EDF’S EXPERIENCES IN HIGH-PERFORMANCE THERMAL POWER GENERATION

Jordan - 5 September 2016
EDF Thermal Engineering Center (JH Paris)
AGENDA

1. A QUICK GLANCE AT EDF GROUP – THERMAL GENERATION

2. NEW TECHNOLOGY OF COMBINED CYCLE : CASE OF BOUCHAIN POWER PLANT

3. REPOWERING OF EXISTING POWER PLANTS : CASE OF MARTIGUES POWER PLANT

4. E-MONITORING : SOLUTIONS AND EXAMPLES
EDF GROUP, AN INTEGRATED ENERGY AND SERVICES PROVIDER

EDF KEY FIGURES (2015)

€ 75 billion turnover

€ 17.6 billion EBITDA

≈ 37.6 million customers

≈ 159,112 employees worldwide

134.2 GW installed capacity worldwide

619.3 TWh of electricity generated a year
EDF THERMAL GENERATION AND ENGINEERING

With a 44 GWe gross installed capacity across the world, EDF is a leader in thermal generation and engineering. EDF Group expertise as technical advisor has been successfully proven in projects involving the most efficient technologies.

10,000 THERMAL RESOURCES IN EDF AROUND THE WORLD (2015)

THERMAL ENERGY-GENERATION WITHIN EDF GROUP:

~ 80TWh/an
44 GW
Installed capacity
35% coal
35% natural gas
13% oil

Nuclear 54%
Hydropower 16%
Fossil-fuel thermal plants 16%
Combined Cycle Gas Turbines & Combined Heat and Power Plants 9%
Renewable 5%
22 SERVICES SUITED FOR THE LIFE CYCLE OF THE POWER PLANT

EDF can act both as **Owner’s Engineer** and **O&M contractor**.

It’s unique expertise as operator allows a better communication regarding the needs of the O&M, easier management of LTSA contract and a greater involvement of the O&M team during important engineering phases.

**STRATEGY**
- Masterplans and grid consultancy
- Power project pre-development/consultancy and feasibility studies

**DECOMMISSIONING**
- Safety and environment focused final shutdown
- Asbestos removal
- Dismantling

**TRANSFORMATION**
- Lifetime extension
- Upgrading
- Conversion
  - Repowering
- Relocation
- Mothballing and Recommissioning

**DESIGN**
- Power project development/basic engineering/bid evaluation

**CONSTRUCTION**
- Construction & commissioning supervision

**OPERATION & MAINTENANCE**
- Full O&M management
- Organization improvement
- Technical assistance and performance improvements
- Training programs and skills development
  - eMonitoring

**ENVIRONMENT – PERFORMANCES**
- Improving & Upgrading & environmental performances enhancement
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BOUCHAIN, SHOWROOM FOR A NEW GENERATION OF COMBINED CYCLE PLANT

EDF and GE have built a CCGT with the brand new GE Gas Turbine (9HA) more powerful and reactive:

- **A partnership based on performance and innovation:**
  - Combination of GE and EDF competencies
  - Definition of a new reference for performances

- **A plant in line with EDF group objectives:**
  - Modernisation of the thermal park
  - International development

- **A showcase for GE innovation:**
  - New technologies design
  - Smart grid principle applied to the electrical and I&C systems
  - An answer to the needs created by the intermittent energies development (such as wind or solar farms)
PERFORMANCES OF THE PLANT

- **Large capacity**
  - Guaranteed 575 MW (site conditions), able to supply 600,000 homes.
  - Demonstrated 605 MW

- **High efficiency**
  - Over 61%
  - Demonstrated Power Island efficiency: 62,2% (World record)

- **High flexibility**
  - Able to start and stop every day to suit to network needs
  - Full power reached in 30 minutes

- **Environment**
  - Low level of emissions, better than current regulation
TIME SCHEDULE OF THE PROJECT

- **Summer 2012**: Site preparation
- **April 2013**: First pile
- **2012**
- **2013**
- **2014**
- **2015**
- **2016**
- **2017**
- **15 February 2016**: First fire
- **1st August 2016**: Commercial operation
- **11 July 2015**: Electro-mechanical erection and start-up operations
- **15 February 2016**: Global commissioning
- **15 February 2016**: Commercial operation

*EDF*
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The « repowering » process consists in using existing installations renovated and associating them with new equipment, such as gas turbines.

- **Audits and expertise**:  
  - Equipment and systems  
  - Malfunction analysis, investigation on incidents  
  - Equipment degradation and behavior analysis

- **Advisory on renovation**

- **Economical and technical feasibility study**

- **Assistance with contracting and project management**, 

- **Training and skills enhancement for operating staff**

For example:
Can be kept and renovated:  
- Steam turbines  
- Pumping station  
- Cooling systems  

Can be added new:  
- Gas turbines and auxiliaries  
- Heat Recovery Steam Generators  
- Generators…
First Combined Cycle Power Plant repowering, in Martigues, a 40-years old EDF asset.

**1970 to 2008:**
- **Heavy fuel oil power plant**
- **150 employees**

**2008 to 2013:**

- **A huge challenge and a construction site with epic proportion**
  - 500 M€ investment
  - 52 months works
  - Up to 900 workers on-site
  - Frequency rate = 2.09
  - No heavy injury
AFTER COD IN 2013:

Increase in efficiency  
from 37% to 57%

Start-up time reduced  
2 to 7 hours

Substantial lowering of CO₂, NOx and SOx emissions

940 MWe : 2 x 470 MWe

**Lifetime extension**: 25 years

THANKS TO REPOWERING:

20% savings on project costs

No new permits needed

The 61 personnel of the future operating team has been involved in the process
THE BENEFITS:

✓ Lifetime extension of the plant and equipment
✓ Performances enhancement
✓ Reduction of the plant environmental impacts

KEY SUCCESS FACTORS

✓ Accurate Feasability & Basic design :
✓ Spare parts available (ST)
✓ Safety management
✓ O&M staff involvement during construction : commissioning
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eMonitoring is a service of remote analyses of power plant process data

Two main objectives are targeted

- **Performance** monitoring
  - Detect and analyze the power plant performance degradation
    - Tools: CSP, TDY, PMAX, EtaPRO

- **Early Fault Detection**
  - Anticipate the potential equipment faults
    - Tool: PRiSM
The eMonitoring center is located at (EDF thermal Engineering center) in Paris.

With a dedicated team:
- Of about 10 people
- With the support of EDF’s process and equipment experts
- Benefiting from the support of the other experts of the EDF Group (EDF-DTG, R&D...)
- Within a 3 level organization
- Independent from the manufacturers

A centralized monitoring enables to:
- Capitalize the alerts on all units of the fleet
- Standardize and share the best practices and initiatives
- Propose pilot sites for developments and speed up their deployment on the other units
EMONITORING – ORGANIZATION & SERVICES

THREE LEVEL ORGANIZATION

Expertise fields (on which EDF lay stress):

- Thermodynamics
- Gas Turbines
- Static machines (HRSG, condenser...)
- Rotary machines (Steam turbines, pumps,...)
- Power Generators
- Transformers
- Ancillary system / Chemistry
EMONITORING – ORGANIZATION & SERVICES
EDF THERMAL EMONITORING AROUND THE WORLD SINCE 2004

VIETNAM
715 MW
- Phu-My CCGT (2-2-1)

BRAZIL
780 MW
- Norte Fluminense CCGT (3-3-1)

GREAT BRITAIN
1,290 MW
- West Burton 3 CCGTs (1-1-1)

NETHERLANDS
870 MW
- Sloe 2 CCGTs (1-1-1)

FRANCE
5,038 MW
- Blénod CCG (1-1-1)
- Martigues 2 CCGTs (1-1-1)
- Bouchain CCGT (2016)
- 9 GTs in open cycle
- 3 coal-fired power plant

SEI
190 MW
- 5 GTs in open cycle

EMONITORING – ORGANIZATION & SERVICES
EDF THERMAL EMONITORING AROUND THE WORLD SINCE 2004

Monitored Capacity (MW)
Performances Monitoring report

- **1 Sheet per main theme**
  - Overall performances
  - Gas turbine
  - HRSG/Boiler
  - Steam Turbine
  - Condenser / Cooling Tower
  - Auxiliary Consumptions

- **On each Sheet**
  - Trend of parameters
  - Filtered average values over the monitored period
  - Recommendations

- **Cross comparison of similar equipments**
EMONITORING – EXPERIENCE FEEDBACK

- Thanks to different technical and economic assumptions, the eMonitoring team is able to estimate the avoided costs in 4 various categories:
  - Avoided power loss
  - Avoided fuel over-consumption
  - Avoided unavailability
  - Avoided material Impact

Gain on Power production due to cooling tower fouling in CCGT Power Plant

- Example in 2013: alert after fast increase of delta temperature of cold water outlet, the fouling is suspected

**Estimated impact**

- \(\approx 8^\circ C\) (cold end)
- \(\approx 13\) MW on ST power

- Change of cooling tower cells packing, discovered filled with mud

![Graph showing performance catches](image-url)
Thank you