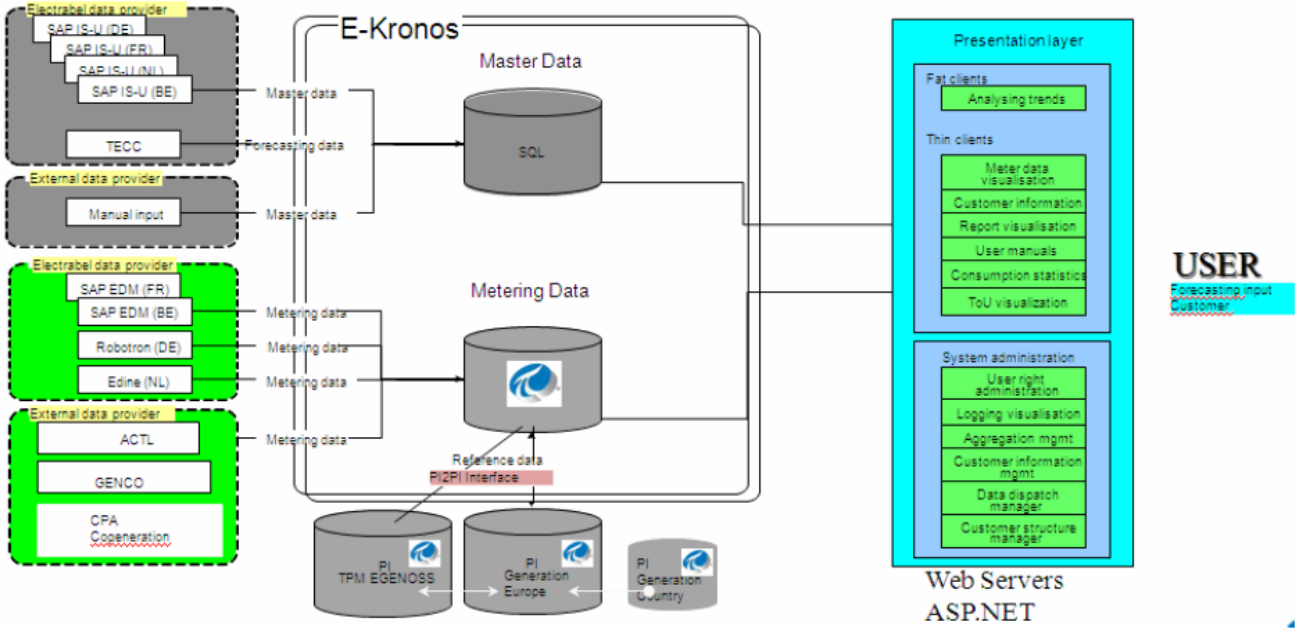
....

(PI System in use since 1999)

GDF SUEZ

GDF Approach

PI Server as 'Data Engine' in existing system architectures



GDF Approach

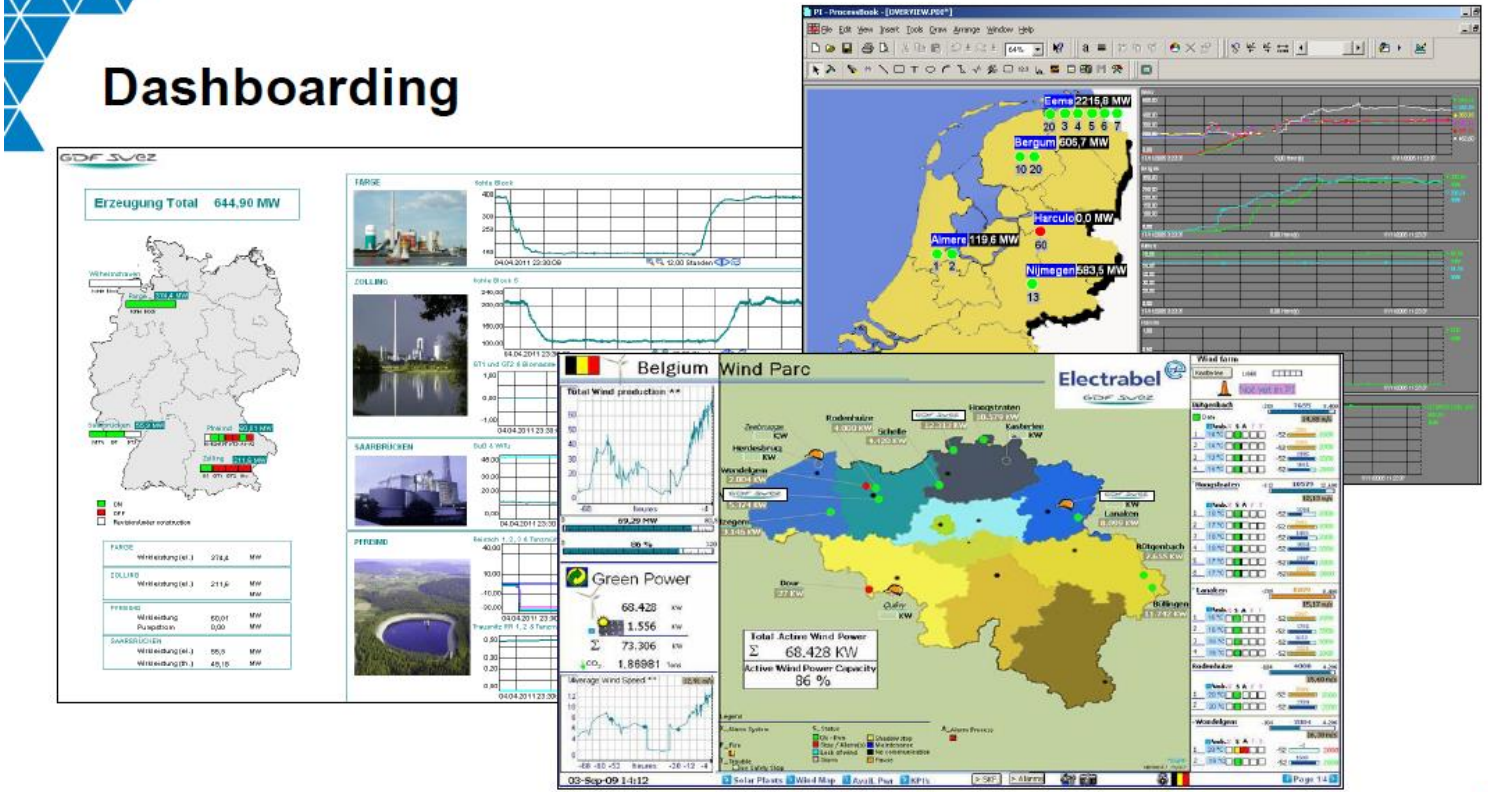
Platform core usage

GDF SUEZ

Power Generation	Trading & Portfolio Management	Marketing & Sales
• Generation Reliability coordination • Production benchmarking • Power plants installations supervision • Generation statistics control • Production deviation control • Plants emission control • Green certificates management • Performance calculations	• Gas Nomination • Gas stocks status • Gas balancing management • Fuel invoices control • Fleet overview and control • Production regulation control • Network Ancillary Services regulation • Spoc[1] of the transmission operator • Customer short term evolution • (Un-)Availabilities coordination	• Client nomination management • Clients on-line metering • Clients deviation management • Clients outages management

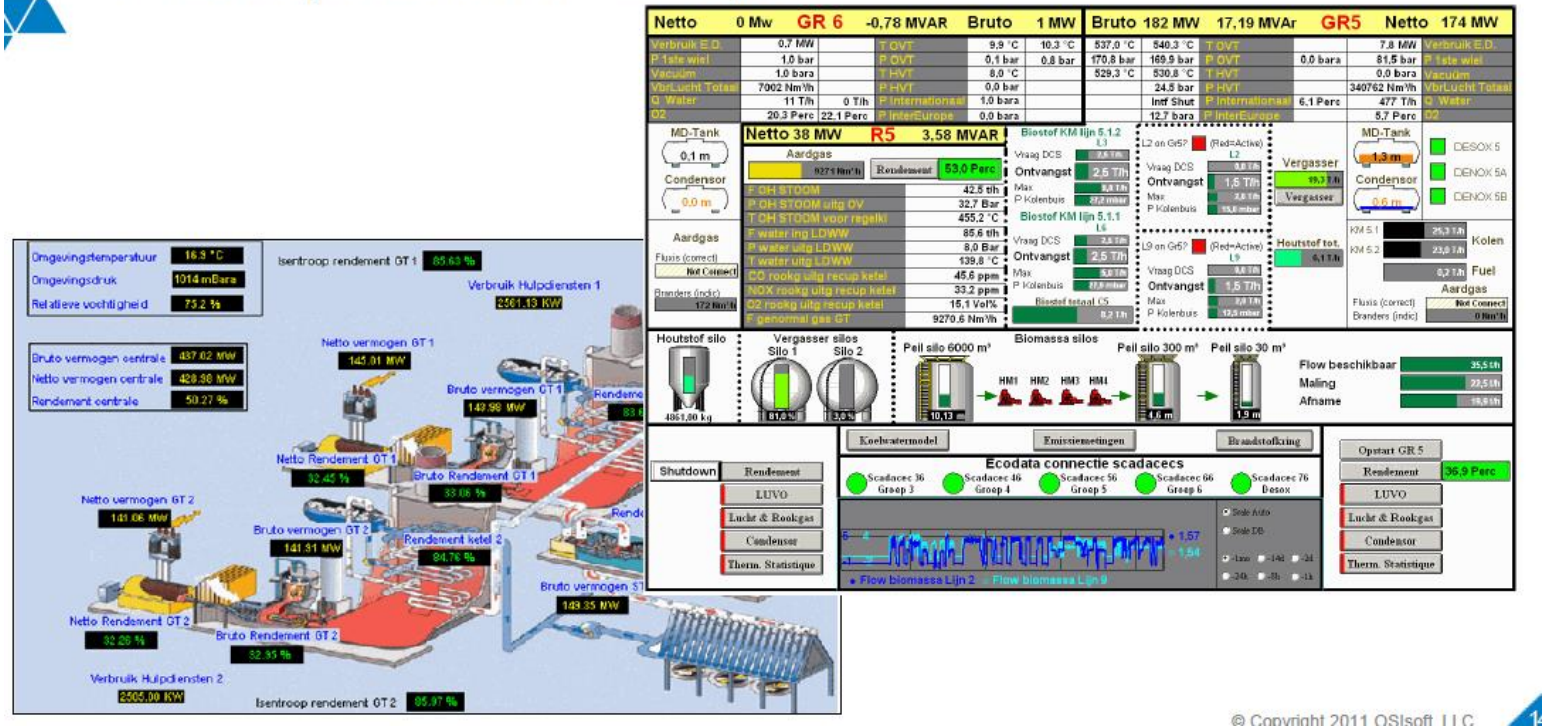
GDF Approach

Dashboarding



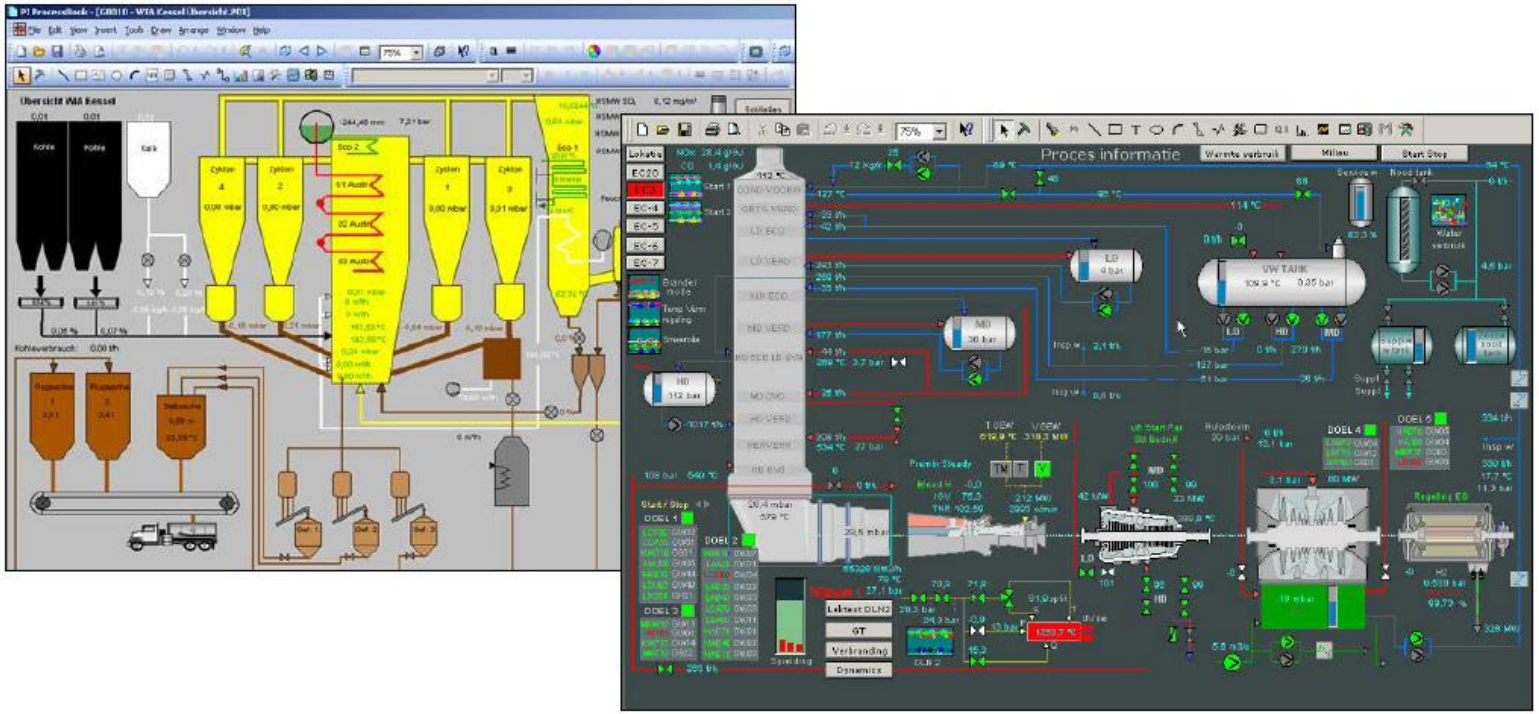
GDF Approach

Plant operational 'Cockpits'



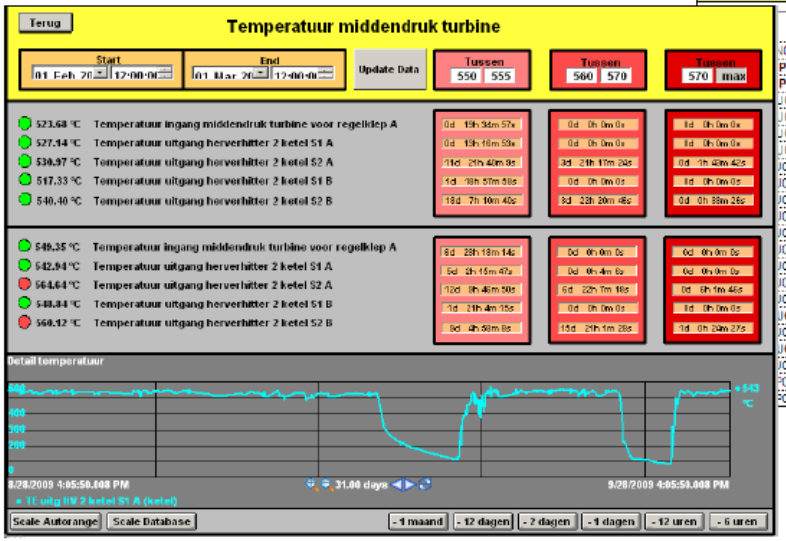
GDF Approach

Detailed installation monitoring



GDF Approach

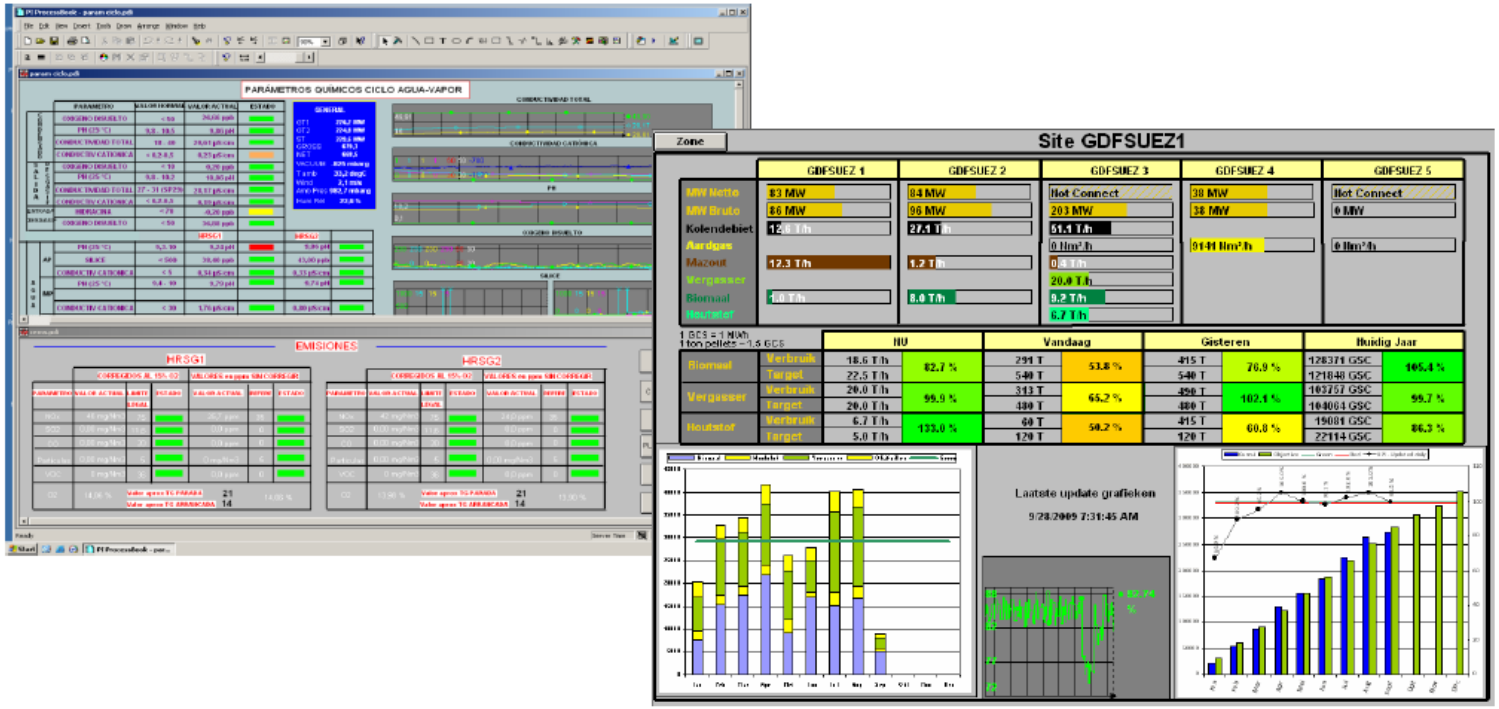
Lifetime monitoring



	B	C	D	E	F	G	H	I	J
	Start Time:	01/01/06 00:00:00	Opname van:	02/01/08 10:00	08/01/08 10:00	02/02/08 10:00	19/02/08 10:00	02/03/08 10:00	19/03/08 10:00
		Description	Current Value	Uren	Uren	Uren	Uren	Uren	Uren
J010-XB01		1 Ventil trafo wijzach- UIT	1	0	0	0	0	0	0
P010-XB01		Aanvulwaterpomp 21-IN	1	34	178	774	1178	1464	1846
P010-XB01		Aanvulwaterpomp 20-IN	0	0	0	173	194	275	346
J011-XB01		Aandrijving aspen Aa-IN	1	34	177	770	1167	1321	1696
J012-XB01		Aandrijving aspen Ab-IN	1	34	177	770	1167	1321	1696
J021-XB01		Aandrijving aspen Ba-IN	1	34	177	770	1167	1321	1697
J022-XB01		Aandrijving aspen Bb-IN	1	34	177	770	1167	1321	1697
J003-XB01		Motor aandrijving 3Ab hutrecht3A-INSCH	1	34	178	774	1181	1468	1850
J004S-XB01		V reg K vlg 3Ab hutrecht 3A - INSCH	0	34	178	774	1181	1275	1691
J007-XB01		Motor aandrijving 3Bb hutrecht3A-INSCH	1	34	178	774	1181	1468	1850
J008S-XB01		V reg K vlg 3Bb hutrecht 3A - INSCH	0	34	178	774	1181	1281	1609
J010-XB01		Motor aandrijving besta A-IN	1	34	178	774	1181	1357	1736
J003-XB01		Motor aandrijving 3Aa hutrecht3B-INSCH	1	34	178	774	1181	1468	1850
J004S-XB01		V reg K vlg 3Aa hutrecht 3B - INSCH	Intf Shut	0	0	0	0	0	0
J007-XB01		Motor aandrijving 3Ba hutrecht3B-INSCH	1	34	178	774	1181	1468	1850
J010-XB01		Motor aandrijving besta B-IN	1	34	178	774	1181	1357	1736
J010-XB01		Aandrijving kolenmolen 3A-IN	0	34	178	774	1181	1278	1604
J010-XB01		Aandrijving kolenmolen 3A-IN	0	34	178	774	1181	1275	1604
J010-XB01		Aandrijving kolenmolen 3B-IN	1	34	178	774	1181	1275	1591
J010-XB01		Aandrijving kolenmolen 3B-IN	1	34	178	774	1181	1275	1591
P010-XB01		Smeeroliepomp reductor KM A-IN	1	34	178	774	1181	1468	1850
P010-XB01		Smeeroliepomp reductor KM B-IN	1	34	178	774	1181	1468	1850

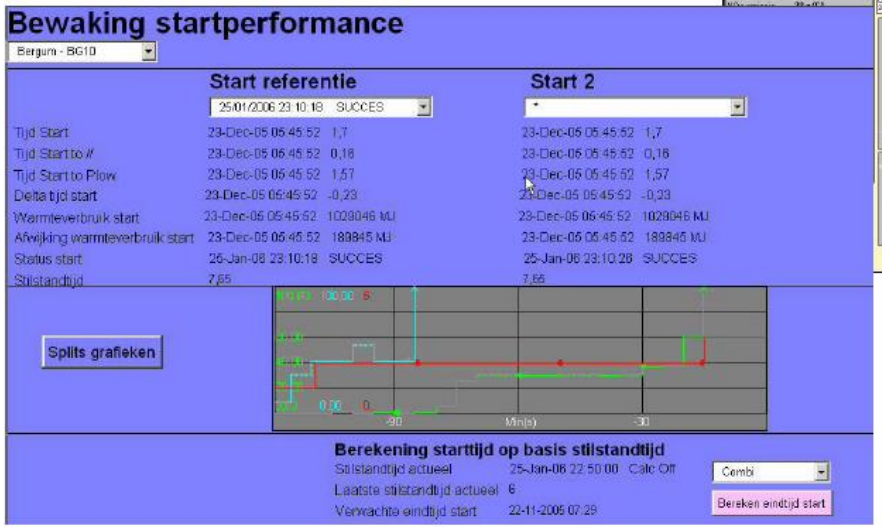
GDF Approach

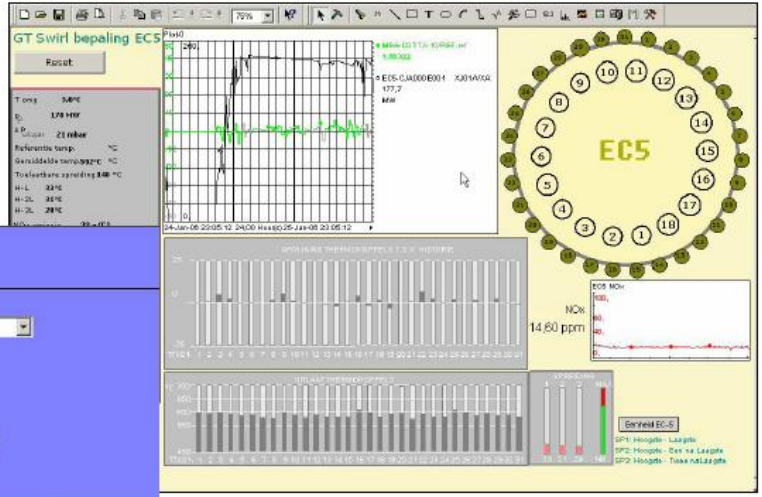
Target follow up for specific sub-processes



GDF Approach

Specialized tools

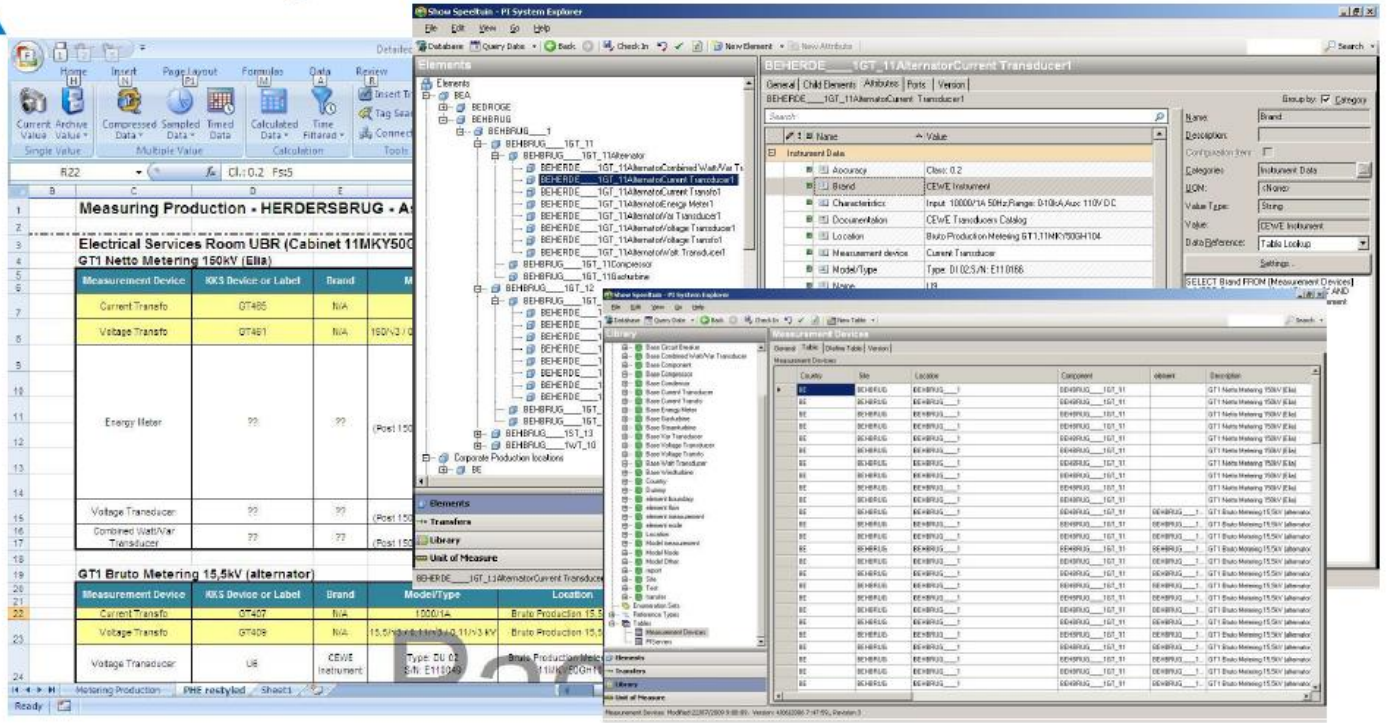




GDF Approach

Modeling: PI Asset Framework

Device List

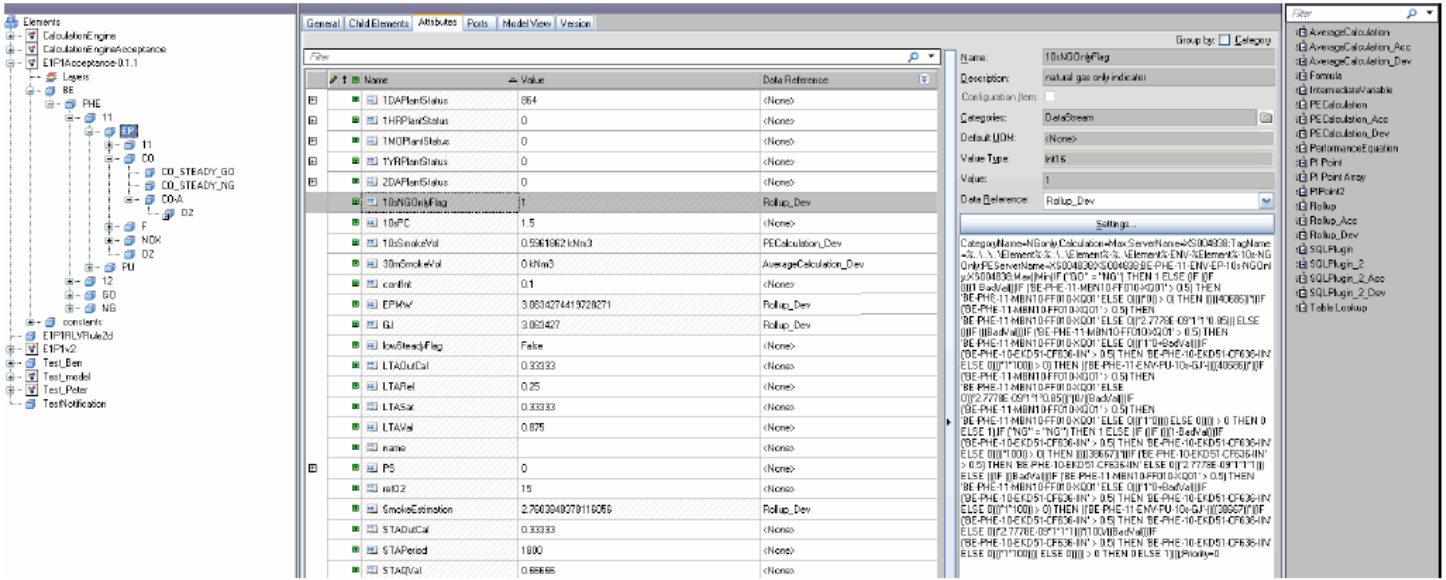


GDF Approach

Modeling: PI Asset Framework

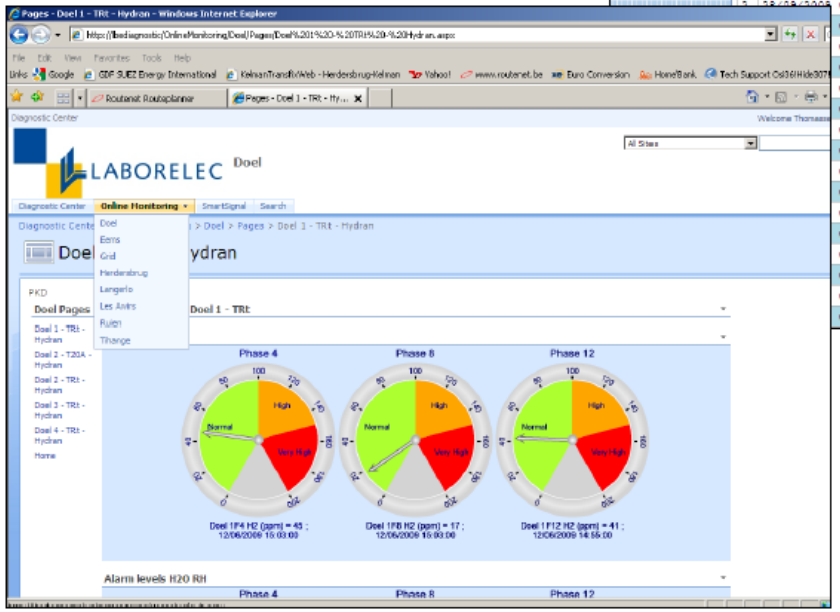
Ecological Data

- Templates: site, unit, emission point, pollutant/concentration measurement, fuel components
- Calculations: PI PE syntax in attributes, with PI ACE Scheduler



GDF Approach

Web publishing



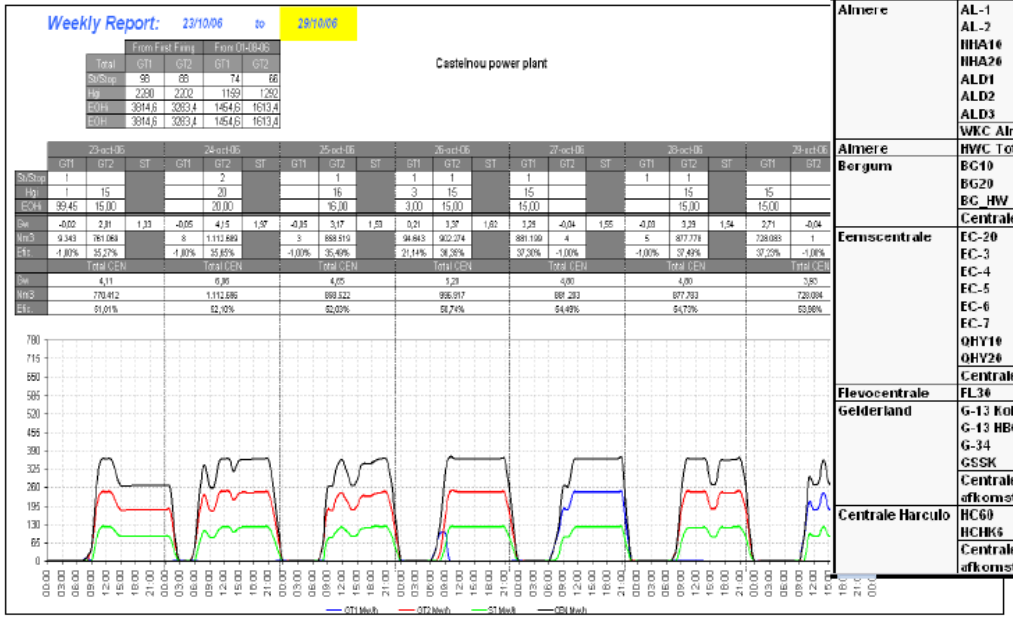
Electrabel GDF SUEZ | Meuse | Rapport journalier: Bilan du jour 28/09/2009

Valeurs brutes | Valeurs validées | Valeurs moyennes 3 heures | Valeurs d'échauffement | Bilan du jour | Hebdomadaires | Mensuels | Annuels | Manual Inv

	Date Heure	Tihange Echauffement moyen journée °C	?	Amay Débit moyen journée m³/s	?	Huy Temperature moyenne journée °C	?
0	28/09/2009 00:15	4,084		81,896		17,316	
1	28/09/2009 00:30	4,097		81,687		17,306	
	28/09/2009 00:45	4,094		81,914		17,296	
	01:00	4,089		81,870		17,289	
	01:15	4,082		82,184		17,286	
	01:30	4,079		82,182		17,279	
	01:45	4,073		82,272		17,272	
	02:00	4,066		82,398		17,268	
	02:15	4,062		82,467		17,263	
	02:30	4,060		82,511		17,256	
	02:45	4,056		82,468		17,250	
	03:00	4,050		82,506		17,244	
	03:15	4,044		82,479		17,237	
	03:30	4,037		82,471		17,231	
	03:45	4,031		82,456		17,224	
	04:00	4,025				17,217	
	04:15	4,016		82,456		17,212	
	04:30	4,009		82,474		17,206	

GDF Approach

Reporting



Invullen: alleen beginperiode invullen
(vul datum in gele veld en toets F9 t.b.v. calculatie)

Beginperiode	01-01-2008
Eindperiode (t/m)	31-01-2008
Jaar	2008

Versie 1.3

Locatie	Eenheid	Soort eenheid	Emissie in de periode [ton]	Emissie heel jaar t/m de periode [ton]
Almere	AL-1	1	22.904	22.904
	AL-2	1	18.264	18.264
	NHA10	2	0	0
	NHA20	2	0	0
	ALD1	2	325	325
	ALD2	2	1.173	1.173
	ALD3	2	2.462	2.462
	WKC Almere totaal (fossiel)		45.129	45.129
Almere	HWC Totaal (fossiel)			
Bergum	BG10	1	26.664	26.664
	BG20	1	43.063	43.063
	BG_HW	3	283	283
	Centrale Bergum totaal (fossiel)		70.010	70.010
Eemscentrale	EC-20	1	72.111	72.111
	EC-3	1	56.000	56.000
	EC-4	1	57.259	57.259
	EC-5	1	75.065	75.065
	EC-6	1	79.836	79.836
	EC-7	1	50.997	50.997
	QHY10	3	487	487
	QHY20	3		
	Centrale Eems totaal (fossiel)		391.754	391.754
Flevocentrale	FL30	1	0	0
Gelderland	G-13 Kolen	1		
	G-13 HBO	1		
	G-34	2		
	GSSK	2		
	Centrale Gelderland totaal (fossiel afkomstig van biomassa		0	0
Centrale Harculo	HC60	1	64.442	64.442
	HCHK6	3	257	257
	Centrale Harculo totaal (fossiel) afkomstig van biomassa		64.699	64.699

GDF Approach

Benefits: 'Can you make money with the PI System?'

Hard to quantify.. But we are sure we do:

- **By monitoring performance of our installation components in detail**

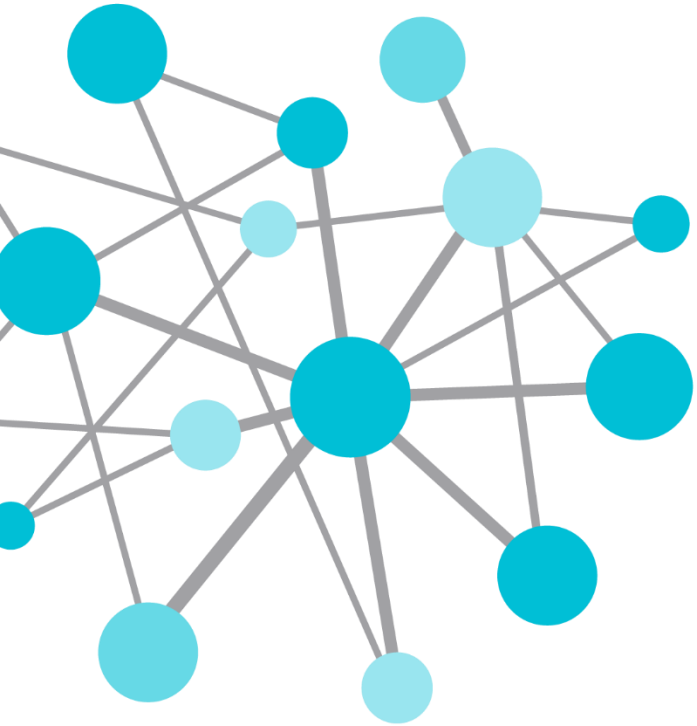
  → Unhide oportunities to improve performance

- **By counting running hours, switching operations, pressure losses in time**

  → Enable proactive maintenance & avoid possible incidents

- **By using PI System data during commissioning of new installations**

  → Compare supplier performance data with ours (force performance improvements or refunds)



Enterprise Approach

Showcases

e·on

E-ON Approach

E.ON UK

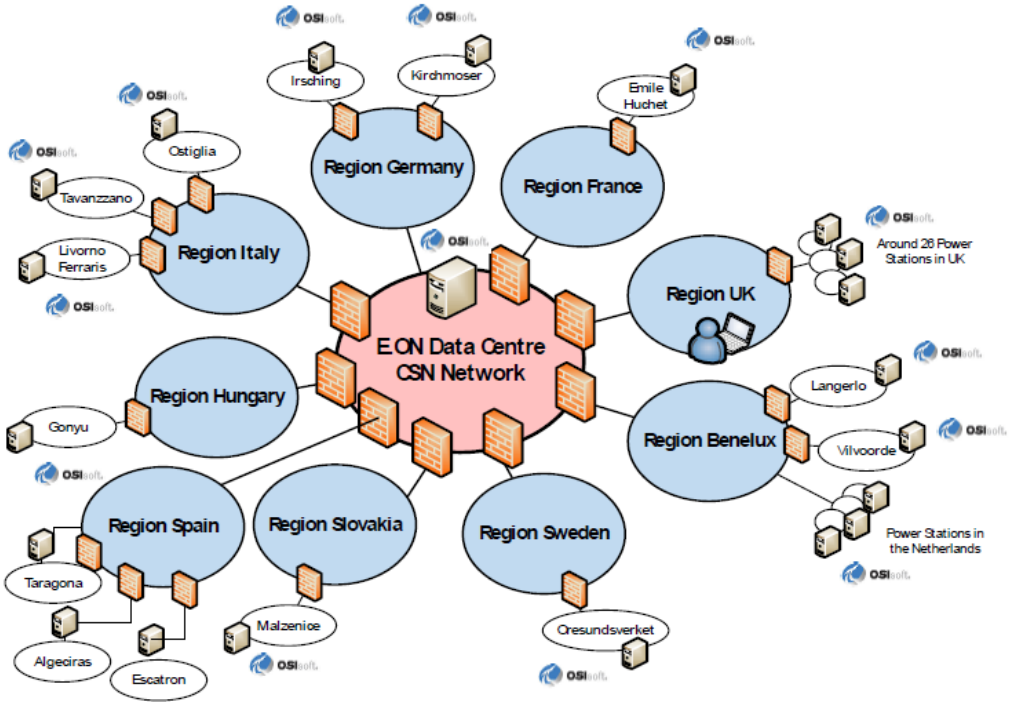
- **Business - Electricity Generation**
- The UK has 5 GW of coal-fired generation capacity, across three sites and 4.4 GW of Gas across 18 sites.
- 2010 business restructure led to the fleet being split into steam and gas which resulted in two Global Fleet Management Centre's (FMC)
  - **Germany – Steam**
  - **UK - Gas**

E-ON Approach

E.ON CCGT & CHP fleet

E-ON Approach

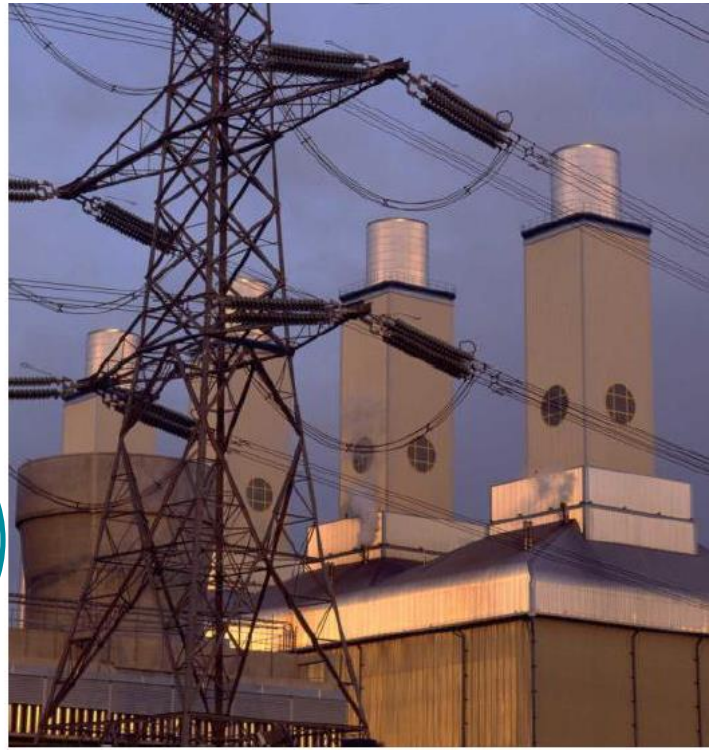
European roll out



E-ON Approach

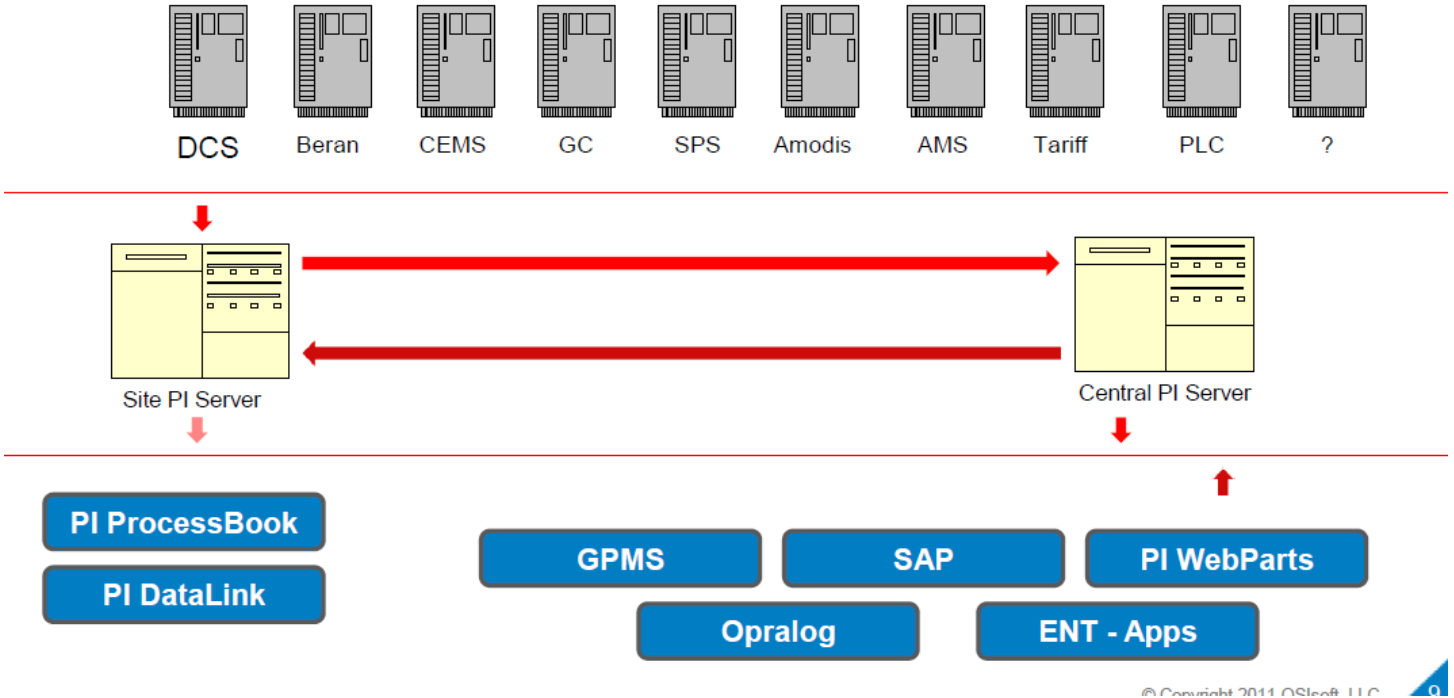
E.ON (CCGT fleet)

- E.ON's Gas-CCGT Fleet is present in 10 countries and responsible for a total of 69 units on 40 sites. It has an installed capacity of around 18 GW.
- We have a vision as being recognised as the **best managed portfolio worldwide.**
- Our business is simple and we will achieve our goal through a key focus on the following areas:
  - **Safety and the environment**
  - **Compliance**
  - **Making Money - we make more money by improving**
    - Plant capacity
    - Availability
    - Flexibility
    - Reliability
    - Efficiency
    - Reducing costs



E-ON Approach

Evolving system



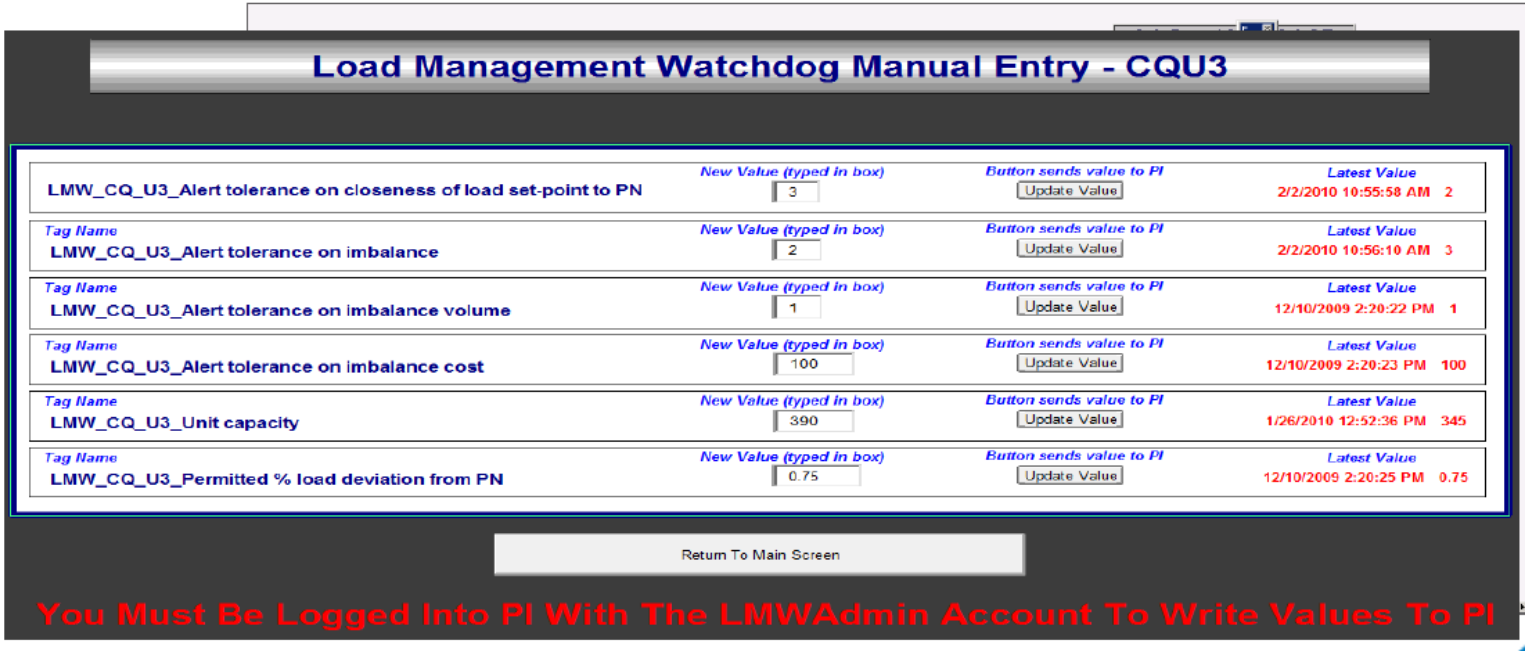
E-ON Approach

Key fleet and site specific projects

- **Interface Failover** – Ensures a more secure data capture environment.
- **LMW Project** – Load Monitor Watchdog (Imbalance tracking).
- **Web Pages Employed** – Displays plant generation overview and allows third party access to authorised data.
- **Future data importing** – through the UFL interface it is possible to compare real values to future forecasts.
- **Capturing of web based data** – Utilising the HTML interface to record data into the PI System from the web i.e. Electricity buy/sell prices etc.
- **SAP integration** – Pushes run time data to SAP for a more accurate maintenance schedule.
- **Weather data** – import and export to Meteor & Metra Groups (**TriGas & CQ).**
- **Performance Watchdog development.**

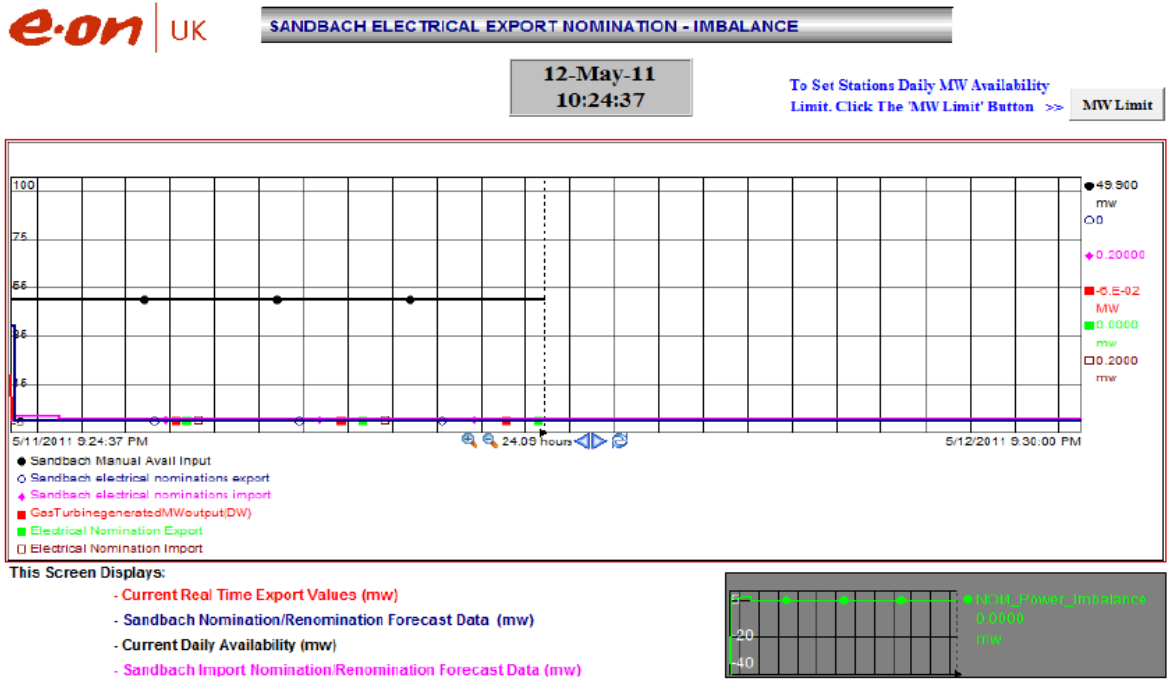
E-ON Approach

Main LMW screens



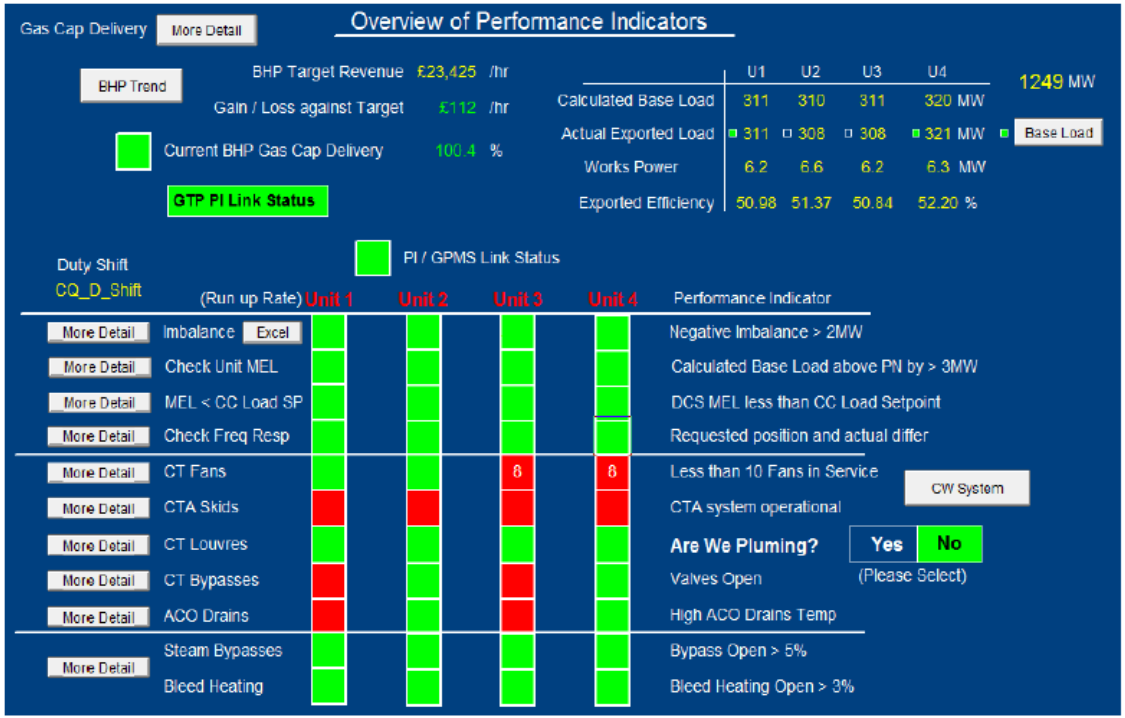
E-ON Approach

Real-time and future data display



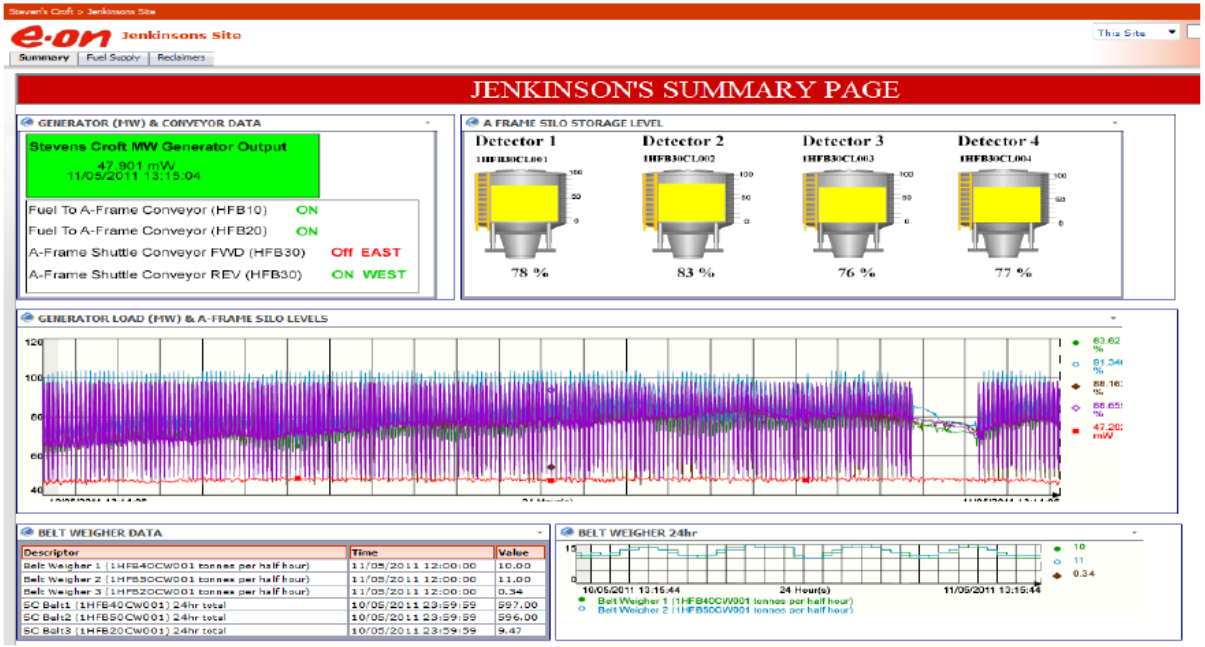
E-ON Approach

CQ – performance watchdog



E-ON Approach

Steven's Croft web page



E-ON Approach

Web-based high level plant information

e·on | UK

UK GENERATION TOTAL MW
5553.77

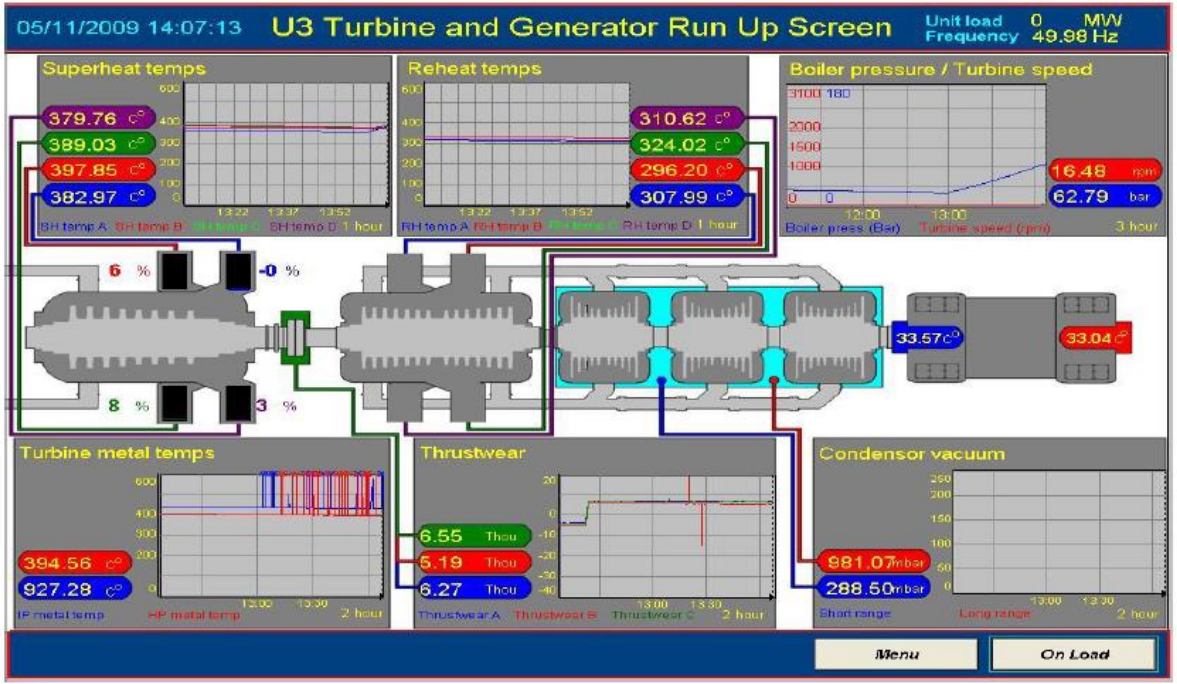
CCGT TOTAL MW GENERATED	STEAM TOTAL MW GENERATED	CHP TOTAL MW GENERATED
1699.93	3608.31	245.53

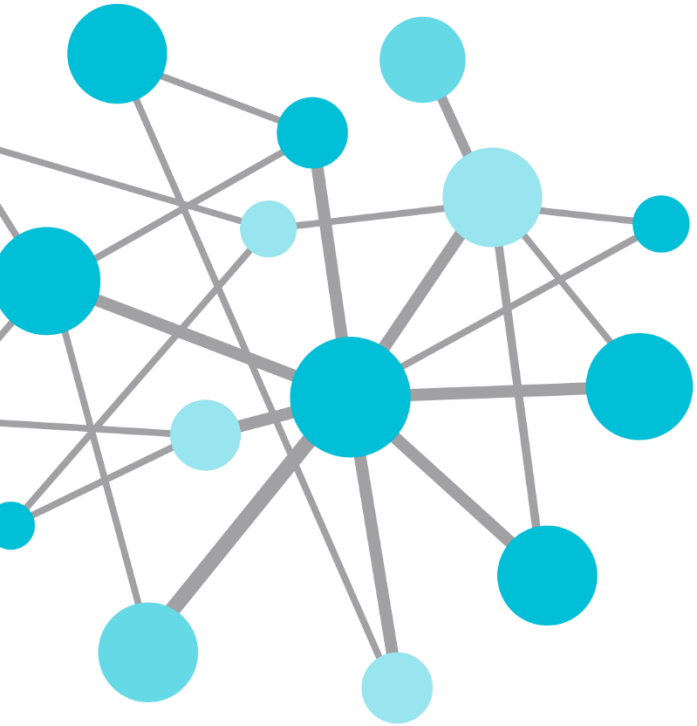
Elec Buy Price (£/MWh)	Elec Sell Price (£/MWh)	Market Price (£/MWh)
61.90	42.58	40.36

CCGT Generation | Steam Generation | CHP Generation

E-ON Approach

Obsolete equipment replacement



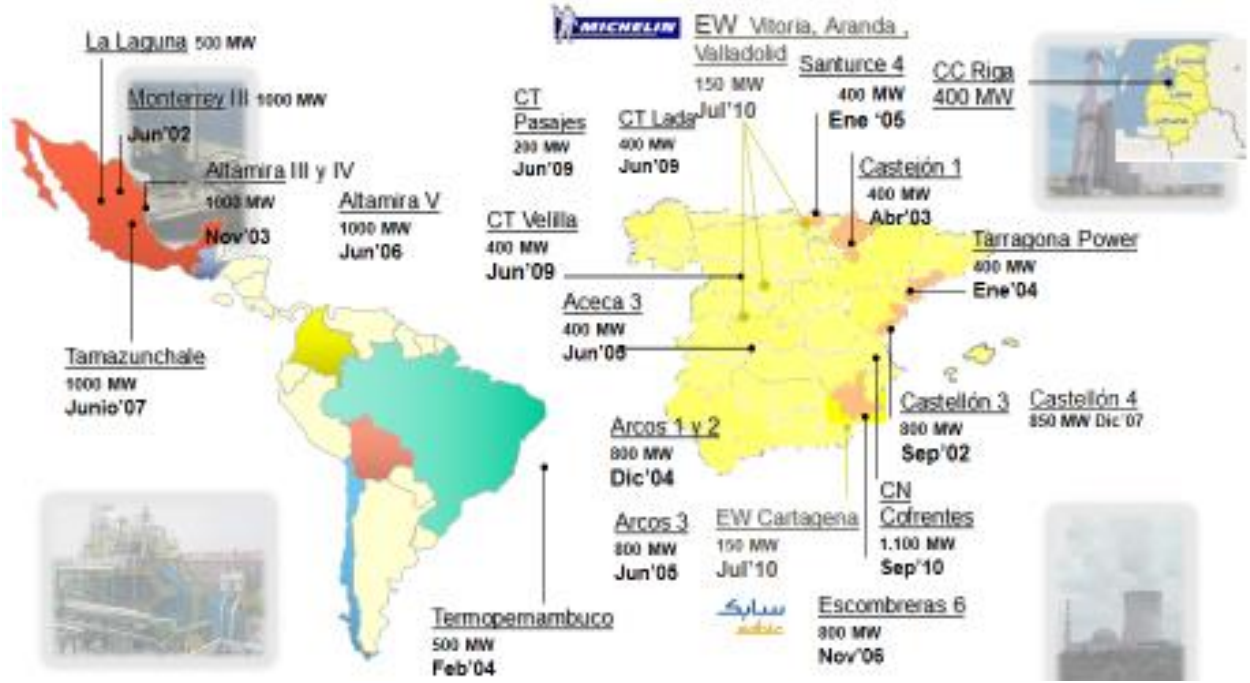


Enterprise Approach

Showcases

IBERDROLA

Iberdrola Approach

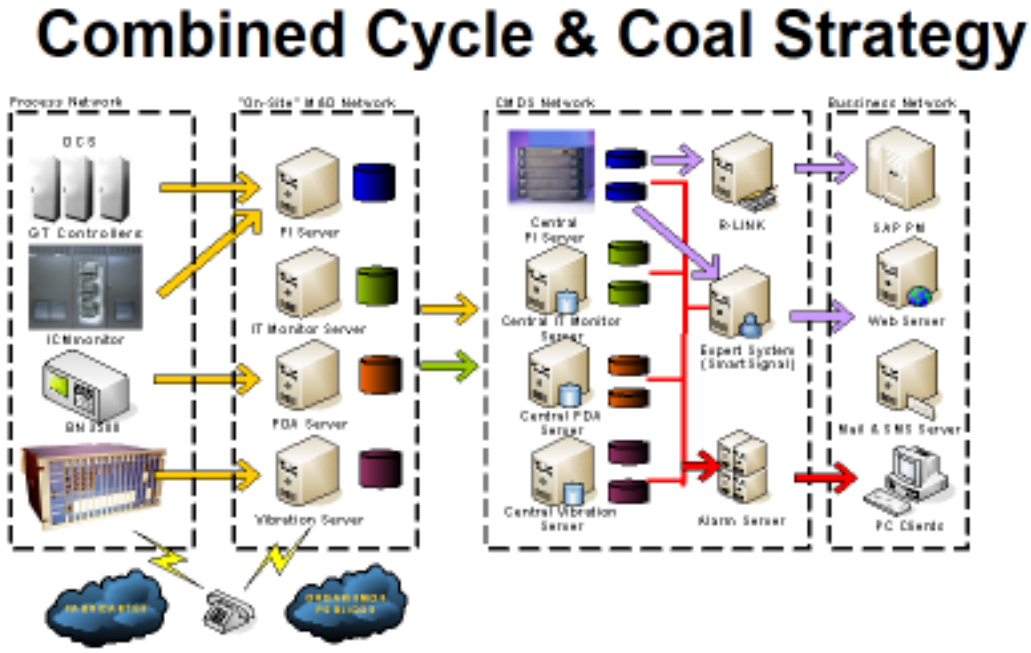


Iberdrola Approach

PI System History

- Started on 2002.
- Actual Installations:
  - 8 PI Systems in Spain's Combined Cycle
  - 5 PI Systems in Mexican's Combined Cycle
  - 1 PI System in Latvia's Combined Cycle
  - 3 PI Systems in CMDS
  - 1 PI System in Distribution Business
  - 4 PI System in Renewable Business
  - 3 PI Systems in Spain's Coal Power Plants
  - 1 PI System in Spain's 100% Owned Nuclear Power Plant
  - 4 PI Systems in Spain's Cogeneration Plant

Iberdrola Approach

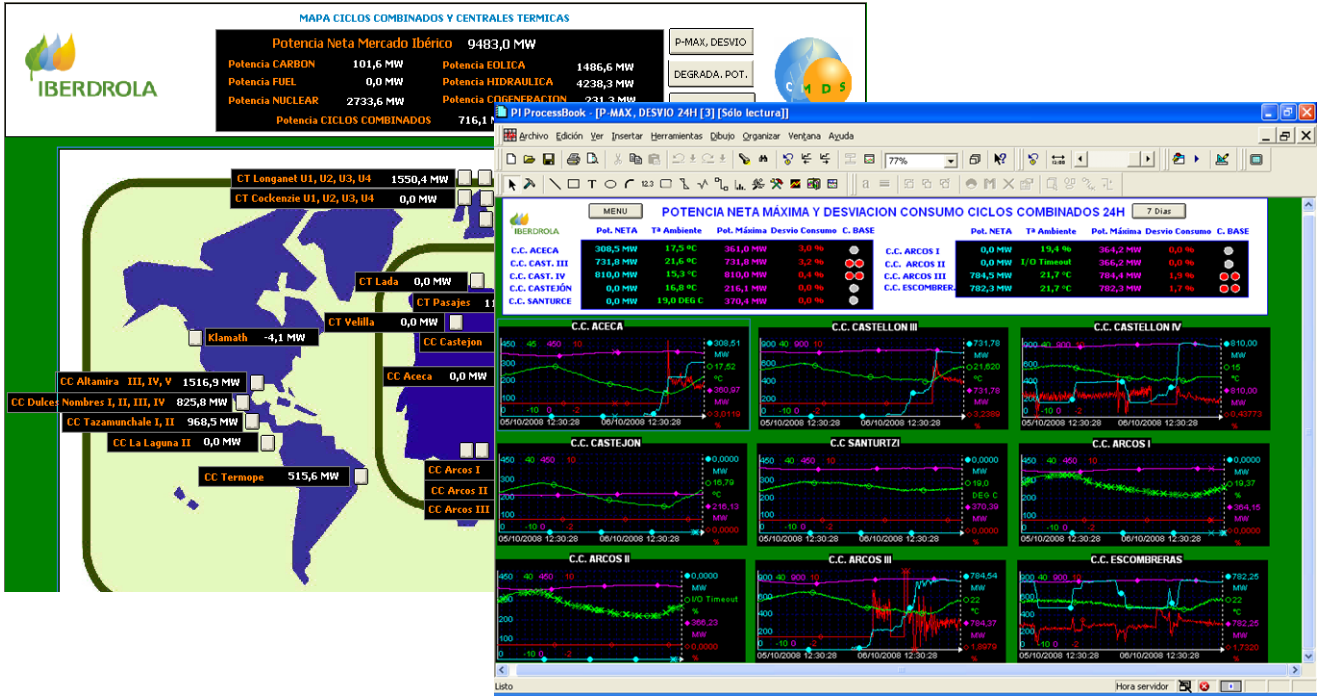


Iberdrola Approach

Developed Applications

- Performance Tracking
- Contract Tracking
- System Advisor
- AEM (Advanced Equipment Monitoring)
- IT Doctor
- GE M&D Connection
- SAP Connection (PM & BW Module)
- EMS Connection (Dispatching Center)
- Daily Inspections
- Others.....

Iberdrola Approach



Iberdrola Approach

Developed Applications

- Performance Tracking
  - Expected Output Power
  - Gas Consumption Deviation (from Expected)

Iberdrola Approach

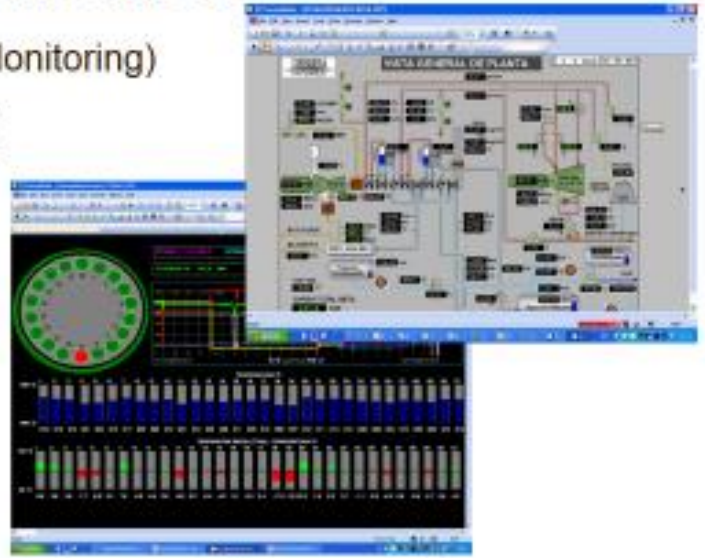
Developed Applications

- Performance Tracking
  - Power Degradation (from Base Line)
  - Heat Rate Degradation (from Base Line)

Iberdrola Approach

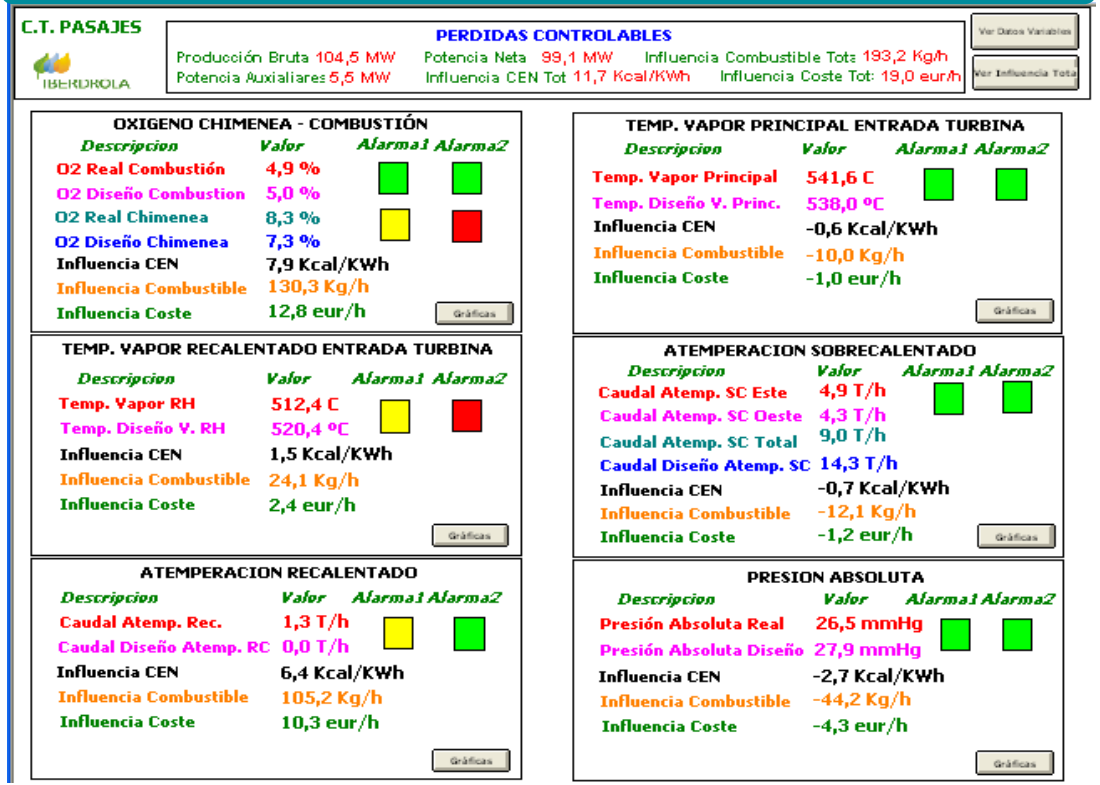
Developed Applications

- AEM (Advanced Equipment Monitoring)



Iberdrola Approach

CONTROLLABLE LOSSES FOR COAL FLEET



Iberdrola Approach

WEB KPIs DASHBOARD (FLEET APPROACH)

Developed Applications

- Web Access

Iberdrola Approach

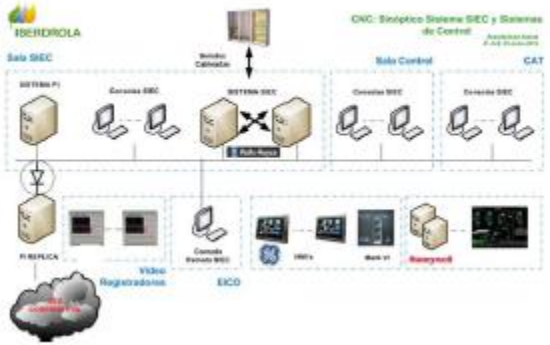
Conclusions

- 10 years PI System experience over Combined Cycle Technology:
  - ***ROI ≈ 2,5 Years***
  - Increasing efficiency →1%-2%
  - Increasing availability → 0,1%-0,5%
  - Easily exportable to another business
- Opening the platform for all users = A lot of value
- Focus on business drivers (take your time!!!)
- Event based monitoring
- Success requires cooperation between operations, maintenance and engineering

Iberdrola Approach

Iberdrola: Modernization of Control Systems at CN Cofrentes

"Cofrentes was built on late 80's with more than 1.000 MW of installed capacity. After more than 25 years of operation the modernization of control systems is required for reaching the excellence in safe and reliable operation and maintenance of the station. To integrate all the data coming from the different digital systems in a secure way is critical for improving the business"



IBERDROLA

Business Challenge

- To integrate all data sources in one system
- To integrate with the digital systems in a secure way
- To reach the excellence in O&M

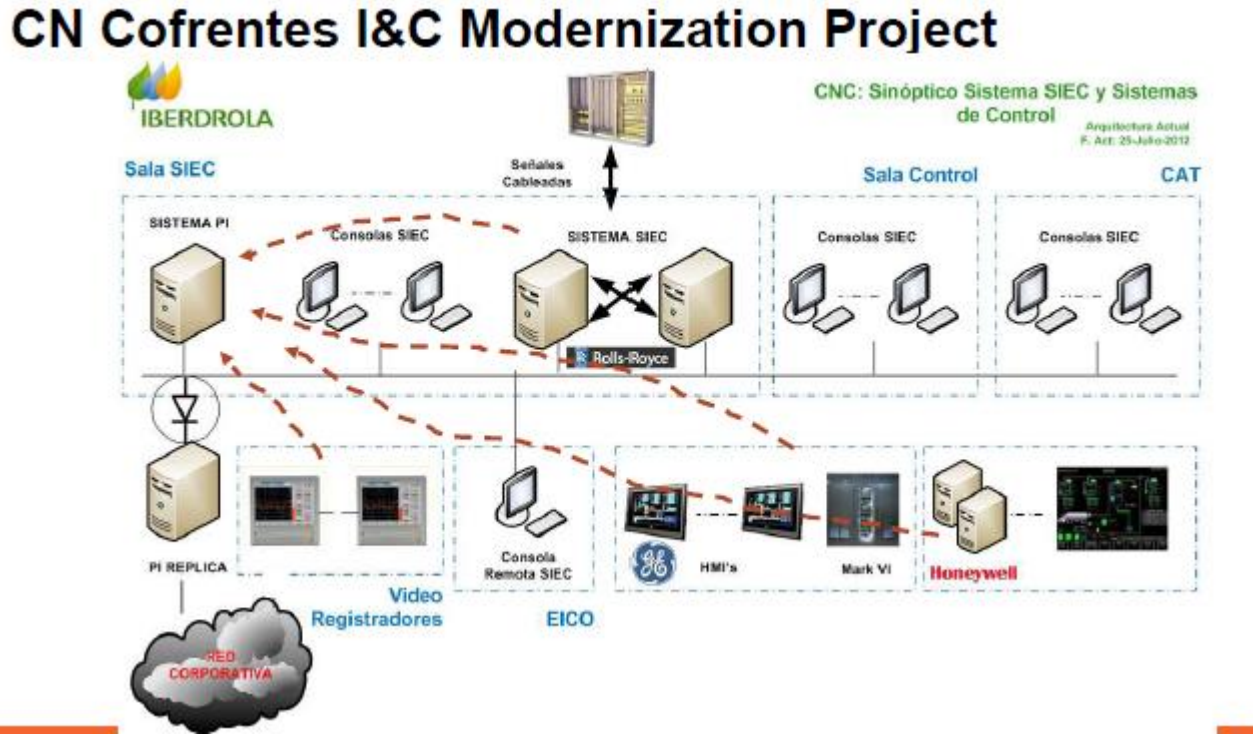
Solution

- Two Cascade PI Systems collecting data from different vendors
- One Waterfall Data Diode equipment for secure deployment
- PI-PB/PI-ACE developments

Results and Benefits

- One version of the truth. One single point with consolidated information
- Securely protected against cyber threats.
- Foundation for O&M optimization

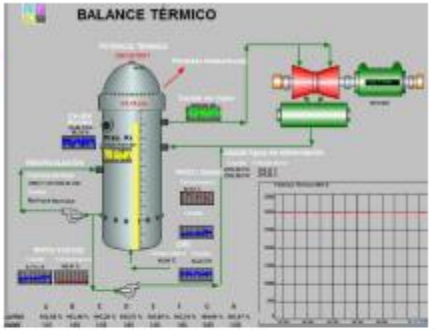
Iberdrola Approach

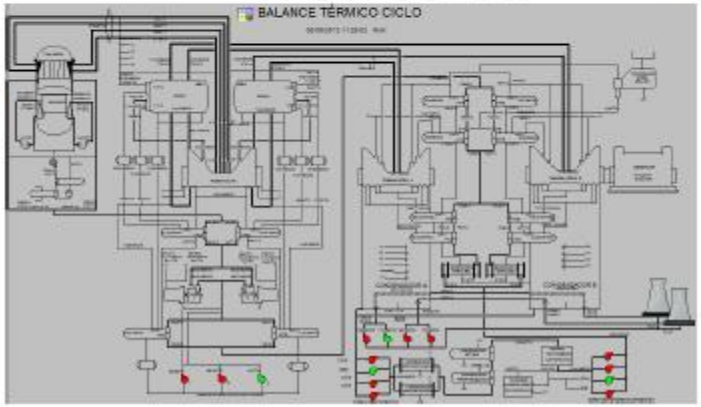


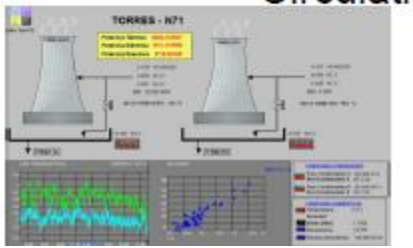
Iberdrola Approach

CN Cofrentes I&C Modernization Project

- PI Processbook developments
  - +61 screens developed
  - BOP systems trending
    - Chemistry
    - Condensate and Feedwater
    - Circulation water



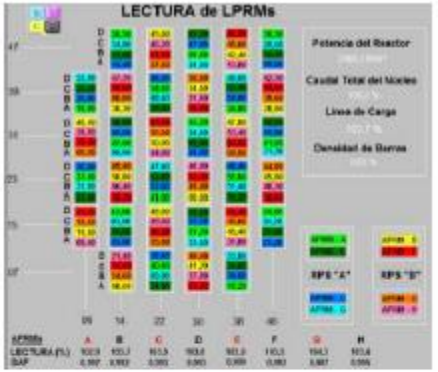


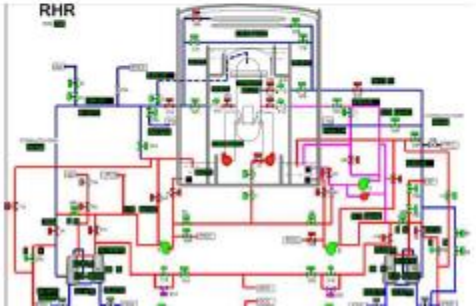


Iberdrola Approach

CN Cofrentes I&C Modernization Project

- PI Processbook developments
  - +61 screens developed
  - Reactivity Supervision
  - Cooling Systems

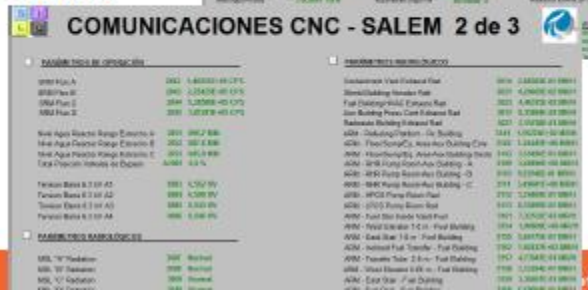




Iberdrola Approach

CN Cofrentes I&C Modernization Project

- PI Processbook developments
  - +61 screens developed
  - Emergency Preparedness
    - Meteorological Data
    - Data for Outer Emergency Center



Iberdrola Approach

CN Cofrentes I&C Modernization Project

- PI ACE developments
  - Emergency Diesel Group Test

Daily Test:

- Event #1: Group starts (there are 3 Divisions of Tandem-Diesel-Generators). The application sends an email.
- TEST STARTS!!!

Iberdrola Approach

CN Cofrentes I&C Modernization Project

- PI ACE developments
  - Emergency Diesel Group Test

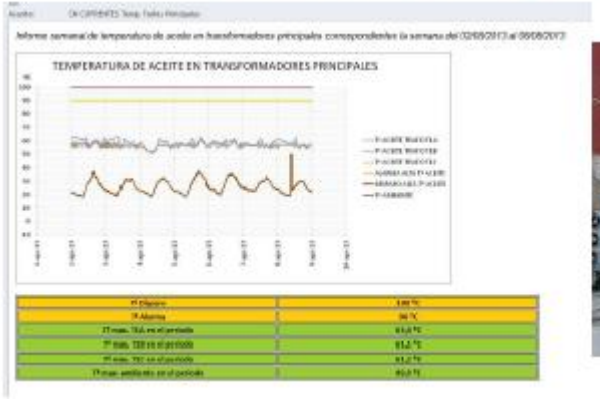
Daily Test:

- Event #2: Group connects to the grid. The application sends another email.
- TEST OK!!!!

Iberdrola Approach

CN Cofrentes I&C Modernization Project

- PI ACE developments
  - Transformer Oil Temperature Tracking



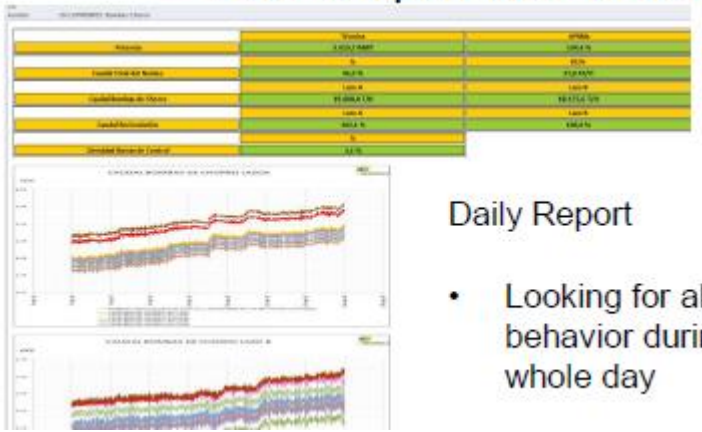
Weekly Report

- Looking for abnormal behavior during a whole week.

Iberdrola Approach

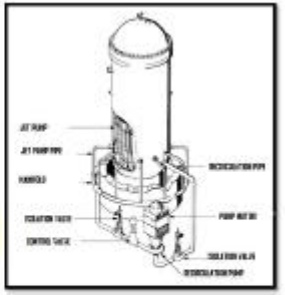
CN Cofrentes I&C Modernization Project

- PI ACE developments
  - Jet Pumps Flow Tracking



Daily Report

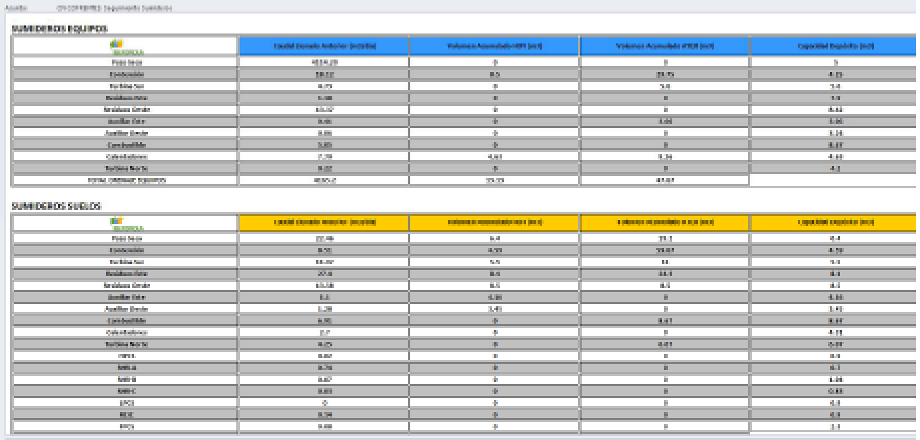
- Looking for abnormal behavior during a whole day



Iberdrola Approach

CN Cofrentes I&C Modernization Project

- PI ACE developments
  - Drain System Tracking



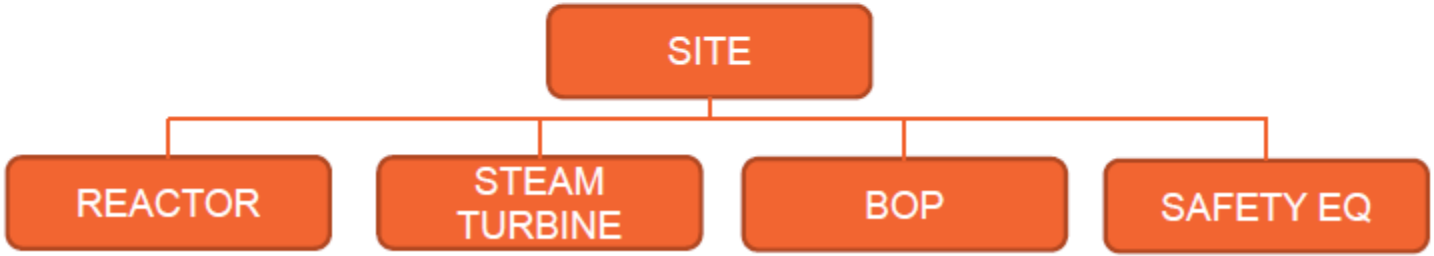
Daily Report

- Looking for abnormal behavior during a whole day

Iberdrola Approach

CN Cofrentes I&C Modernization Project

- PI ACE developments
  - Next Steps – AEM Concept (Advanced Equipment Monitoring)

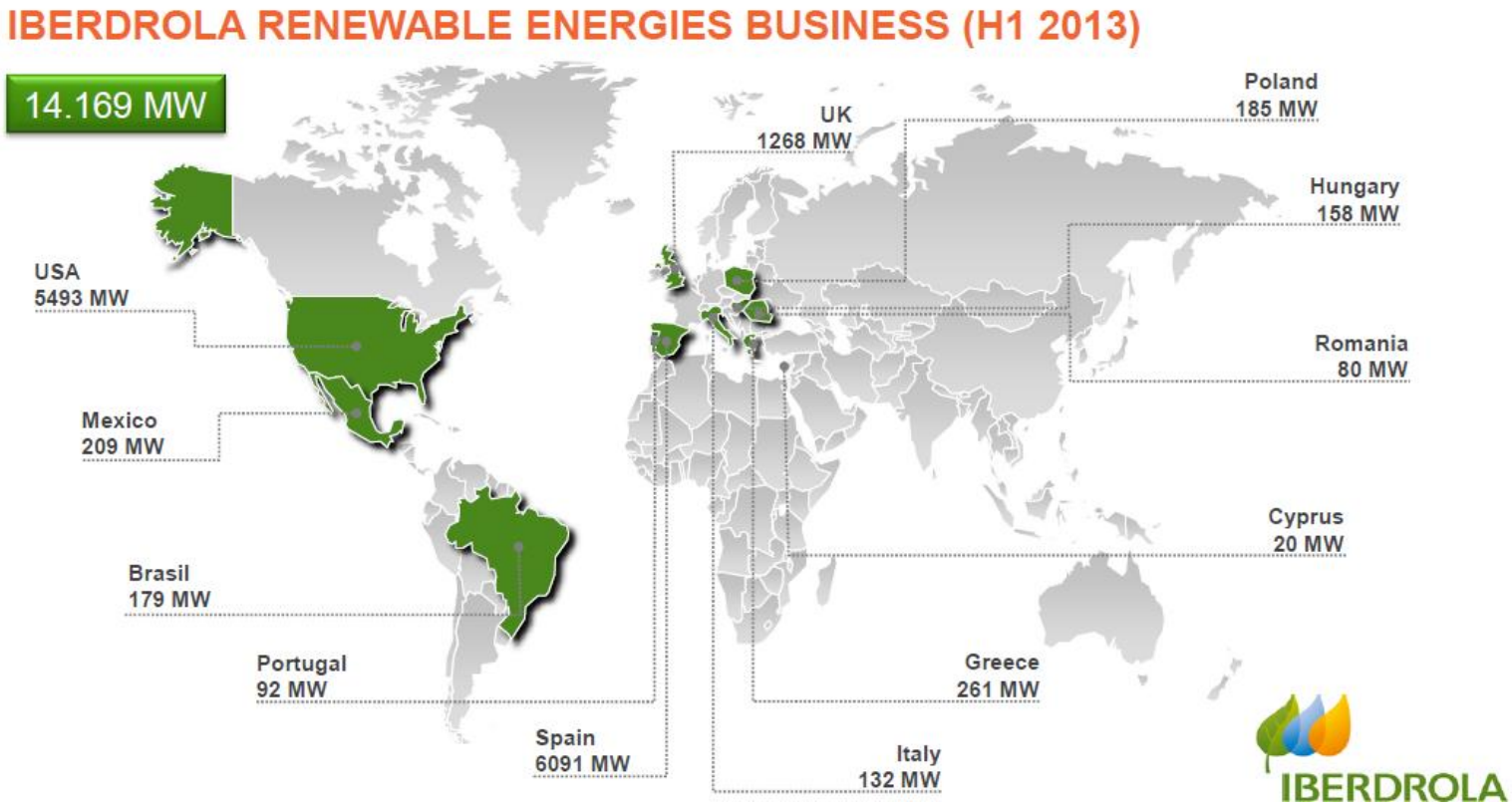


Iberdrola Approach

Conclusions & key lessons learned

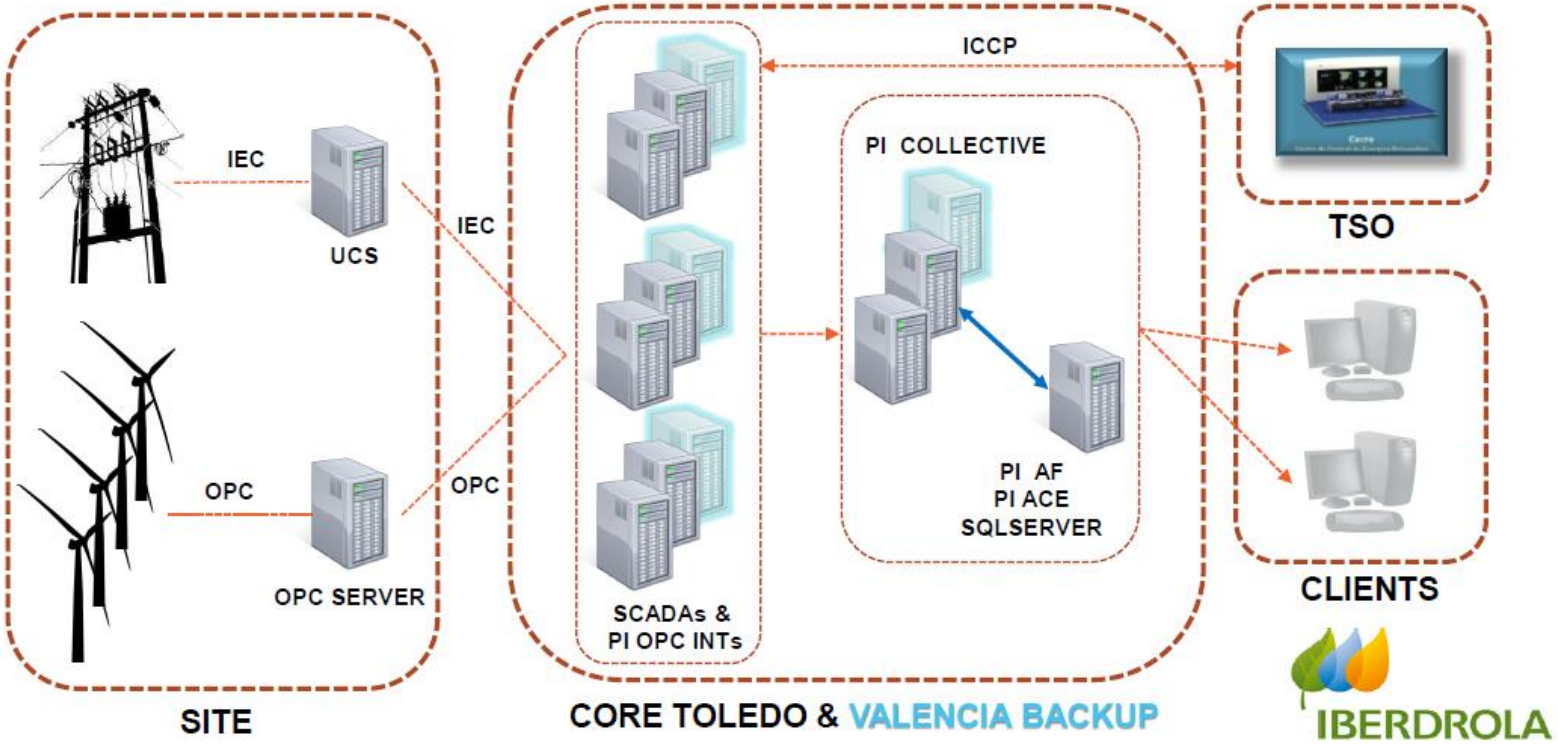
- Integration of multiple data sources
  - Different sources through one shared channel
  - New ideas for Operation optimization
- Securing the connection
  - Isolated from outside cyber threats
- Developing applications
  - Foundation for O&M optimization
  - Using existing know-how speed-up the process

Iberdrola Approach



Iberdrola Approach

PI System Architecture



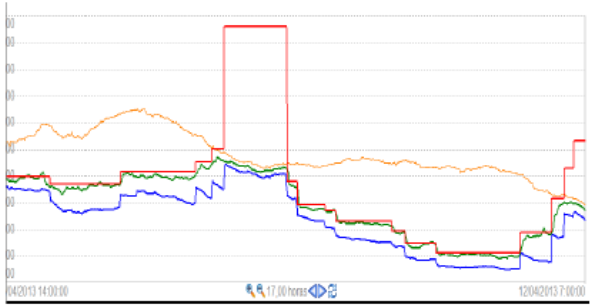
Iberdrola Approach

PI System usage to improve Curtailment Strategies

"… Along this month generation has been increased in more than 50 GWh, which would not have been generated if we had followed the former curtailment strategies."

"This means an important benefit to our company. And also a few other facts such as less mechanical wear of our turbines, less urgent works on site, … which are more difficult to quantify"

Gustavo Moreno
CORE Manager



Business Challenge

- Reduce inefficiencies
- To use aggregate real time data for real time decision making during curtailment issued by TSO

Solution

- PI AF training, design, planning and deployment
- CoE help with PI ACE deployment
- Calculated data inserted in PI Servers

Results and Benefits

- Average increase in energy generation: 30% with peaks above 60%
- Other benefits not quantified yet

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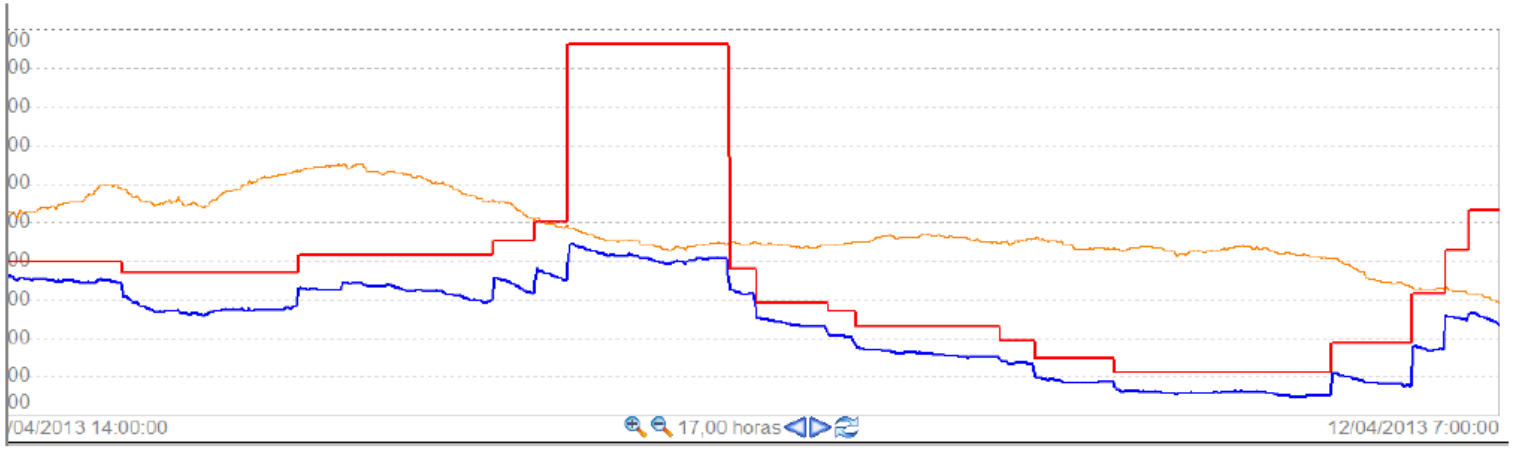
Iberdrola Approach

BEFORE: Curtailment with Individual Setpoints



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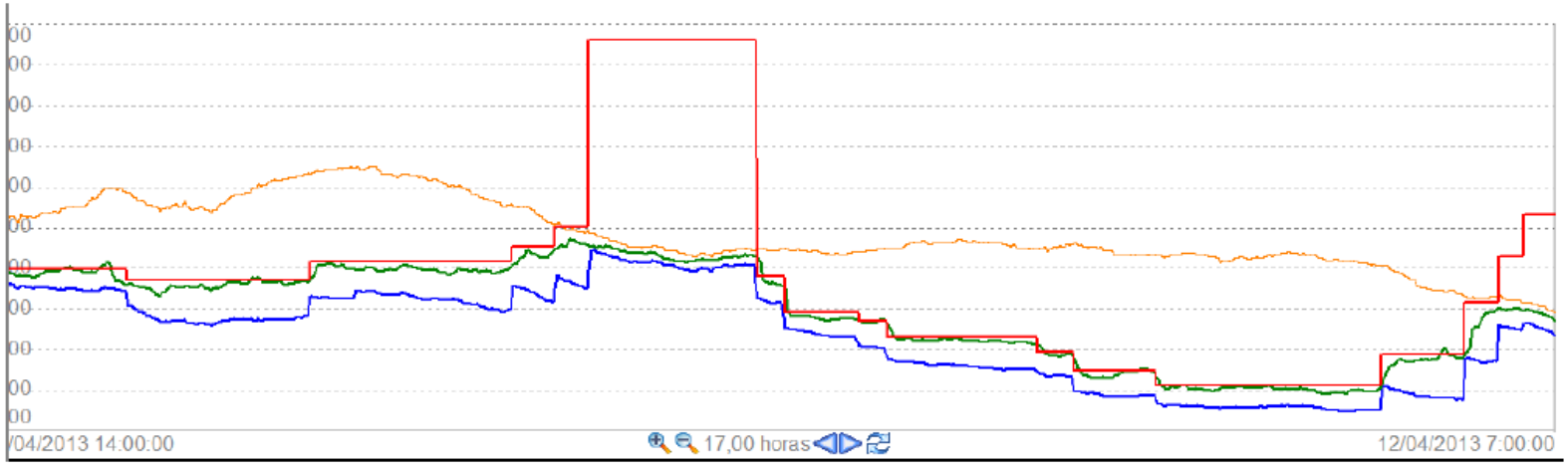
Iberdrola Approach

CURRENTLY: Global Setpoint Curtailment



Average increase in energy generation: 30% with peaks above 60%

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Iberdrola Approach

Summary

- **PI AF + PI ACE provided us with reliable tools for quick decision making**
- **In terms of income:** significant increase in production
- Other intangible benefits:
  - Less mechanical wear out of turbines
  - Less local and urgent calls on site
  - Better adjustment to setpoints
  - Easier to manage for operation shifts: more secure and less errors

IBERDROLA

Q&A

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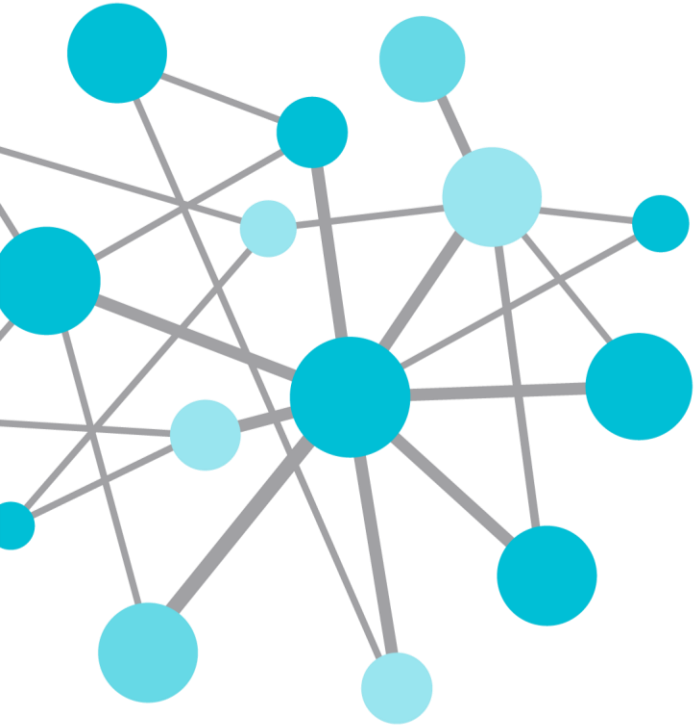
mchavero@osisoft.com

EMEA P&U Industry Principal

OSIsoft, LLC



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