



Advanced Equipment Monitoring on Combined Cycle Power Plants

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IBERDROLA



- IBERDROLA & THE MARKET
- IBERDROLA & CMDS
- AEM CONCEPT
- AEM CASE HISTORIES

- IBERDROLA & THE MARKET
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IBERDROLA & the market



Estrategic Plan 2001-2006: To double size

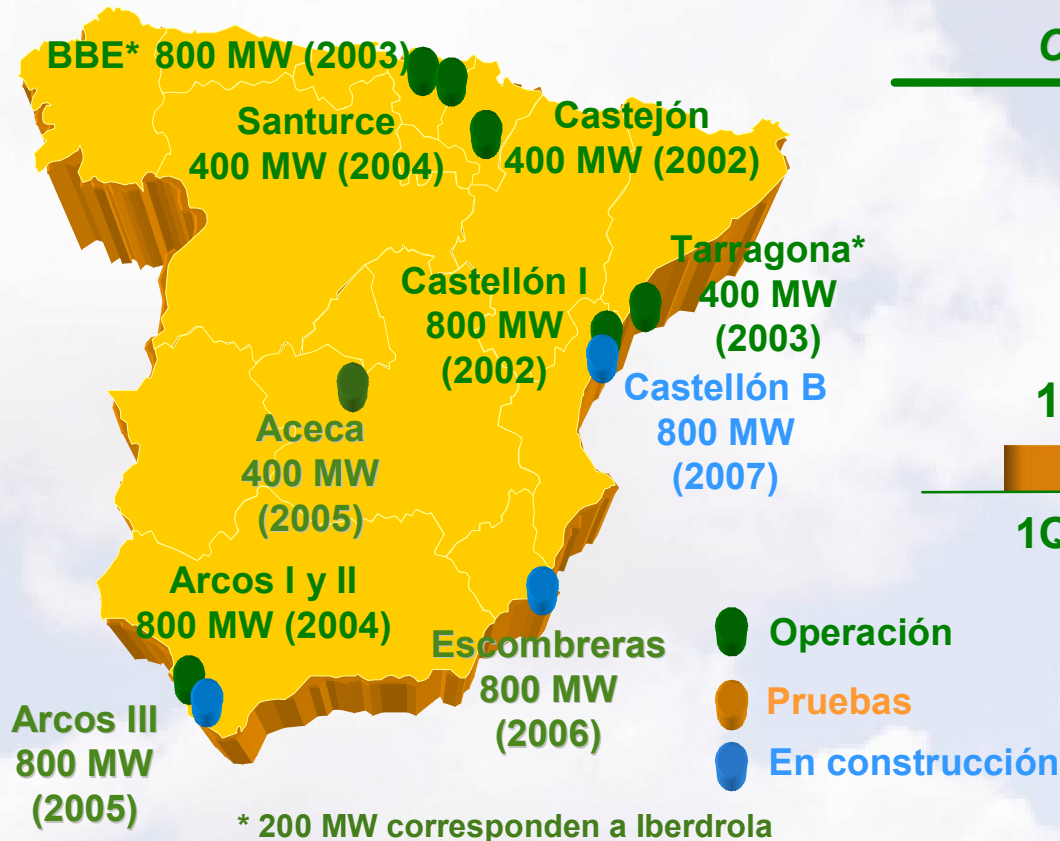


Total investment	16.200 Mill. € (2001-2008)
Net Profit	2006: 1.600 Mill. € Growth: 04-08: > 10%
Indebtedness	50% in 2008

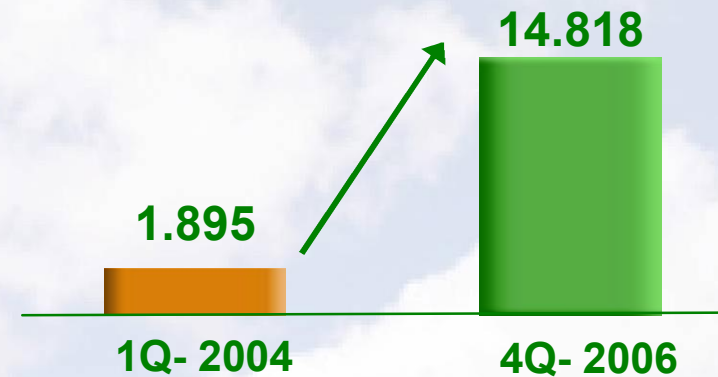
IBERDROLA & the market



We lead the construction of combined cycle power plants on Spain...



CCGT Production (GWh)



...5.600 MW in 2006

IBERDROLA & the market



First private producer on Mexico with 5.000 MW.....



Ciclos combinados

Operativo

Enertek	120 MW	2001 ✓
Monterrey	1.040 MW	2002 ✓
Altamira III y IV	1.036 MW	2003 ✓
La Laguna II	500 MW	1 ^{er} T-2005 ✓
Altamira V	1.121 MW	2006 ✓
Tamazunchale	1.135 MW	2007

Parques eólicos

Operativ

Oaxaca	100 MW	2006
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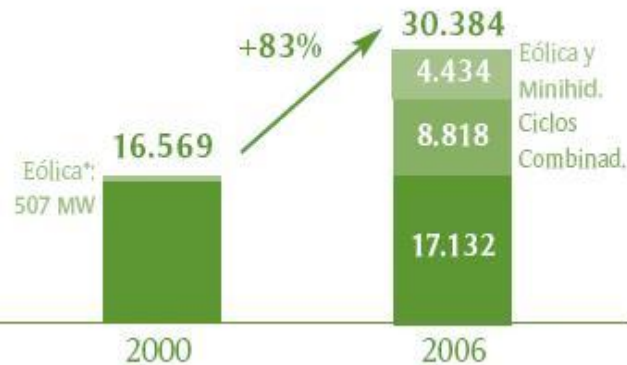
3.800 MW in 2006.....

IBERDROLA & the market



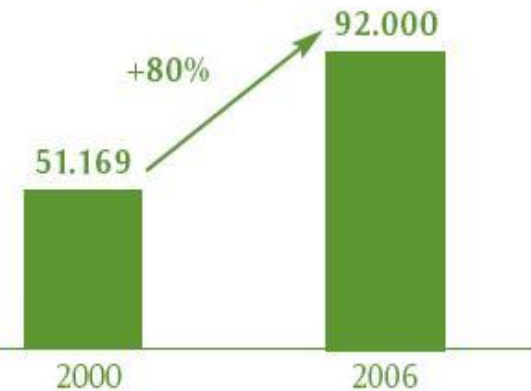
Installed Capacity

Capacidad instalada Grupo (MW)



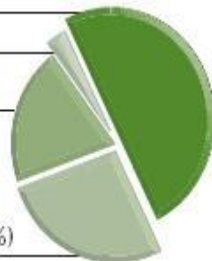
Total Production

Producción Grupo (GWh)



Hidroeléctrica: 50%
Renovables: 3%
Nuclear: 20%

Térmica (Carbón y fuel-oil: 27%)

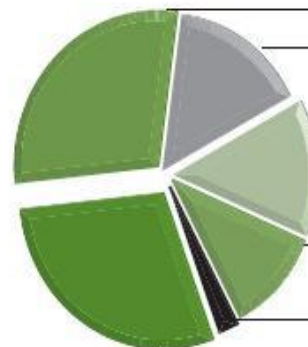


Hidroeléctrica: 29%
Renovables: 15%

Térmica (carbón y fuel-oil): 14%

Nuclear: 11%

Cogeneración: 2%
Ciclos combinados: 29%



IBERDROLA & the market



IBERDROLA + Scottish Power



	IBE	SPW	IBE + SPW*	
Installed Capacity	23.989	6.574	30.563	+27%
Renewable	4.076	1.964	6.040	+48%
Installed Capacity (total in MW)	28.065	8.538	36.603	+30%
Points of Supply	18,1	3,3	21,4	+18%

IBERDROLA & the market



IBERDROLA + Scottish Power

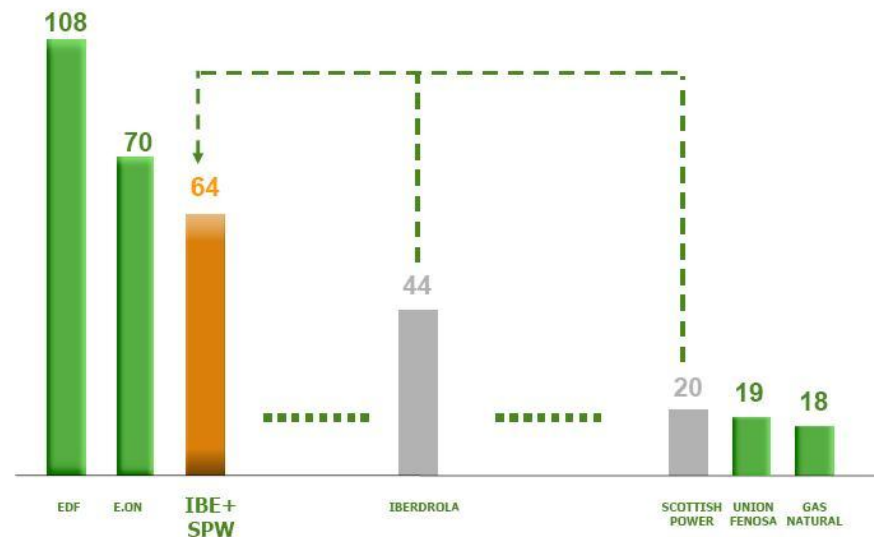


65.000 Million Euros Total Value

Renewable World Leader



3rd European Utility



38.000 MW Renewable pipeline...

IBERDROLA & the market

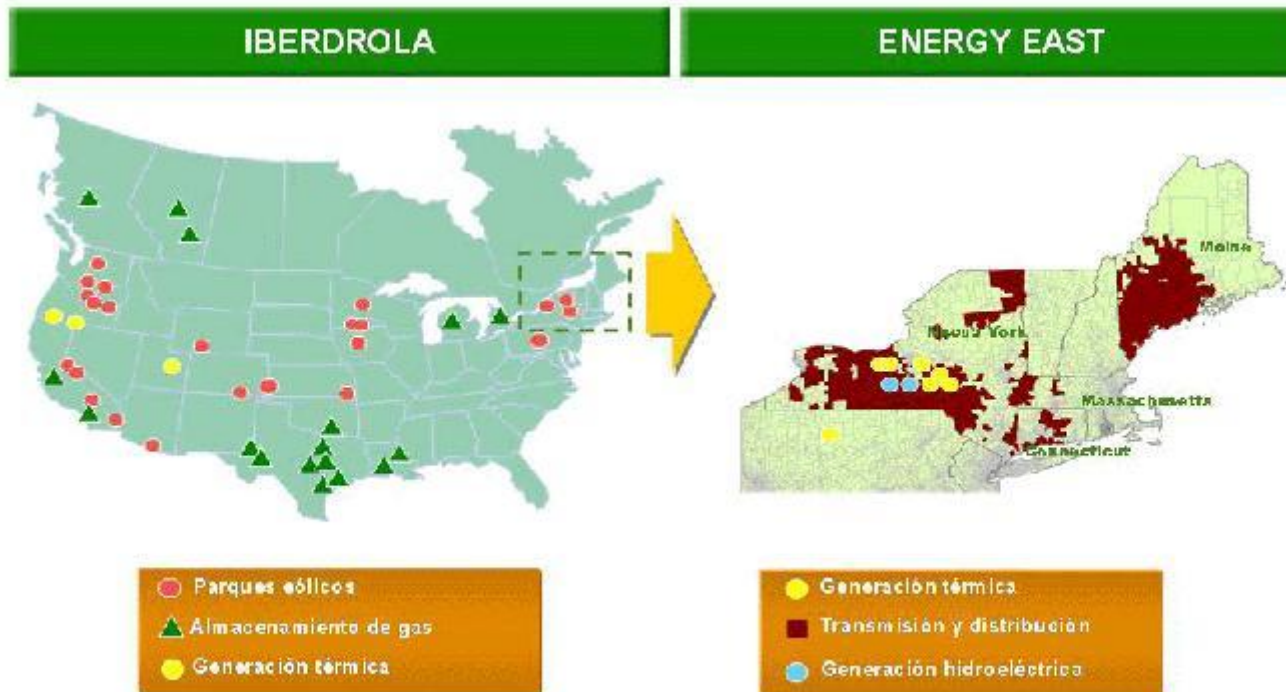


IBERDROLA + Energy East



83.000 Millions Euro Total Value

Up to 42.000 MW Installed Capacity



- IBERDROLA & THE MARKET
- IBERDROLA & CMDS
- AEM CONCEPT
- AEM CASE HISTORIES

IBERDROLA & CMDS



MAIN GOALS

- Maximize efficiency, availability and reliability
- Support power plants to:
 - O&M in an optimum way
 - Minimize costs
 - Unify technology management



POWER PLANTS O&M OPTIMISATION

ADDITIONAL PROFITS

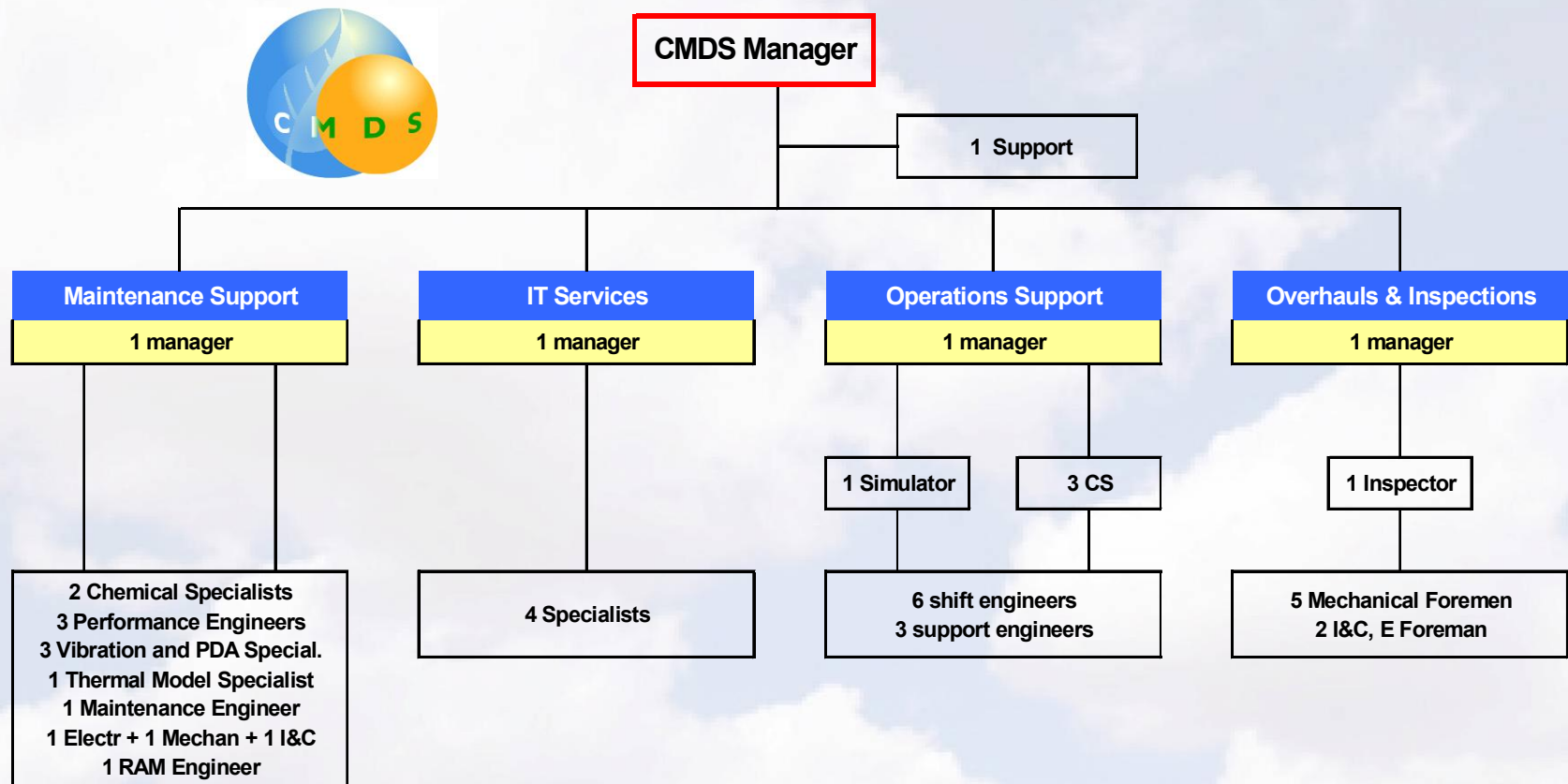
- Common O&M model for all stations : Fleet approach
- O&M on-site and on-line support
- Share operational experiences and best practices
- Center of Excellence
- Reduce OEM dependency



IBERDROLA & CMDS



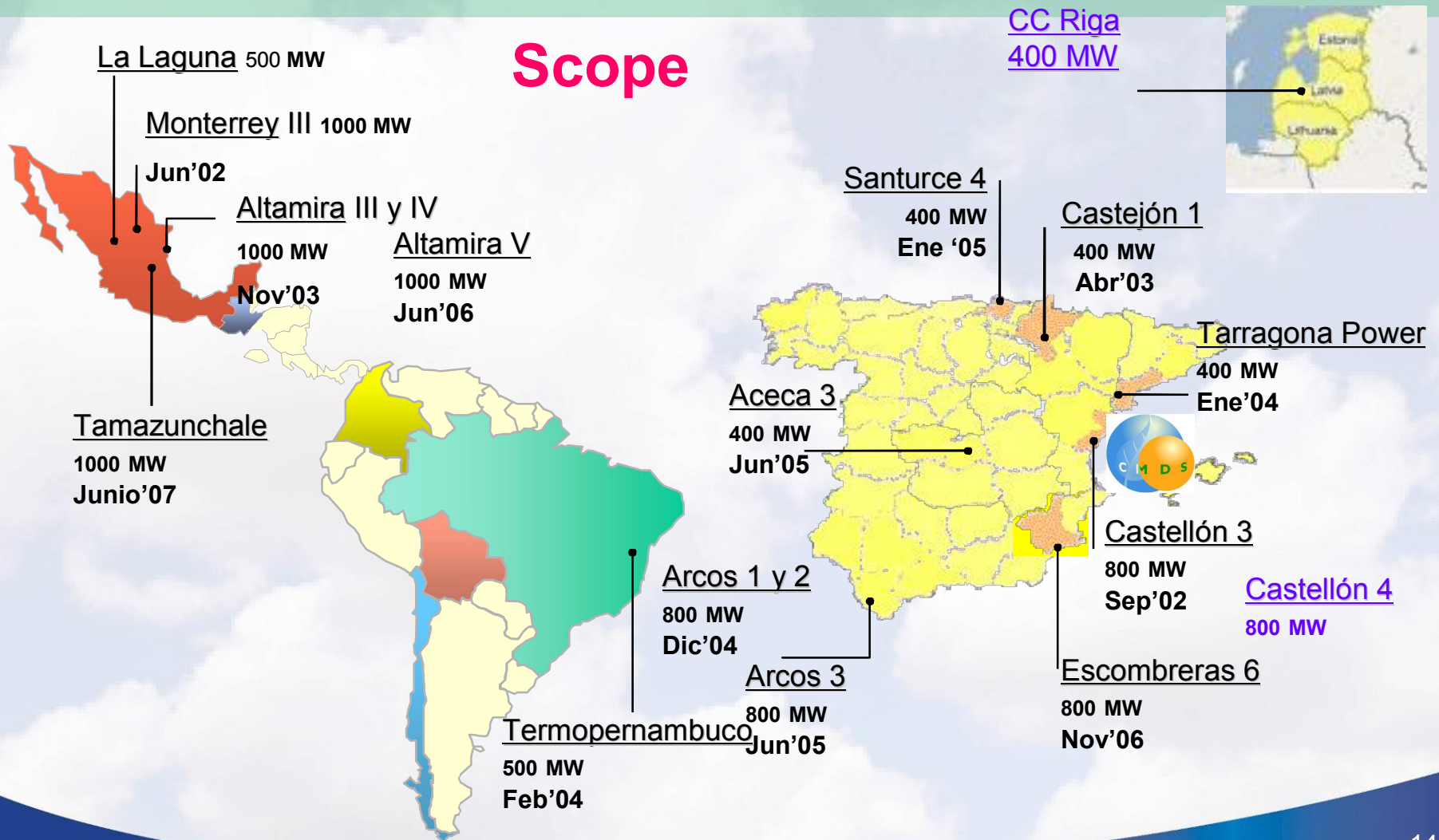
45 specialists, end '07



IBERDROLA & CMDS



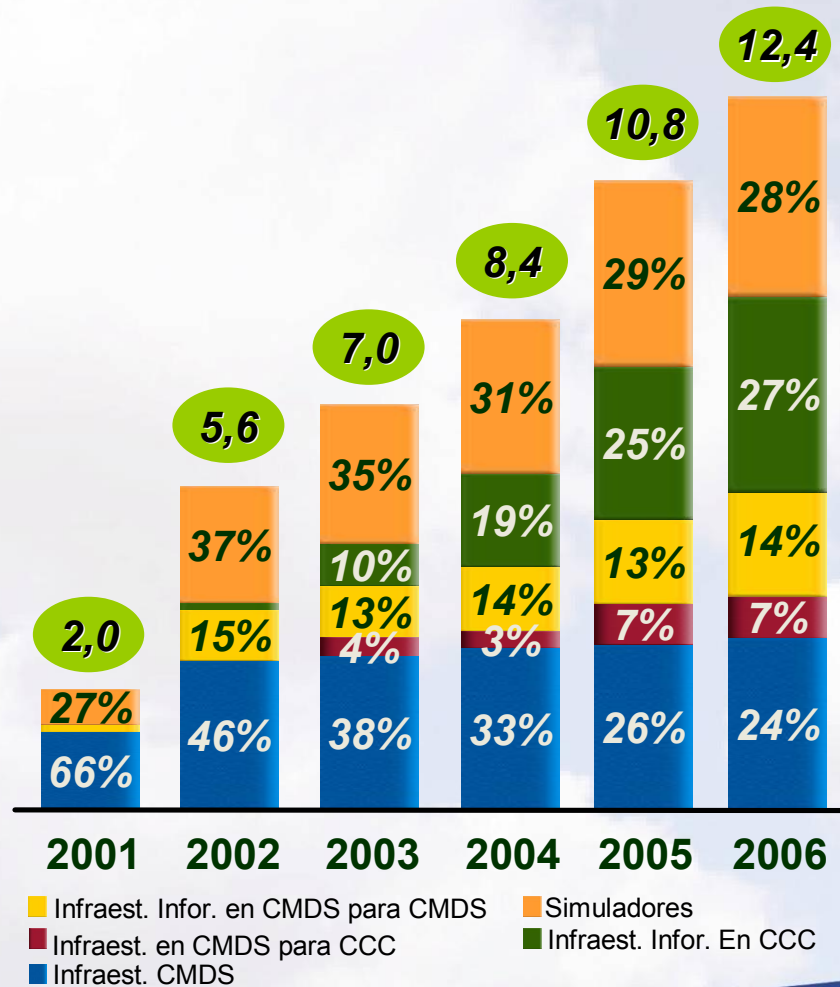
Scope



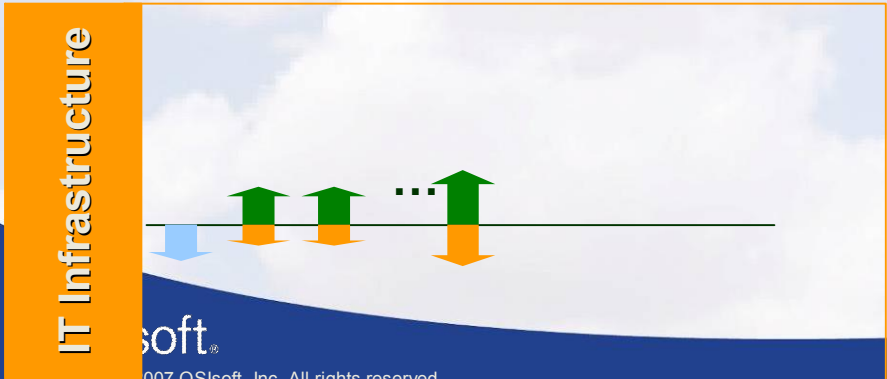
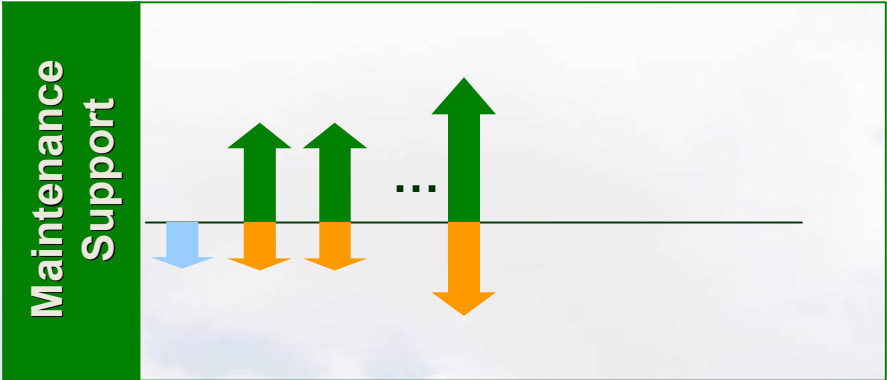
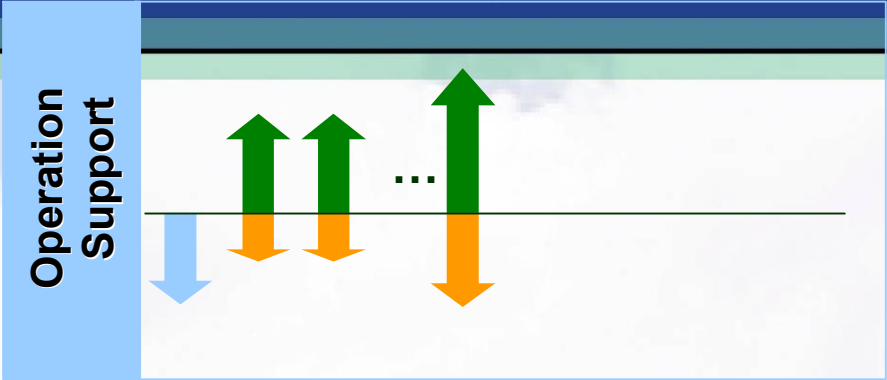
IBERDROLA & CMDS



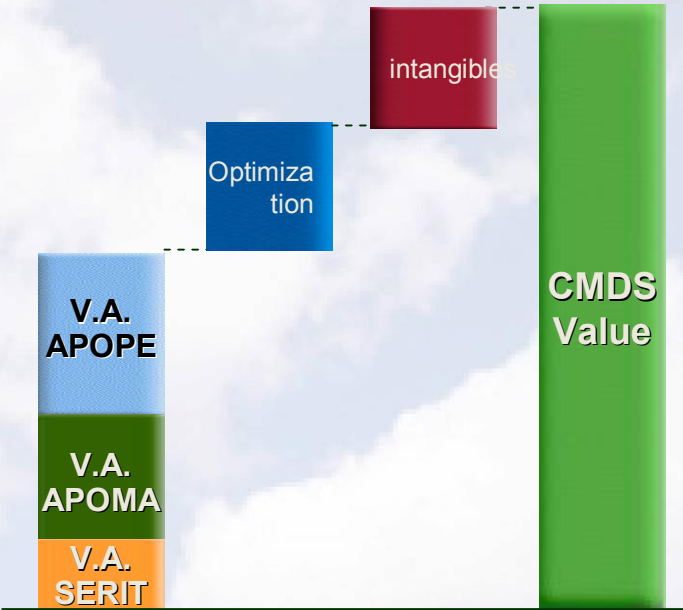
Cumulative Investment¹ (M€)



IBERDROLA & CMDS



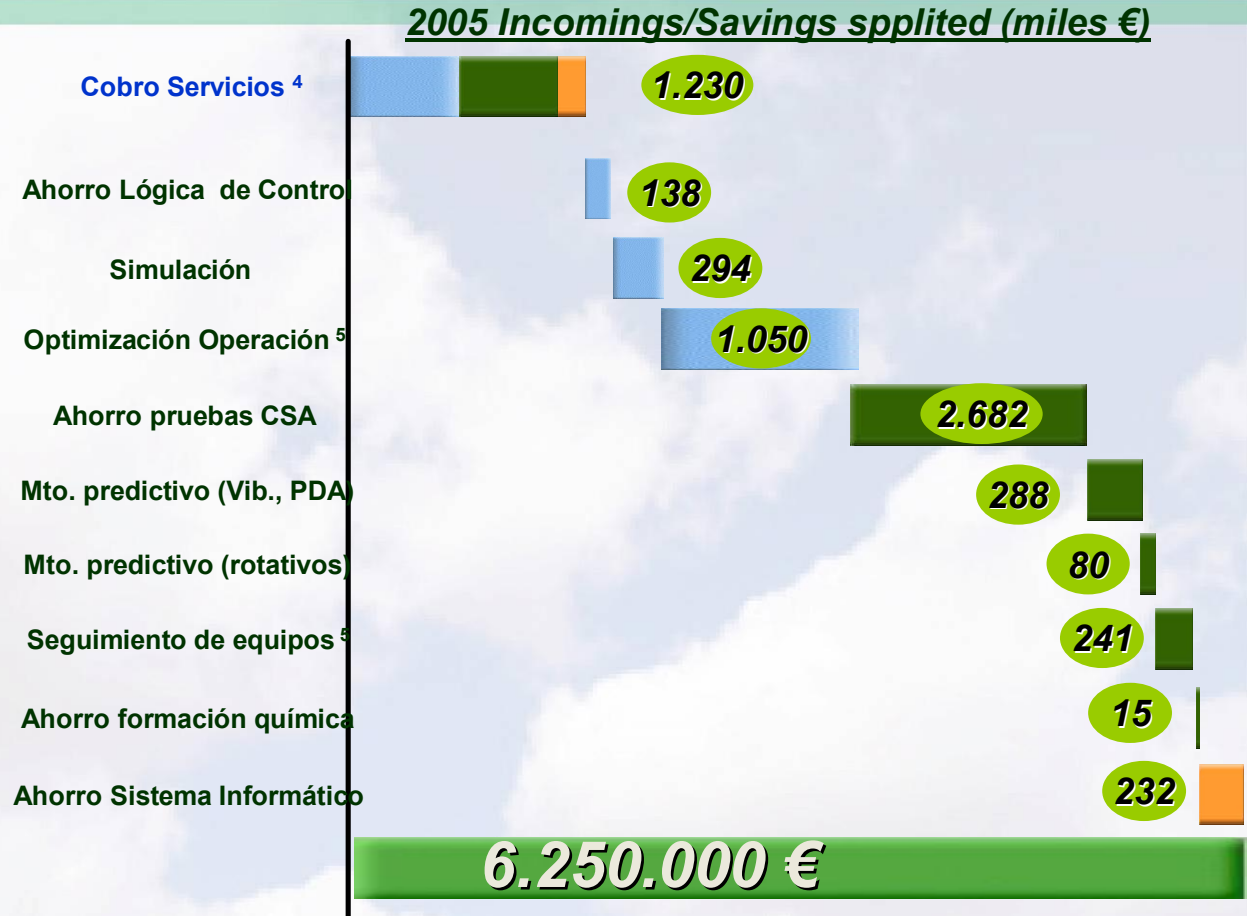
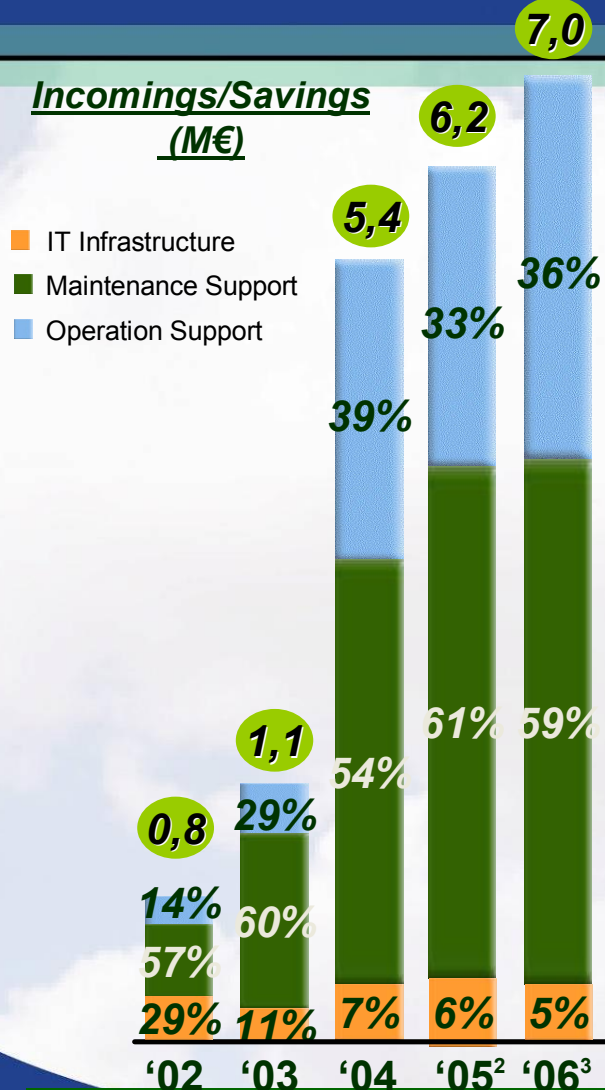
- Center of Excellence: best practices
- Know-How
- Image



Direct Value Better O&M Intangible Value

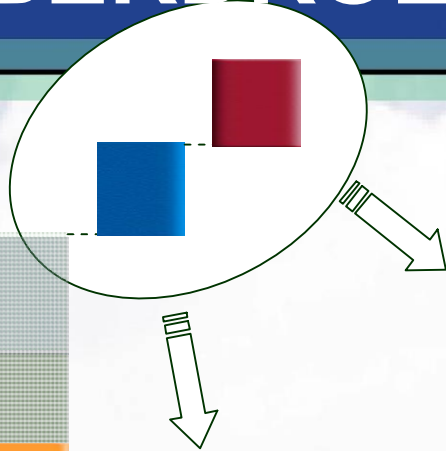
- Technical improvement
- O&M Optimization

IBERDROLA & CMDS



The CMDS provides earning, savings, know-how and flexibility to IBERDROLA

IBERDROLA & CMDS



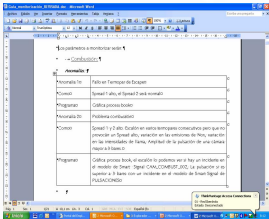
- **CMD S as a Technology Center enhances the image of Iberdrola**
- **Subcontract Iberdrola's core business could lead to a loss of competitive advantage in the medium/long term**
 - The value of Know-how
 - Increases power to better negotiate
- **Chance to apply CMD S knowledge in other generation technologies**

- **Support to LTSA management: bonus-LD's**
- **Improve staff confidence to face abnormal operational situations with the use of dynamic simulators**
- **Life extension of plant components:**
 - Chemical parameters optimization $\equiv$ equipments health (HRSG, ST...)
 - Search of new control loops improvements
 - Maintenance procedures and maintenance frequencies optimization
 - Performance monitoring

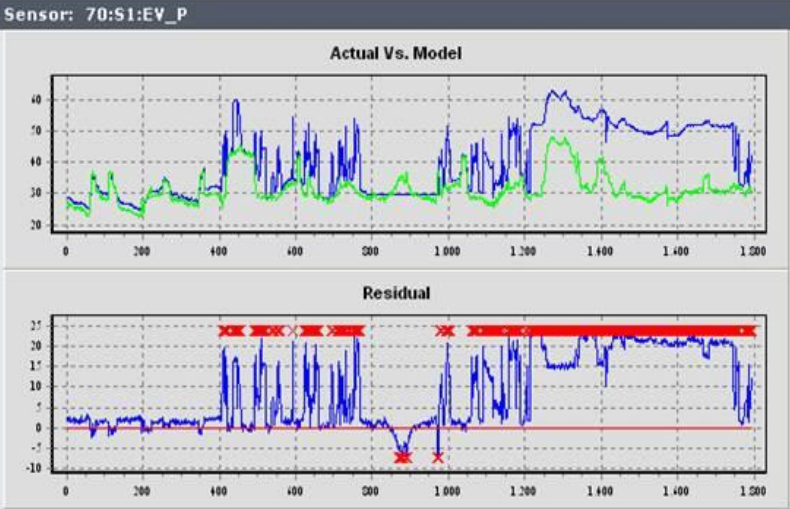
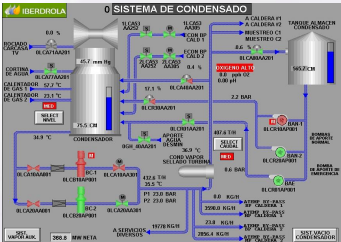
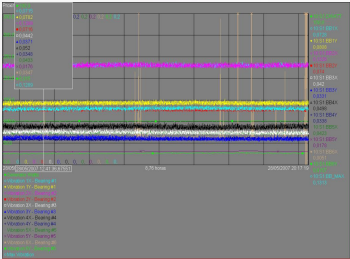
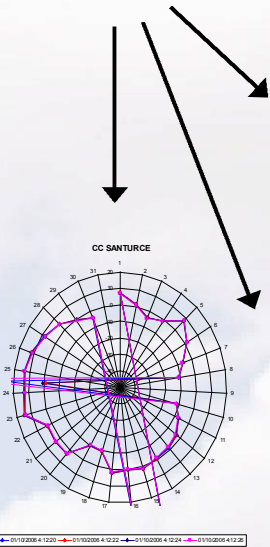
IBERDROLA & CMDS



Check List



Monitoring Tools



MONITORIZACIÓN ON-LINE

	CC CASTELLÓN				CC TARRAGONA		CC ARCOS		CC ARCOS 3		CC ACECA		CC SANTURCE		CC ESCOMBRERAS		
TURBINAS	TG1	TG1	TG2	TV	TG	TV	TG1	TG2	TG3	TG4	TV	TG	TG	TG1	TG2	TV	
Combustion																	
Alarma 1 SPREAD EN CARGA BASE																	
Alarma 2 POSIBLE FALLO CAMARA DE COMBUSTIÓN																	
Alarma 3 FALLO EN TERMOPAR																	
Generador																	
Alarma 1 FALLO SENSOR																	
Alarma 2 MEDICIÓN ANORMAL																	
Alarma 3 FALLO 2 O MAS SENSORES																	
Aireatomización																	
Alarma 1																	
Alarma 2																	



CMDS Lay-Out

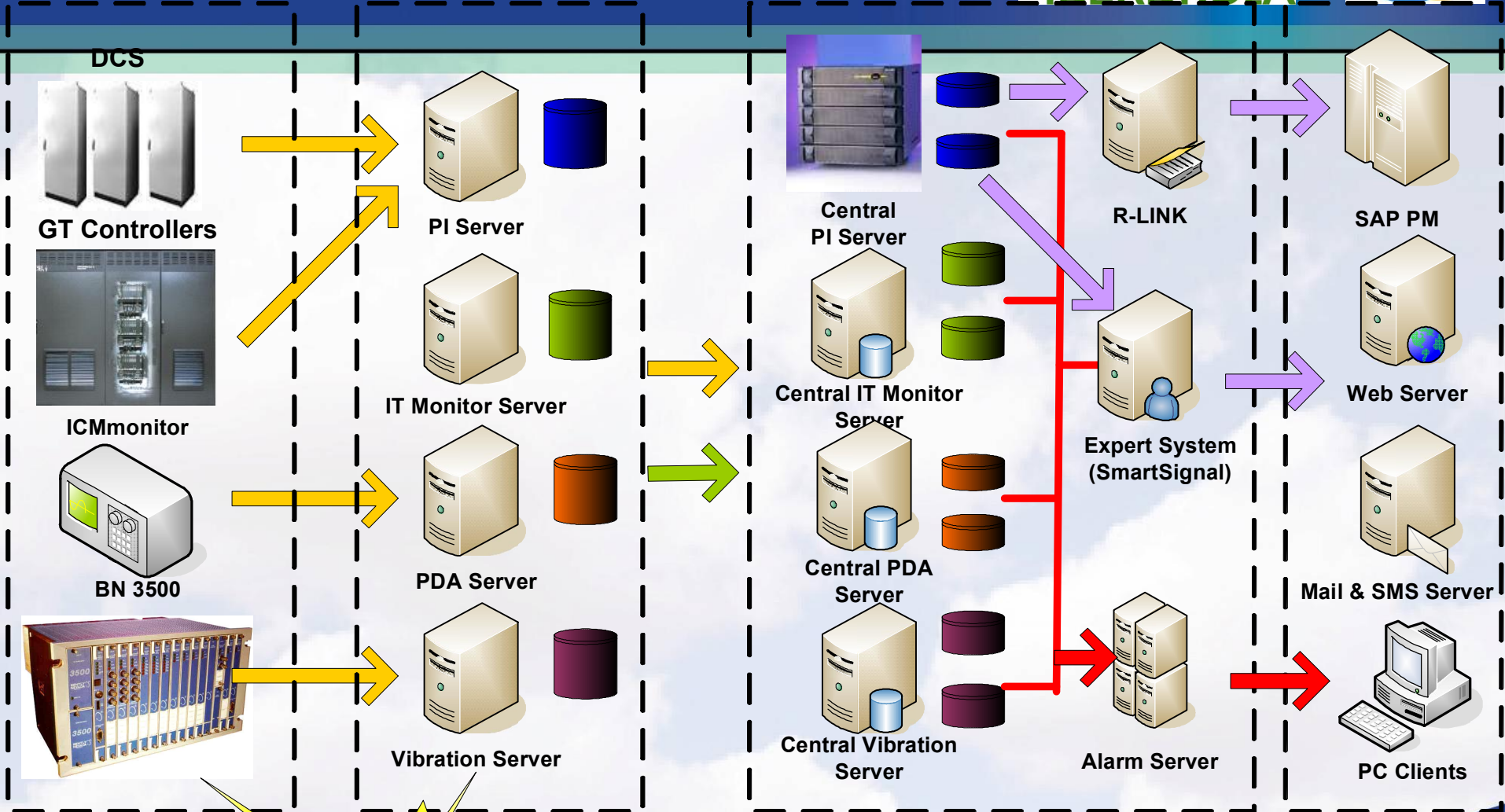


Process Network

"On-Site" M&D Network

CMDS Network

Business Network



- IBERDROLA & THE MARKET
- IBERDROLA & CMDS
- **AEM CONCEPT**
- AEM CASE HISTORIES

AEM Concept



- AEM: Advanced Equipment Monitoring
- Goals:
 - ▶ Optimize Generation Assets
 - ▶ Prevent failures on Generation Assets
 - ▶ Maintenance Contracts Tracking
 - ▶ Performance Tracking
 - ▶ Ensure IT assets availability

AEM Concept



- Why AEM?

- ▶ Up to 100.000 tags coming “on-line” to CMDS
- ▶ Moving to Rule-Based Monitoring instead trending
- ▶ Fleet Wide Monitoring: Easy to spread knowledge
 - Same Rule for equivalent assets
 - Drag and Drop capabilities
- ▶ Spend resources when needed

AEM Concept



- AEM Types

- ▶ Anomaly Detection
- ▶ Maintenance/Energy Contract Tracking
- ▶ Performance Tracking
- ▶ System Advisor
- ▶ IT Monitoring

- IBERDROLA & THE MARKET
- IBERDROLA & CMDS
- AEM CONCEPT
- AEM CASE HISTORIES

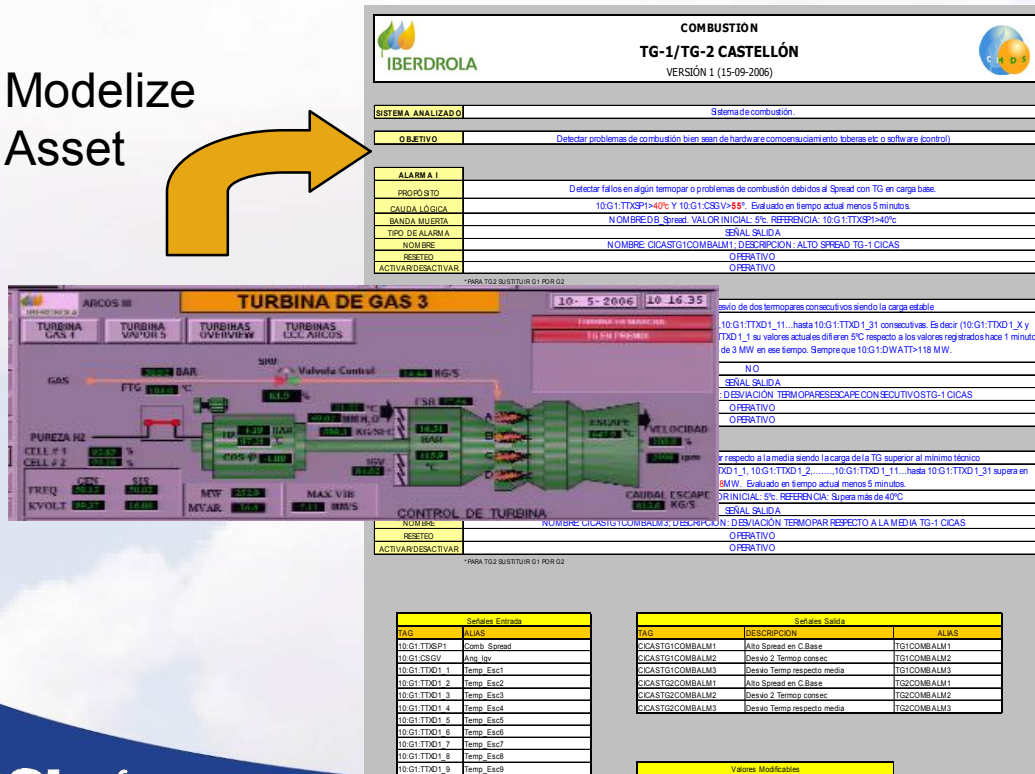
AEM Case Histories



● ANOMALY DETECTION

► Developing Process

Modelize
Asset



Engineers

DEVELOP MODEL

IT staff

PROGRAMING
V1

Engineers

VALIDATION
V1.....

IT Staff

PROGRAMING
V2...

Engineers

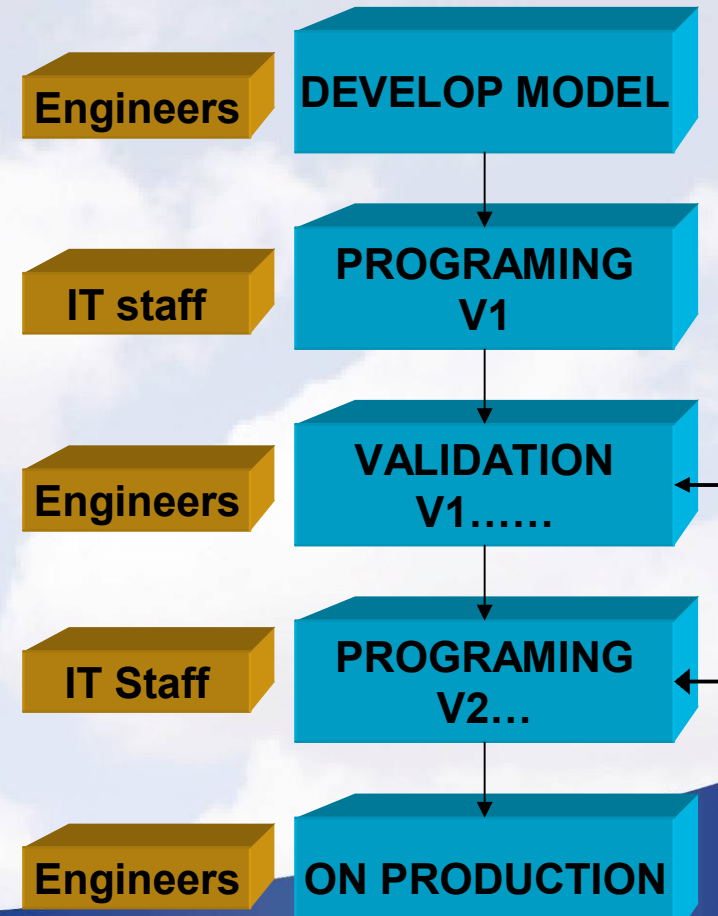
ON PRODUCTION

AEM Case Histories



● ANOMALY DETECTION

- ▶ Models in place
 - Combustion System
 - Generator Monitoring System
 - Generator Hydrogen System
 - Atomizing Air System
 - Proximitors - Vibration Sensors
 - Condensate System
 - HP Attenuation System
 - HP - IP Feedwater Pumps
 - Steam Turbine Sealing System
 - Steam Turbine Exhaust System
 - Steam Process System
 - Turning Gear System



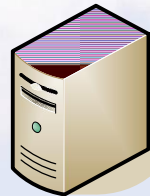
AEM Case Histories



- ANOMALY DETECTION

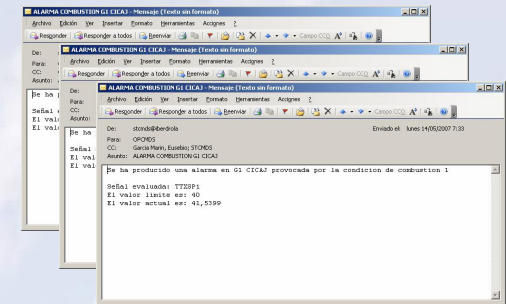
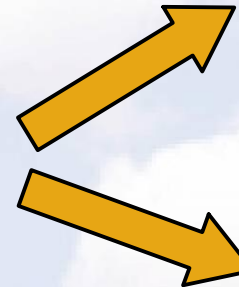
- Notification

The Rule Engine
triggers an event

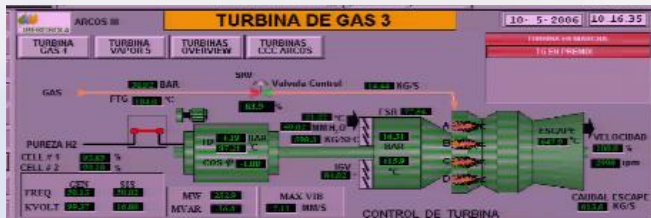


ACE Module

E-Mails



PB Warning
Screen

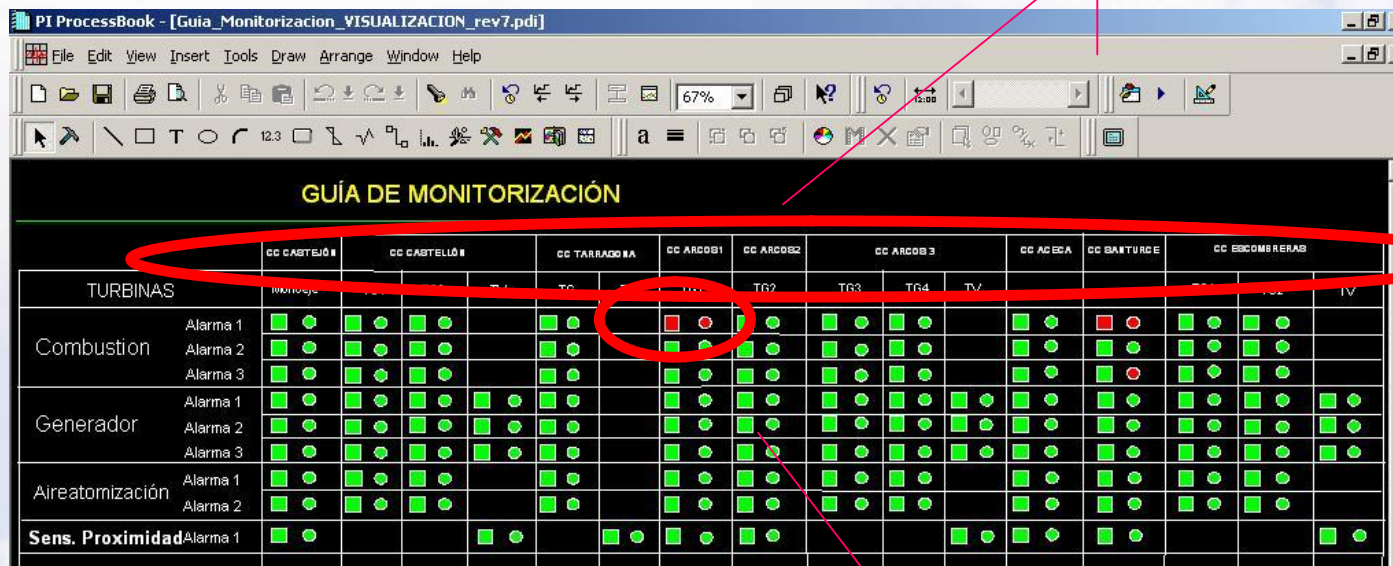


AEM Case Histories



- ANOMALY DETECTION

- ▶ Human Interface – Warning Screen



Fleet

Event

AEM Case Histories



- ANOMALY DETECTION
 - ▶ Human Interface – Operator Screen

PB Displays
Related

PI ProcessBook - [Guia_Monitorizacion_RECONOCIMIENTO_rev7.pdi*]

File Edit View Insert Tools Draw Arrange Window Help

<

Acknowledge

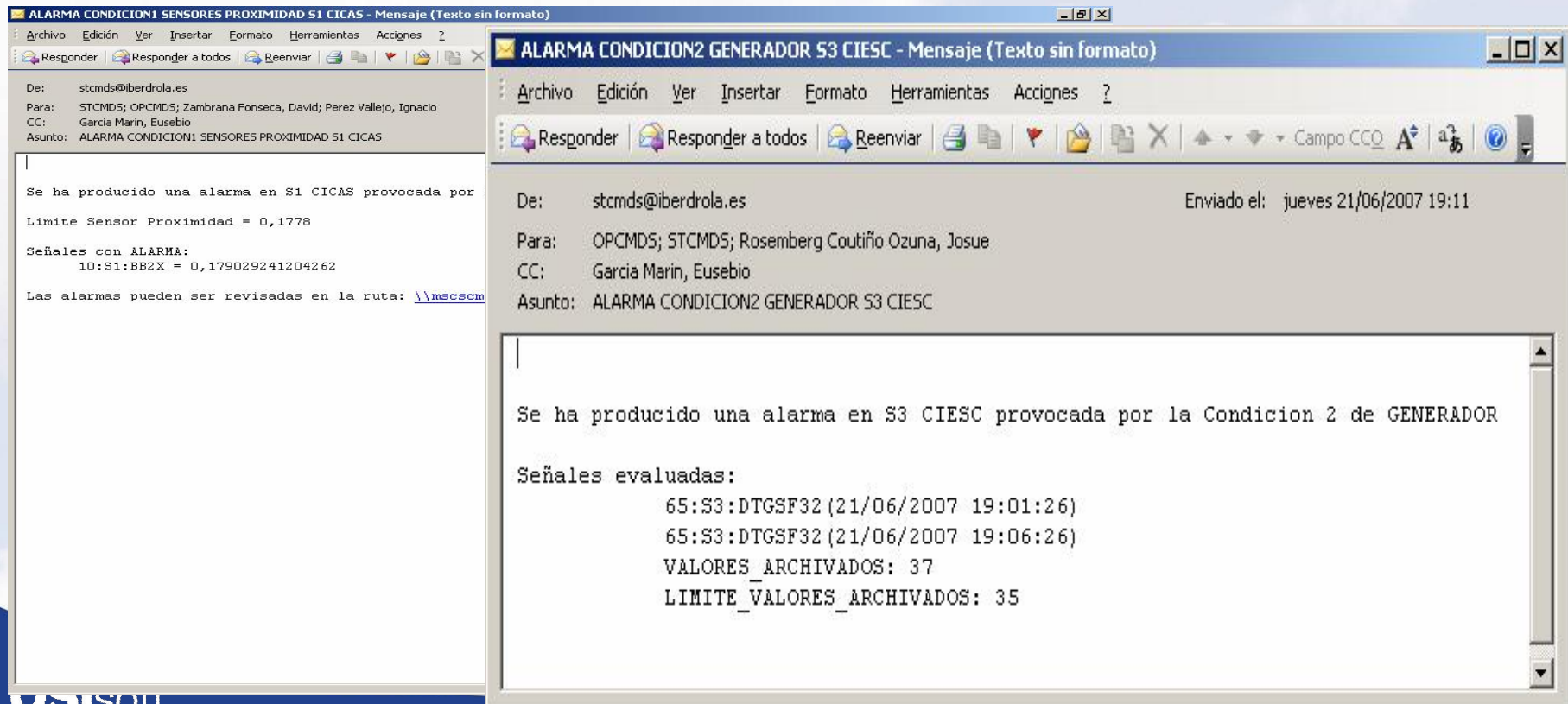
VALUE NOW, VALUE OVER TIME

AEM Case Histories



- ANOMALY DETECTION

- ▶ Emails details



● ANOMALY DETECTION

▶ Examples

- 16/03/2007 – CC Tarragona – Thermocouples problem - Boroscopic inspection.
- 25/04/2007 – CC Arcos II – spread pattern modification – Continuous monitoring
- 01/06/2007 – CC Tarragona – Generator RTD probes failure – Replacement

AEM Case Histories



- MAINTENANCE / ENERGY CONTRACT TRACKING
 - ▶ Maintenance Contract Tracking – FS App
 - CSA between General Electric and Iberdrola
 - Bonus calculations based on FS (Factored Starts)
 - On the beginning manual calculations
 - First Option was to implement on Control Systems
 - GE proposal was 25K USD for GT
 - Iberdrola has more than 14 GE GT's so....350k USD!!!
 - We developed on ACE on 3 weeks!!!

AEM Case Histories



- MAINTENANCE / ENERGY CONTRACT TRACKING
 - ▶ Maintenance Contract Tracking – FS App – Notification

NUEVOS CALCULOS FS T1 CIARC - Mensaje (Texto sin formato)

De: stcmds@iberdrola.es
Para: Garcia Marin, Eusebio
CC: Palacin Fernandez, Jose Roberto
Asunto: NUEVOS CALCULOS FS T1 CIARC

Enviado el: viernes 22/06/2007 0:26

Se ha producido un nuevo calculo de FS en:

```
CENTRAL = CIARC
TURBINA = T1
FECHA_INICIO = 20/06/2007 2:01:51
FECHA_FIN = 22/06/2007 0:24:25

FS_HGPI_INICIAL = 96,4220109712734
FS_CI_INICIAL = 162,409082252138

Potencia_Max = 378,40625
Potencia_Total = 389
b= 0
c= 1

<< FS ocasionado por: PARADA >>

----FS HGPI:----
FS_Arranque = 1
FS_Disparo = 0
FS_HGPI = 97,4220109712734
----FS CI:----
FS_FS_Arranque = 1
FS_Disparo = 0
FS_CI = 163,409082252138
```

AEM Case Histories



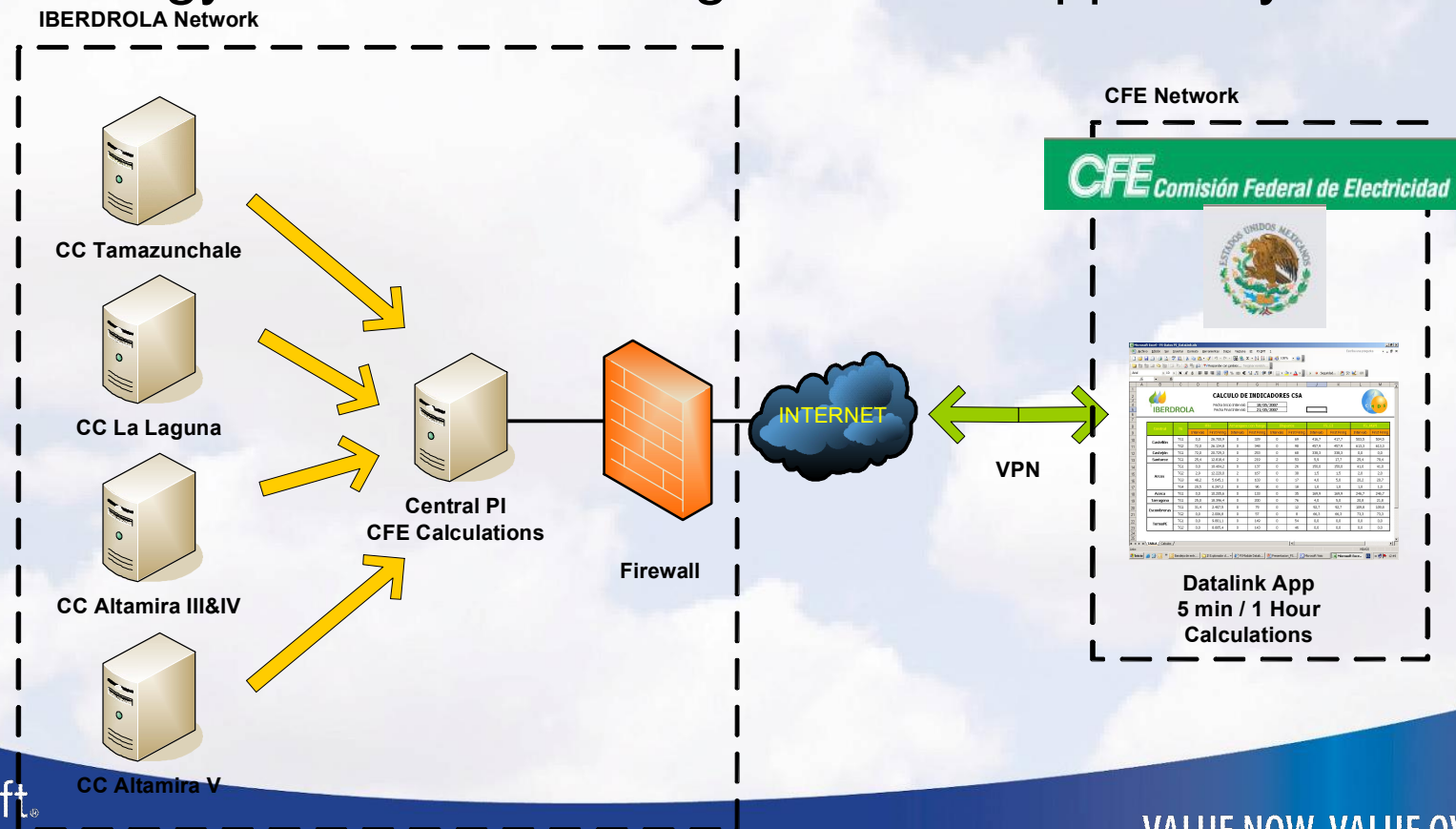
- MAINTENANCE / ENERGY CONTRACT TRACKING
 - ▶ Energy Contract Tracking – PI-CFE App
 - Only applies for Mexican Power Plants
 - Long term energy contract with CFE (Mexican Government)
 - Is mandatory to provide real time calculations to CFE
 - First Option was developed using non OSI tools...it was a nightmare!!!
 - After moving to ACE calculations, we get congratulations from CFE!!!!

AEM Case Histories



- MAINTENANCE / ENERGY CONTRACT TRACKING

- ▶ Energy Contract Tracking – PI-CFE App – Lay-Out



AEM Case Histories

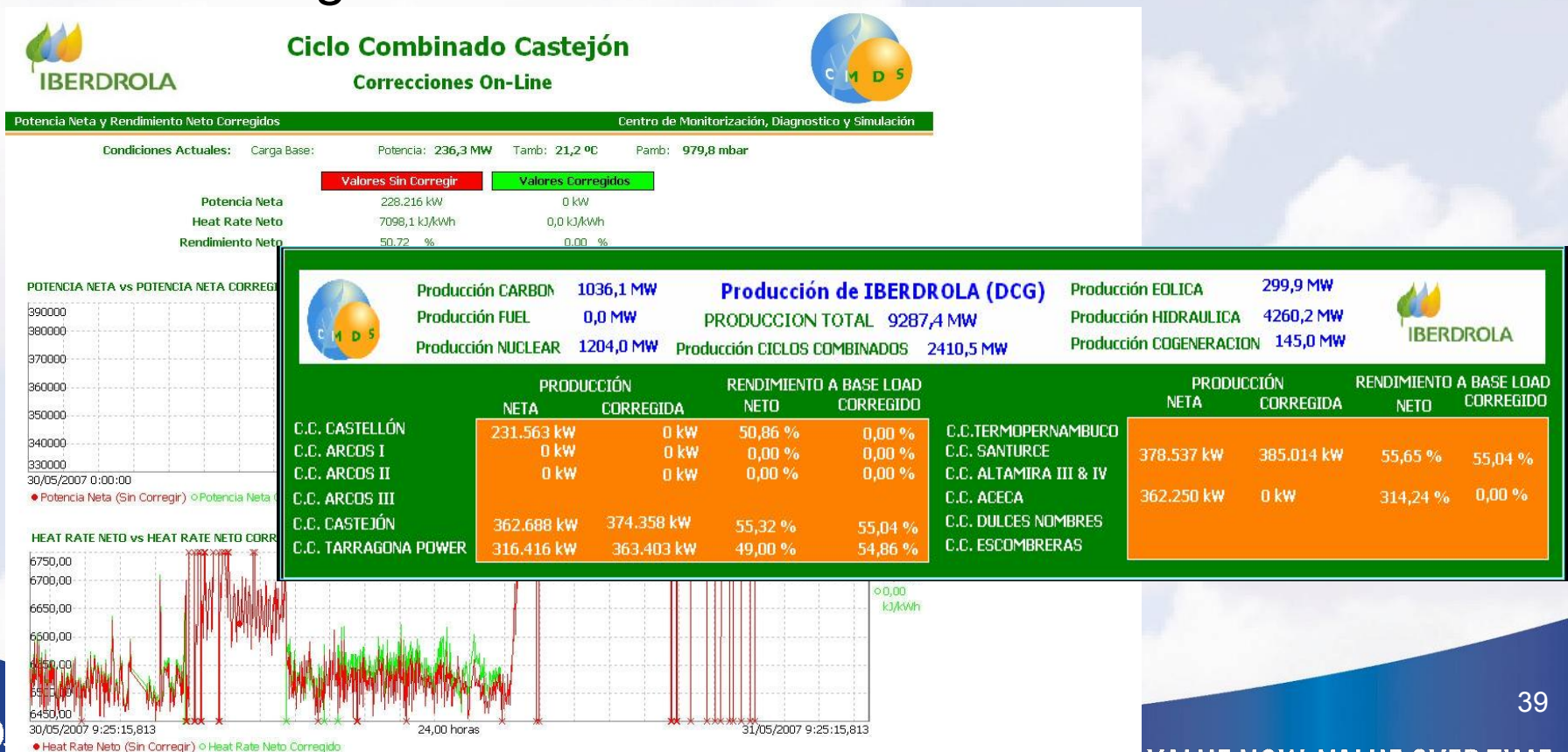


- PERFORMANCE TRACKING
 - ▶ Real time calculations:
 - Corrected Power
 - Corrected Heat-Rate
 - ▶ Corrected using ISO Conditions
 - ▶ Allow comparisons against fleet
 - ▶ Deviations from normal conditions are notified

AEM Case Histories



- PERFORMANCE TRACKING
 - ▶ Tracking Screens



AEM Case Histories



- SYSTEM ADVISOR
 - ▶ Trip Notifier
 - ▶ Start-Up Notifier
 - ▶ On-Demand Notifier

AEM Case Histories



- SYSTEM ADVISOR

- ▶ Trip Notifier

- GT/ST Trip recognition
 - GT Runback recognition
 - Email and SMS to O&M staff
 - Email to General Electric M&D on Atlanta
 - This E-Mail supports common trip avoid process
 - Reduction of TTR (Time to Trip Recognition) from 30 min to 5 min

AEM Case Histories



- SYSTEM ADVISOR
 - ▶ Trip Notifier - Details

DISPARO en la TG2 del CC de ESCOMBRERAS - Mensaje (HTML)

Archivo Edición Ver Insertar Formato Herramientas Acciones ?

Responder Responder a todos Beenviar

De: stcmds@iberdrola.es Enviado el: miércoles 20/06/2007 7:35
Para: md.center@ps.ge.com
CC: STCMDs; OPCMDs; alfonso4.sanchez@ge.com; richard.quintal@ps.ge.com
Asunto: DISPARO en la TG2 del CC de ESCOMBRERAS

Datos adjuntos: iberdrola_logo.bmp (22 KB)

"This is an automatic message generated by IBERDROLA M&D to support the common trip avoid process. There is a problem in the TG2(298475) . Please revise it and call back to 34 964 55 77 19 with recommendations"



DATE
20/06/2007 7:34:09

TRIP NUMBER (CONTADOR MKVI)
9

CC ESCOMBRERAS
TRIP SIGNAL VALUES

ITEM	VALUE
TG2(298475) power:	177 MW
Total power:	267 MW
Turbine speed:	2998 rpm
Generator breaker:	Closed
Trip counter value:	8

A trip has been produced on TG2(298475) from CC ESCOMBRERAS when the load was **177 MW** and the machine was **engaged**



AEM Case Histories



- SYSTEM ADVISOR
 - ▶ Start-Up Notifier
 - Email and SMS to O&M staff

NOTIFICACION ARRANQUE TG1 CCC CASTEJON - Mensaje (HTML)

De: stcmds@iberdrola.es
Para: STCMDS
CC: OPCMDS; Doblado Goberna, Manuel; alvaro.ceteck@grupocivera.com; STCMDS; Martin Mas, Manuel De; Martinez Fernandez, David
Asunto: NOTIFICACION ARRANQUE TG1 CCC CASTEJON
Enviado el: Lunes 02/07/2007 5:22
Datos adjuntos: iberdrola_logo.bmp (22 KB)

IBERDROLA

FECHA
02/07/2007 5:21:34

NUMERO DE ARRANQUE
(CONTADOR MKVI)
259

Six Phases

Diff Time

CICLO COMBINADO DE CC CASTEJON
DATOS EN EL MOMENTO DEL ARRANQUE

HITO	HORA	Duracion Etapa
Inicio del Rodaje	02/07/2007 2:30:03	0 s
Encendido:	02/07/2007 2:46:10	0h 16m
FSNL:	02/07/2007 2:52:41	0h 6m
Acoplamiento:	02/07/2007 2:54:20	0h 2m
Inicio Admision Vapor:	02/07/2007 3:14:58	0h 20m
Vapor 100%:	02/07/2007 4:26:00	1h 12m
Minimo Tecnico:	02/07/2007 5:21:14	0h 55m

Se ha completado el arranque de la TG1 de CC CASTEJON en 2h 51m.

AEM Case Histories

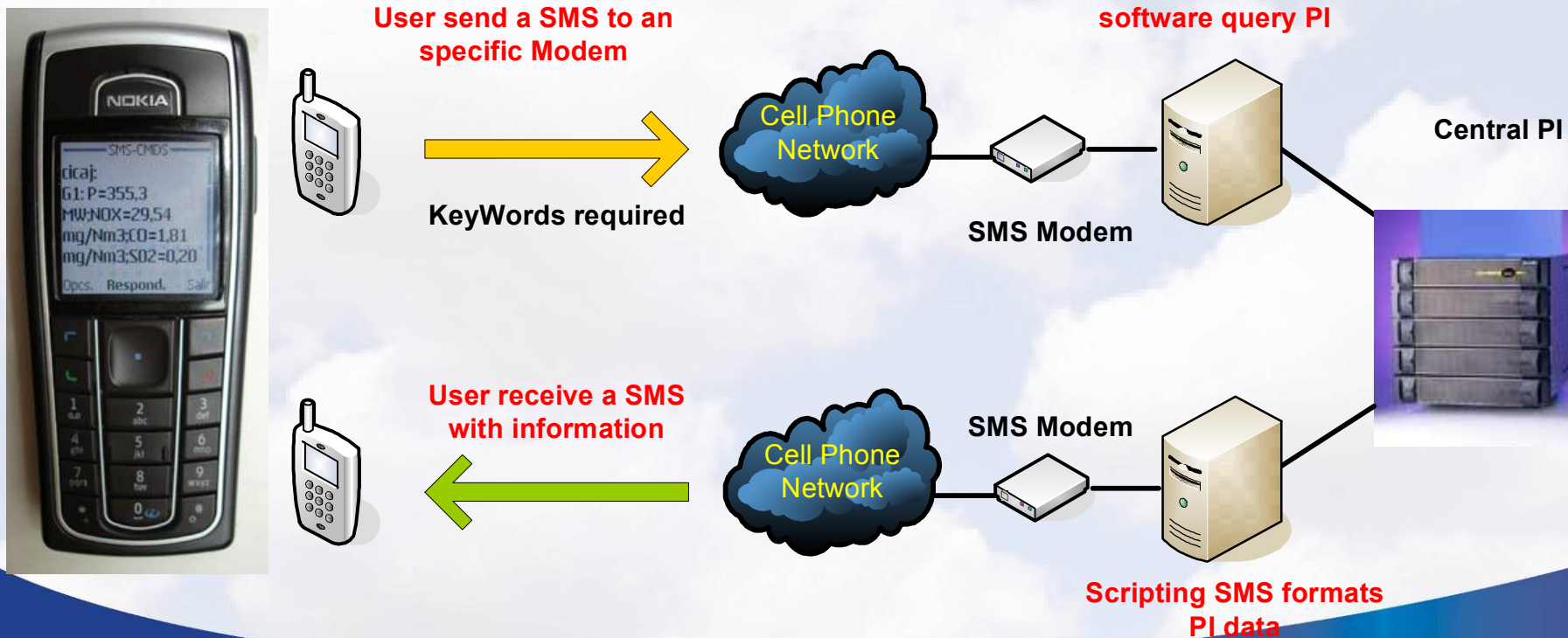


- SYSTEM ADVISOR
 - ▶ On-Demand Notifier
 - On-Demand queries by cell phone
 - Get Real time data from selected GT
 - Output Power
 - Emissions
 - Overall performance

AEM Case Histories

- SYSTEM ADVISOR

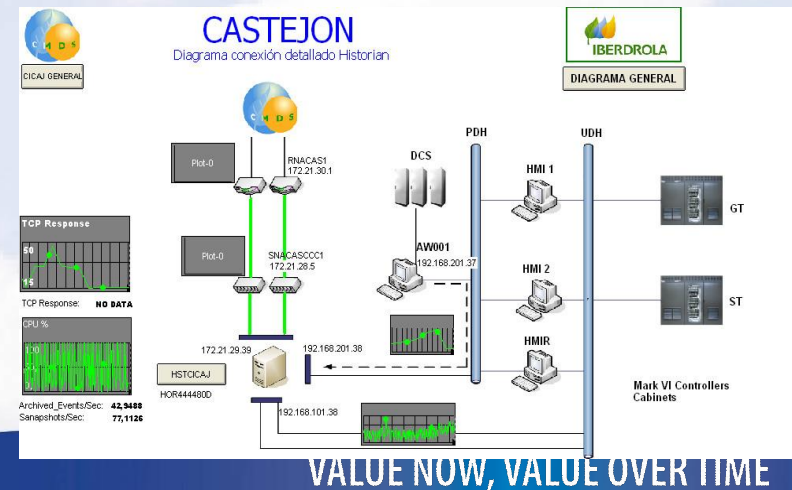
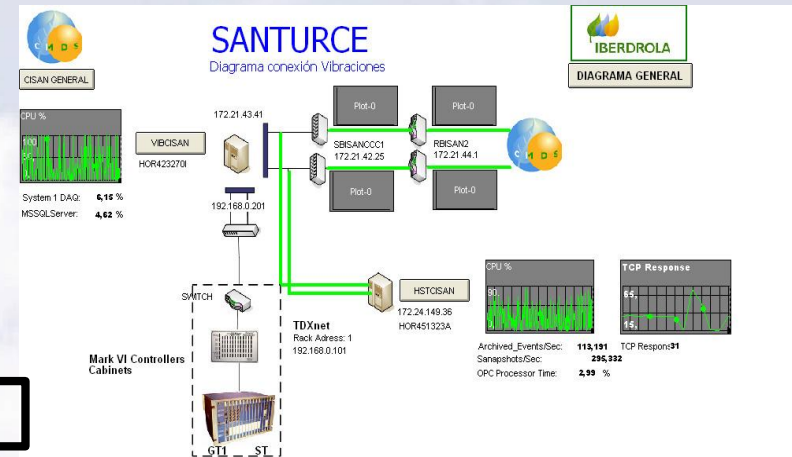
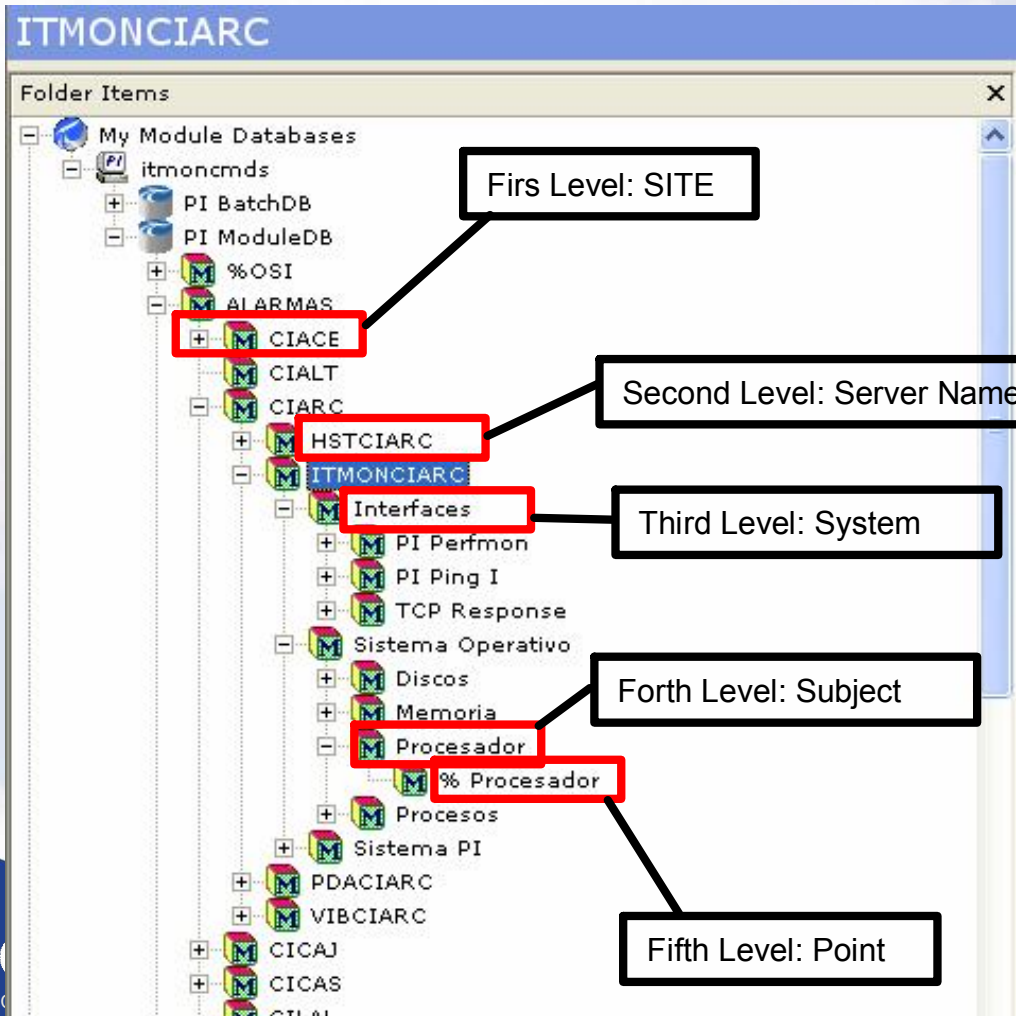
- ▶ On-Demand Notifier – Lay-Out



AEM Case Histories



● IT Monitoring



VALUE NOW, VALUE OVER TIME

Conclusions



- AEM concept really improves operation and maintenance of Power Plants
- Moving to Rule Based monitoring is the key
- PI-ACE is a powerful tool: Robust and high availability
- Direct Cost Savings (only PI-ACE) > 500k USD

VOYAGE2007



***Thank
You***

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VALUE NOW, VALUE OVER TIME