TWG-NPPIC Country Report: Spain

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Nuclear Power in Spain

Installed power capacity as at 31 December (102,259 MW)
- Combined cycle 24.8%
- Coal 10.7%
- Nuclear 7.7%
- Fuel/gas 0.5%
- Cogeneration and other 7.0%
- Hydro (1) 19.5%
- Wind 22.3%
- Solar photovoltaic 4.3%
- Solar thermoelectric 2.2%
- Renewable thermal 1.0%

Maximum peak power demand 38,666 MW
4 February 2014 (8:00-9:00 pm)

Installed power evolution

Spanish peninsula electricity demand coverage 2014
- Combined cycle 8.5%
- Coal 16.4%
- Nuclear 21.9%
- Cogeneration and other 10.4%
- Hydro (1) 15.4%
- Wind 20.4%
- Solar photovoltaic 3.1%
- Solar thermoelectric 2.0%
- Renewable thermal 1.9%
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### Nuclear Power in Spain

<table>
<thead>
<tr>
<th>Plant</th>
<th>Start Operation</th>
<th>Unit Capacity (MW)</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Santa María de Garoña</td>
<td>1971</td>
<td>466</td>
<td>BWR (General Electric)</td>
</tr>
<tr>
<td>Almaraz I</td>
<td>1981</td>
<td>1,035,30</td>
<td>PWR (Westinghouse)</td>
</tr>
<tr>
<td>Almaraz II</td>
<td>1983</td>
<td>980</td>
<td>PWR (Westinghouse)</td>
</tr>
<tr>
<td>Ascó I</td>
<td>1984</td>
<td>1,032,50</td>
<td>PWR (Westinghouse)</td>
</tr>
<tr>
<td>Ascó II</td>
<td>1986</td>
<td>1,027,20</td>
<td>PWR (Westinghouse)</td>
</tr>
<tr>
<td>Cofrentes</td>
<td>1985</td>
<td>1,092</td>
<td>BWR (General Electric)</td>
</tr>
<tr>
<td>Trillo I</td>
<td>1988</td>
<td>1,066</td>
<td>PWR (Siemens-KWU)</td>
</tr>
<tr>
<td>Vandellós II</td>
<td>1988</td>
<td>1,087,14</td>
<td>PWR (Westinghouse)</td>
</tr>
</tbody>
</table>
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### Nuclear Power in Spain

<table>
<thead>
<tr>
<th>Plant</th>
<th>Current operating permit (10 year period)</th>
<th>Owners</th>
</tr>
</thead>
<tbody>
<tr>
<td>Santa María de Garoña</td>
<td>Shut Down Dec 2012*</td>
<td>Nuclenor: Endesa 50% + Iberdrola 50%</td>
</tr>
<tr>
<td>Almaraz I</td>
<td>Jun 2010</td>
<td>Iberdrola 53% Endesa 36% Gas Natural Fenosa 11%</td>
</tr>
<tr>
<td>Almaraz II</td>
<td>Jun 2010</td>
<td>Iberdrola 53% Endesa 36% Gas Natural Fenosa 11%</td>
</tr>
<tr>
<td>Ascó I</td>
<td>Sep 2011</td>
<td>Endesa 100%</td>
</tr>
<tr>
<td>Ascó II</td>
<td>Sep 2011</td>
<td>Endesa 85% Iberdrola 15%</td>
</tr>
<tr>
<td>Cofrentes</td>
<td>Mar 2011</td>
<td>Iberdrola 100%</td>
</tr>
<tr>
<td>Trillo I</td>
<td>Nov 2014</td>
<td>Gas Natural Fenosa 34,5% Iberdrola 48% HCEnergía 15,5% Nuclenor 2%</td>
</tr>
<tr>
<td>Vandellós II</td>
<td>Jul 2010</td>
<td>Endesa 72% Iberdrola 28%</td>
</tr>
</tbody>
</table>
Enresa, the public company in charge of the safe management, storage and disposal of the radioactive waste produced in Spain, is responsible for the ATC

- In Dec 2011 the location was selected
- In 2017: To become partially operational
- 100 years lifetime
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### New Build Projects

#### ATC I&C Design Criteria

- Centralized operation, control and supervision
- Automated and remote operation
- Design is oriented to ease operation and maintenance: unifying technologies, infrastructures, instruments, HMI, PLCs,…
- Common infrastructures, common services, unified software and software and standards
- Technology, standards and protocols for stability, flexibility, scalability, connectivity, normalization, object oriented, safety,…
- Human Factors Engineering, operation procedures, changes management, simulation, training,…
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I&C Modernization projects

Modernization strategy
• Migration to digital systems: Hybrid Control Rooms
• Migration plan in different phases starting by non safety related systems
• DCS provided by the reference vendor of each plant (except Cofrentes that involves additional vendors)

Use of Full Scope Simulators
• Installation in advance of DCS in simulator
• Stimulation strategy
• Early detected errors
• Engineering test at simulator
• Operation staff familiarization and training

Future
• Computerized procedures
• Integrated and advanced alarm systems
• Electronic work packages
• Operation support integrated environment: interactive tables, Tablets, etc
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I&C Modernization projects. Cofrentes NPP

- **BOP DCS (Honeywell)**
  - Honeywell TPS 6 phases from 1998 to 2001: systems related to Heater Drain, Radwaste and Feedwater
  - Drawings & operator station upgrade to Experion (Tecnatom 2010)
  - Essential Services Water (Tecnatom 2009 to 2013)

- **Turbine Control (Mark VI- GE)**
  - HVAC & radioactive waste buildings (Tecnatom 2010)
  - In simulator by Tecnatom (FAT)
  - OFF-GAS (Tecnatom 2011)

- **Plant Process computer**
  - Turnkey project by Tecnatom (2011)
  - RTP & Rolls-Royce technology
  - Historical System OSIsoft PI
  - Modbus and OPC clients (Tecnatom 2013-5)

- **Others**
  - Radioactive Gases Evacuation System
    - 2013 Radiation monitor (Canberra)
  - TIP (Toshiba Westinghouse 2011)
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I&C Modernization projects. Cofrentes NPP

Future Plans BOP DCS
- Valves opening and closing measuring time (Tecnatom 2015)
- HVAC new logics (Tecnatom 2015)
- Hardware modernization (2017)

Future Plans New Systems
- Feedwater Control System. Level Control and Turbopumps Mark VI-e GE (2015)
- Fuel Transfer Tube (Hauser) (2015)
- Recirculation Control. Exciter Control (No date)

Ongoing Cybersecurity (all NPPs)
- Process Network isolation (data-diodes) Portable devices analysis
- Sub-networks firewall-segmentation: PPC, DCSs, Historical, PLCs, videoregisters (2015)
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I&C Modernization projects. Cofrentes NPP. FWCS panels impact
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I&C Modernization projects. Ascó NPP

DCS: Ovation

- Plant Process Computer:
  - Oct 2012 Asco I
  - May 2013 Asco II

BOP: Feedwater Heater & Moisture Separator Reheater:
- Oct 2012 Asco I
- Apr 2013 Asco II

HFE

- Analysis of Design modification impact in the operation concept
- Proposals for optimization of DCS new screens: number, position, orientation, etc
Future Plans
DCS: Ovation

- Reactor Control System & Turbo-Pumps
  - Oct 2015 Asco I
  - Apr 2016 Asco II

- DEH: Turbine Control
  - Apr 2017 Asco I
  - Oct 2017 Asco II

Future Plans
Other systems

- Cooling and circulating water discharge system
  - Not programmed

MCR workplace re-design

- Installation of digital systems that improve the availability
- Room optimization of the workplaces (better communication and supervision with operators)
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I&C Modernization projects. Vandellós NPP

Others

1E Radiation Monitors (2013)

DCS: Ovation

Essential Services Water (2009)

Future Plans DCS: Ovation

Reactor Control System & Turbo-Pumps 2016

Plant Process Computer (May 2015)

HVAC (PLCs) 2016

380 Kv Park Remote Control 2014 ending May 2015 (monitorization)

Turbine Control Not programmed
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I&C Modernization projects. Trillo NPP

Migration to SPPA-T2000
- Teleperm XP (S5 migrated to S7)
  - 220 Kv. Park remote control
  - Leak Detection System
  - Azud Water Collection
  - Water Treatment
- Plant Process Computer & Protection Objectives
  - 2011
- Turbine Control and Protection System
  - May 2015

HFE
- Analysis of Design modification impact in the operation concept
- Large screens: number, position, size, etc

Others
- Alternator emergency evacuator, S7 Post-Fukushima 2014
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I&C Modernization projects. Almaraz NPP

Others
- Auxiliary Feedwater Turbo-pump control, Safety (Exlar)
  - Jun 2015 Almaraz II
  - 2016 Almaraz I
- Spent Fuel Building cooling system register (post-Fukushima) 2014
- Alternative Shutdown Panel (post-Fukushima) 2014

DCS: Ovation
- Reactor Control System
  - 2006 Almaraz I
  - 2007 Almaraz II
- Turbine Control
  - 2005 Almaraz I
  - 2004 Almaraz II
- Plant Process Computer
  - 2011 Almaraz I
  - 2012 Almaraz II
- New cooling towers
  - 2012 Almaraz I
  - 2012 Almaraz II

HFE
- Analysis of Design modification impact in the operation concept
- Large screens: number, position, size, etc
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Fukushima response

Stress Tests and Peer Reviews

• According European Nuclear Safety Regulators Group (ENSREG)
• Assessments show significant margins beyond the design bases
• Regulatory body (CSN) issues Complementary Technical instructions (ITC) to each Plant
• Action Plans to be implemented in three steps

Centralized Support Center

• National emergency support center (CAE) managed by Tecnatom
• Operative in January 2014
• Equipment, expertise and capacity to intervene at any NPP
• 2 Airports and heliport access in 30 minutes
• Military Unit support
• Emergency drills successfully carried out at all NPPs

On-site Support centers

• Alternative emergency management center (CAGE) at each site
• Operative in 2015 and 2016
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Fukushima response

Fukushima Response Projects
- Each NPP is implementing the actions required. Examples:
  - Spent fuel pool instrumentation modernization: level, temperature, radiation
  - Outside radiation monitoring communication to MCR (radio)
  - Alternator emergency evacuator
  - Reinforcement of communications (wireless, TETRA, satellite)
  - Severe Accident Management Guideline Tool (supplied by Tecnatom)

International Projects
- Emergency Control Room in Krsko NPP (Slovenia) (Tecnatom and IDOM)
- Fukushima response for Barakah (Emirates) (Tecnatom)
- Chinese NPP emergency capacity response
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New build I&C status

- Spanish Engineering Companies are working:
  - In I&C modernizations
  - In I&C of new Plants abroad (Tecnatom Example below)
  - ITER design and supply

No New Plants

Since 1997

- “Lungmen NPP” (Taiwan): “ABWR of General Electric”
- “ABWR & ESBWR of General Electric Hitachi”
- “AP1000 & ABWR of Westinghouse-Toshiba”
- “Pebble Bed Modular Reactor” (PBMR PTY Ltd.)
- “CPR1000 of CNPE and AREVA (China)”

Now

- Control Room design and full delivery
- Analysis of human factor engineering
- Design and implementation of man-machine interface
- Verification and validation
- Development of simulators and simulation models
- Development of operation and emergency procedures
- Training of operation and plant personnel
- Engineering and licensing services
- Development and/or qualification of critical components
- Qualification of systems and inspection techniques
- Development of ISI equipment
- Development of PSI and ISI programs

Activities
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Recommendations

Maintenance of digital I&C systems

• Mobile devices use in Control Rooms to support operation (addressing also cyber and EMC issues)
• Support for field workers – smart devices and two-way communication with information sources and experts (addressing also cyber and EMC issues)

Human factors engineering

• VDU based control room, operating experience, sharing the benefit and challenges
• Alarm management
• Human Risk Analysis (HRA)

Support for new units

• Design for easy refurbishment and future upgrading during the long service life of the plant
• Design tools in general, and integration of the tools of different areas