ENEL GREEN POWER
RENEWABLE ENERGY MANAGEMENT SYSTEM
BASED ON THE PI SYSTEM SOLUTION

INDRA – Services & Experience
January 2011
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EXECUTIVE SUMMARY

WHO WE ARE

- The premier IT company in Spain and a leading IT multinational in Europe and Latam
- €2,513 M in revenues
- 30,000 professionals
- 106 countries
- €500 M invested in R&D in three years
EXECUTIVE SUMMARY

LEADER IN SEGMENTS AND VERTICAL MARKETS

Distribution by offering

- Services 27%
- Solutions 73%

Distribution by geography

- Spain 64%
- Rest of Europe 18%
- USA 1%
- Latam 11%
- Others 6%

Distribution by sector

- Telecom & Media 11%
- Financial services 13%
- Public Admin & Healthcare 14%
- Energy & Industry 15%
- Transport & Traffic 20%
- Security & Defence 27%
EXECUTIVE SUMMARY

STRONG INTERNATIONAL PRESENCE FOCUSED ON GEOGRAPHICAL MARKETS WITH HIGH POTENTIAL GROWTH

More than 20,000 projects per year

References in more than 106 countries...

Over 30 subsidiaries

...which represent 85% of World GDP

Algeria  Andorra  Angola  Argentina  Armenia  Australia  Austria  Bahrain  Belize  Bolivia  Bosnia  Herzegovina  Botswana  Brazil  Bulgaria  Cameroon  Canada  Cape Verde  Chile  China  Colombia  Congo  Costa Rica  Croatia  Czech Republic  Dominican Republic  Ecuador  Egypt  El Salvador  Ethiopia  Finland  France  Germany  Greece  Guatemala  Honduras  Hungary  India  Indonesia  Ireland  Italy  Jordan  Kazakhstan  Kenya  Latvia  Libya  Lithuania  Luxembourg  Macedonia  Malta  Mexico  Moldavia  Monaco  Morocco  Mozambique  Netherlands  New Zealand  Nicaragua  Nigeria  Norway  Oman  Panama  Paraguay  Peru  Philippines  Poland  Portugal  Puerto Rico  Romania  Russia  Rwanda  Saudi Arabia  Serbia and Montenegro  Singapore  Slovakia  South Africa  South Korea  Spain  Switzerland  Syria  Tunisia  Turkey  Uganda  Ukraine  United Arab Emirates  United Kingdom  United States  Uruguay  Venezuela  Vietnam  Zambia  Zimbabwe

More than 20,000 projects per year

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SOFTWARE LABS

20 Software Labs

24 hours a day
3,500 professionals

Project management methodology
CMMi 3

ISO 20000
ITIL Best Practices

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ENERGY MANAGEMENT IN INDRA

PRODUCTS AND SOL\textsuperscript{n} FOR THE WHOLE VALUE CHAIN

Level 1
- Plant I&C
  - DCSs and PLCs
  - Plant instruments
  - RTUs
  - Weighbridges
  - Energy measurement
  - Environmental cabins
  - Vibration measurement
  - OPC servers
  - Simulators

Level 2
- Plant Data acquisition
  - PI Data reconciliation
  - Facilities & measures
  - Maintenance Management
  - Operation Management
  - Fuel Management
  - Environmental Management
  - Performance monitoring
  - Condition monitoring

Level 3
- Fleet Management
  - Monitoring Center
  - Plant Simulator
  - Condition monitoring
  - Performance monitoring
  - Optimization
  - Fleet Operation
  - KPIs management
  - Integration portal

Level 4
- Energy Trading & Logistic
  - Market and operations
    - Trade OTC & Markets
    - Contracts management
    - Settlements and billing
    - Market & Credit Risk
    - Portfolio optimization
    - Auction management
    - Fuel logistics
    - Network Scheduling

Level 5
- Corporate management
  - Administration
    - Finance and resources
    - Purchasing and warehouses
    - AP & AR
    - Documentary management
    - BI & Reporting
    - GRC

Siemens
Yokogawa,
Invensys, GE,
ABB, Schneider,
Honeywell,
Etc.

PI SYSTEM
OCEN
RCM
EPI*center
EtaPRO

Sharepoint
Trading Simulators
EPI*Center
EtaPRO
OCEN

Trading,
logistics and risk
management

Corporate
management
(BI/
ERP/GRC)
ENERGY & INDUSTRY

Over **140 utilities companies** use Indra technology solutions

- More than 700 power generation plants managed

**Offering**
- Energy Markets
- Generation Solutions
- Commercial and Distribution Open Utilities
- Solutions for the Petroleum Industry
- Solutions for the Water Industry
- Technical consultancy
- Control and Measurement Systems
- Modelling and Monitoring
- Outsourcing

**Main clients**

Gas Natural Fenosa  |  Grupo PP&L
REE               |  GALP
Gas Natural       |  Petrobras
Repsol YPF        |  Arcelor
CEPSA             |  Fagor
Enel              |  Sidenor
Viesgo            |  Metrovacesa
Iberdrola         |  Navantia
Endesa            |  ENRESA
AES Brasil        |  Carburos Metálicos
Canal Isabel II   |  Grupo EDF
Agbar             |  Mosenergo (Rusia)
Elektro (Brasil)  |  ENRESA
Grupo EDF         |  Gas Natural
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INDRA IS OSIsoft GLOBAL PARTNER

- integration
- development
- commercialization
- owns product natively integrated with OSIsoft’s platform (si and isv partnership)
SPANISH OFFICE (MADRID HQ) ALONE COUNTS ON MORE THAN 15 PI SYSTEM CONSULTANTS WITH OVER 10 YEARS OF EXPERIENCE ON PI SYSTEM
REFERENCES PI SYSTEM IMPLEMENTATION

INDRA’s EXPERIENCE
implementation of more than 50 pi sys providing:
- pi consulting services
- pi implementation
- pi development
- pi training
- pi documentation…

AT PRESENT INDRA MAINTAINS MORE THAN 40 PI SYSTEMS WORLDWIDE.
REFERENCES

ENERGY SECTOR SPECIFIC REFERENCES
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ENEL GREEN POWER

Enel Green Power, founded in December 2008, is the Enel Group company dedicated to developing and managing energy generation from renewable sources at an international level, with a presence in Europe and the American continent. Building on Enel’s competencies in this sector, aims to grow by substantially increasing both installed capacity and efficiency. The company objective is to develop technology mix following the renewables potential of each country.

Enel Green Power is world leader in this sector, with 20.7 TW/h produced year, covering the energy consumption of 7.8 million families, avoiding 15 million tons of CO₂ emissions every year. Installed capacity from wind, solar, geothermal, hydroelectric water flow and biomass energy sources is over 5,600 MW and there are 618 plants in operation around the world.
Enel Green Power needed a system able to integrate information of plant production with that of plant management under a common technology and to monitor all owned renewable plants around the world.

The NEW SYSTEM had to recover the information for all the renewable plants and to integrate with the corporate ERP systems already implemented in the company.
INDRA’s experience and world wide presence, was rewarded with the contract to develop both the **Global Monitoring Room system** and the **Plant Management System**, as well as being assigned the **PI System implementation project** world wide.
The product is integrated, scalable (easy to incorporate additional modules or information) and complete (covering the entire value chain and all the renewable technologies).

Integrated with plant system. The product has the possibility of integrate with any Scada, DCS or another control plant system in order to get the information.

World integration system: The most important characteristic is the possibility of integrated plant information of different countries around the world.

Multi PI installation: The strategy in order to get information of the different plants has choose a PI system from OSIsoft as a key system for the platform.

Web-technology. The system is based on a central web portal (monitoring room) where users can connect (from any country) in order to get/see/use the centralized information.

Multi language: The system is multi language, in order to allow users to view the information on its country.
The Global Monitoring Room and the Plant Mngt System, are BOTH built upon the same PI architecture distributed around the world at EGP premises.
EXECUTIVE SUMMARY

A COMMON ARCHITECTURE

This scalable, robust, modular standards-based architecture constitutes a solid platform to enable the system to meet even the most demanding customer needs, as these evolve over time, totally guaranteeing the investment.
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The Global Monitoring Room and the Plant Mngt System, are BOTH built upon the same PI System architecture distributed around the world at EGP premises.
PI SYSTEM ARCHITECTURE

ARCHITECTURE: MAIN FEATURES

- PI HA configuration **40k tags** for centralized PI System
- PI Standard configuration **2k tags** for peripheral PI System
- **14 PI2PI** Interfaces to connect PI System centralized with peripheral PI System
- Installed an **average of 5 interfaces** to different plant system (SCADA or DCS) for each peripheral PI System
- Interfaces to plant system: **OPC, RDBMS, UFL, DNP3, MODBUS, …**
- more than 6k calculated tags using **PE, Totalizer and ACE**
- PI **COMBO** users
- Web Portal .NET developed, integrated with PI System via **SDK**.
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GLOBAL MONITORING ROOM

GMR FUNCTIONALITY: GUI

Home Page and Multilanguage, Multi Time zone functionalities

MultiLanguage and multi Time zone
GLOBAL MONITORING ROOM

GMR: DATA REPRESENTATION

Graphical and tabular views of data with different levels of aggregation

Graphic view by geography and by technology

Table Forms, with view by geography and by technology
GLOBAL MONITORING ROOM

GMR: DATA REPRESENTATION

Tabular values of plant status

Table Forms, with status and available power by plant, or by Generation Group
GLOBAL MONITORING ROOM
GMR: DATA REPRESENTATION

Graphical representation of all parameters

Graphical representation of values of selected parameters, by geography, technology, plant or production group
Data can be uploaded manually or by file, directly into TAGS, to account for data loss or data correction as well as forecasts.
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PLANT MANAGEMENT SYSTEM

Modules

- Asset Management
- Event Log Management
- Maintenance Alerts
- Planned and Unplanned Downtimes
- Measurements & Relevant Parameters
- Key Performance Indicators
- Reports Centre
- Users Profile Management

PLANT MANAGEMENT: FUNCTIONALITY
RENEWABLE ENERGY MANAGEMENT SYSTEM

PLANT MANAGEMENT: FUNCTIONALITY

- **Geographical and Organizational** Representation
- **Maintenance of relevant asset information** (manufacturer, type of generators, GPS coordinates, etc.)
- **Interface with external systems** (e.g., SAP-PM) to import asset data and hierarchy.

**Navigation Tree**

- Geographical and Organizational Representation
- Maintenance of relevant asset information
- Interface with external systems

**Asset Management**

**Asset Detail view**

- Global Monitoring
- Room
- Plant Management
- PI System
Event Log Management

- Event Dictionary related and specific to each element Type.
- Signal Category- Event Type- Specific Element automatic association.
- Connection to Plant Information (PI OSIsoft) for AUTOMATIC EVENT CAPTURE.
- Tag-associated and man-launched event types
- Event Log and VALIDATION WORKFLOW of events
- Automatic generation of SMS/ e-mail alerts to users/groups of Mail Center
- Automatic SERVICE ORDER proposal based on event occurrence or on sequence of occurrences
RENEWABLE ENERGY MANAGEMENT SYSTEM

PLANT MANAGEMENT: FUNCTIONALITY

- Automatic creation of ‘Maintenance Alerts’ from events collected and validated of Event Log, with different specification data, dates, affected components, relevant technical problems, etc ...
- **ALERT categorization**: start and end dates of planned and description of the failure, causes, elements affected, priority, etc ...
- Flow to external Maintenance systems (SAP PM system) for relevant information and status tracking of the generated ‘Maintenance Alerts’
- Association of relevant documentation to specific Alert
Planned and Unplanned Downtimes Management. Automatic generation from validated events of the events log module.

Characterization of Downtimes: start, scheduled and real end dates, origin causes, physical element origin, condition, associated documents, etc. ...

Downtimes Gantt chart view and navigation, with possibility of zoom-in on each data item (temporal scaling)

Allocation of unavailable energy on a daily basis

Allocation of causes and asset element origin.

Grouping of downtimes and duplication
Retrieval of Plant Information (PI – OSIsoft) parameters of measurements or related to events or as separate queries.

Retrieval of relevant technical parameters "on line" data, stored in the PI database.

Graphical representation of different operational variables: power, production, wind speed, temperature, etc...

Graphics utilities: chart types, different scales series analysis, filtering values, etc...

Data can be seen also in tabular form through a separate tab
RENEWABLE ENERGY MANAGEMENT SYSTEM

PLANT MANAGEMENT: FUNCTIONALITY

Key Performance Indicators

- Gross, Net, and Reactive Power
- Gross and Net Production
- Load and Capacity Factor
- Plant, group status
- Events Types
- Operation Hours

Production

KPI’s

Efficiency
- Consumptions and Losses
- Speed – Power Curve
- Lost Energy due to inefficiency

Availability
- Unavailability Energy
- Turbine availability index
- Plant availability index
- Downtimes Causes Analysis
- Planned vs Unplanned Downtimes
- Downtimes vs Origin components
Reports Centre

- Production Report
- Load Curve Report
- Event Report
- Alarm Report
- Availability reports: time, energy, causes
- Downtimes Gantt view
- Wind velocity Report
- PI System parameters retrieval
- Export to EXCEL functionality

Database access by selection of:

- Data and period.
- Country, Plant, turbine,…
- Downtime causes
- Others
Role-based user account management for differentiating access: User-based configuration

WSSO Access policy (Web Single Sign On)

Creation and maintenance of users with different attributes: personal data, accessible language by default, use the default access times, ...

Allocation of permits with different profiles: consultations, writing, operator, manager, etc ...

Facility-based permission policy
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CONCLUSIONS

- A PI System for data acquisition is the **first step** towards a fully integrated RENEWABLE ENERGY PLANT MANAGEMENT SYSTEM.
- These solutions meant a **rapid go-live and allow full scalability** to business needs as this expands countrywide, worldwide and technology-wide.
- The **management system** is thoroughly **customizable** to adapt to the most diverse business requirements (generation technology, business processes, company organization, geography, etc…) always providing an **integrated and homogeneous** view of the **whole** generation business and KPIs.
- The PI SYSTEM-PLANT MANAGEMENT SYSTEM integration is a key feature for a **complete information system** throughout the company supplying data at plant level as well as management level and allowing full **benchmarking capabilities**.
- EGP-Indra collaboration has been the key to the **successful** implementation of GMR and Plant Management System.
- Indra’s **worldwide presence and deep knowledge** of the renewable energy sector provides the best support to EGP’s expansion in the renewable energy sector.
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