EDF fleet approach: Advantages and challenges for decommissioning costs

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EDF has built and currently operates 58 reactors spread across 19 sites that share the same technology & design - Pressurized Water Reactor (PWR) with 3 series :

- ✓ 900 MW : 34 units
- ✓ 1300 MW : 20 units
- ✓ 1450 MW : 4 units

The 58 units have been built in only 20 years.

As architect and units manager, EDF is in charge of the whole lifecycle of its nuclear power plants, from the build phase to the decommissioning activities.
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Feedback #1
EDF Nuclear Build Program (1980 – 1990)

• Between 1980 et 1990, EDF has built 50 nuclear power plants based on the same Westinghouse design.
• Design and build activities were handled by a unique internal division, allowing a standard design and important cost reductions:
  ✓ up to 80% of generic studies, applicable on all new plants to be built
  ✓ Increased productivity of a internal « site supervision » teams
• An ambitious industrial policy was implemented with multi-sites contracts and securisation initiative for external partners

Feedback #2
Steam generator replacement program (1990 – ongoing)

• Since the early 1990’s, EDF replaces old steam generators on operating plants in order to extend their lifespan.
• Preparation and execution activities are handled by a unique internal division (CIPN), allowing up to 80% of generic studies, applicable on all units
• An appropriate industrial policy is used with the creation of a dedicated structure that groups the four main contractors involved
• Dedicated Purchase policies for tools and equipements allow costs and schedules optimization
• A Feedback policy optimizes security, quality, safety, shedule and costs
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1 Pressurized Water Reactor (PWR)
- Chooz A (300MW) 1967-1991

1 Heavy Water Reactor (HWR)
- Brennilis (70MW) 1967-1985

6 Natural Uranium Graphite Gas reactors (UNG)
- Chinon A1 (70MW) 1963-1973
- Chinon A2 (200MW) 1965-1985
- Chinon A3 (480MW) 1966-1990
- StLaurent A1 (480MW) 1969-1990

1 Fast Neutron Reactor (RNR)
- Creys Malville (1240MW) 1985-1997

EDF Main storage facilities
- APEC : combustible Creys Malville
- Iceda : déchets MAVL (site du Bugey)
- Silos St Laurent : graphite

**Stakes**: benefit from EDF experience feedbacks and use EDF fleet approach to secure and optimize the decommissioning of the 58 reactors currently operated.
Initiative #1 – creation of a new “DP2D” entity to merge all previous engineering divisions for decommissioning and waste management

- New synergies between decommissioning projects and waste management activities, for both technical and financial viewpoints.
- Creation of a dedicated department responsible for gathering experience feedback
- Project organization composed of 5 project departments
MAIN INITIATIVES (2/3)

**Initiative #2** – creation within DPD2 of a project department dedicated to the decommissioning of Pressurized Water Reactors (PWR), with 3 main projects:

**Chooz A**
- Decommissioning project for an 1st generation PWR 305 MW unit located in the Ardennes area
- Operational Feedback and cost estimates for key operations
- Best industrial processes and dismantling methods

**REP2T**
- Engineering project to design, prepare and secure the decommissioning of EDF PWR fleet lead reactors (2 reactors)
- HR Transition
- Permanent Shutdown preparation
- Preliminary design
- Sampling methods
- Physical and Radiological inventories

**STD REP**
- Anticipative approach to identify, study and secure both financial and technical aspects of the future fleet decommissioning program
- Cost estimates for PWR fleet
- Benchmark & technical feedbacks
- IT and reference data
- Standard Cost estimation tool
- Archiving for key documentation
STRATEGY FOR PWR

EDF Decommissioning strategy

- Dismantling program and schedule
- Industrial policy
- Human resources policy
- Shareholders management

Generic program for EDF PWR Fleet

1. Generic studies
   - Technical & engineering studies
   - Risks analysis and opportunities studies
   - Data repository and standard IT solutions
   - Anticipatory actions with operators

2. Cost estimates for EDF PWR Fleet
   - Up-to-date cost estimates for a 2X900 MW PWR / for the whole fleet
   - Feedback integration (Chooz A, REP2T)
   - Benchmark integration

3. Liabilities
   - Accountings
   - Internal and external audits
   - International benchmarks

Operational decommissioning projects

- Fleet lead reactor
- Other reactors – standard approach
**Initiative #3** – Based on 1st generation feedbacks and previous audit conclusions, creation within DP2D of a dedicated project to estimate decommissioning costs and maximize series effect for the PWR fleet

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<th>Activities</th>
<th>Objectives</th>
<th>Main deliverables</th>
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<td>1 Decommissioning Cost estimates</td>
<td>• Gather available technical and financial studies and consolidate them into a unique PWR fleet cost estimate for decommissioning</td>
<td>• Up-to-date cost estimate for a 2x900 MW PWR and global EDF PWR Fleet</td>
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| 2 Risks and Opportunities     | • Identify, study and implement financial, technical or organizational opportunities to reduce decommissioning costs  
• Analyse main risks on EDF PWR decommissioning program and reduce their Financial impacts                                                                                                                                                                                                                          | • Technical and financial analysis for identified opportunities  
• Risks analysis and mitigation plan (to be integrated in the cost estimate)                                                                                                                                                                |
| 3 IT and Data repositories     | • Design, build and maintain EDF tools and systems for cost estimation activities  
• Identify and update data repositories for cost estimation activities and future decommissioning project (and ensure traceability / auditability)                                                                                                                                                             | • Standard Tools and solutions  
• Shared and up-to-date data repositories                                                                                                                                                                                                     |
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OVERALL METHODOLOGY
PRECAUTIONARY APPROACH BASED ON FEEDBACKS

DECOMMISSIONING COSTS ESTIMATES

2X900 MW Cost estimate

EDF PWR FLEET Cost estimate

REFERENCE SCHEDULE

Gross Costs

Extrapolation analysis

Permanent shutdown program & schedule

Mutualisation effects
   Fleet effects
   Transposition effects

Reference cost
d and schedule
for a 2x900 MW PWR

Additional Fleet costs + risks

Gross costs
   For the PWR fleet

Gross and present costs for EDF PWR Fleet

Costs distribution

Operational feedback
   Reference data

Analytic, parametric or analogic methods

Costs estimate for each item

Gross costs

Costs Distribution during the project

Reference cost
d and schedule
for a 2x900 MW PWR

ITDE items

Reference Schedule

Cost estimate Breakdown structure

Reference Scenario

Costs

Reference Schedule

Gross Costs

For each PWR design

For the PWR fleet
EXTRAPOLATION

Based on previous audit recommendations and ongoing EDF Programs (steam generator replacement and Grand Carénage)

- Mutualisation effects
  - Take into account the presence of 2 pairs of reactors on a site
  - Some expenses (engineering studies, tools, investment and operating costs) are shared between the plants on the same site

- Fleet effects
  - Take into account cost reduction effects between the lead reactors and next reactors
  - Generic EDF studies and Standard external deliverables
  - Productivity improvements

- Transposition effects
  - Take into account all minor design differences between CPY PWR and N4/P4 PWR
  - Impacts on quantities and waste to be removed
  - Additional studies to be done for each design
Additional fleet costs are shared between all plants to be decommissioned and include

- Mockups
- Mutualized tools
- Investment cost for centralized steam generator program
- Generic EDF studies
- Generic EDF authorization for waste Disposal
MAIN CHARACTERISTICS

EDF policy

- Prudential approach and hypothesis
- Systematic analysis for identifying opportunities to optimize EDF fleet approach
- In depth Risk management
- Standard and Up-to-date data repositories
- Benchmark and feedback

Important fleet effect based on EDF team productivity

EDF ability to launch anticipatory actions with plants operators to secure and reduce future decommissioning costs

Ability to invest on studies and mockups in order to limit risks and reduce cost uncertainties

Up-to-date and secured cost estimates

Previous decommissioning feedbacks to reduce risks and optimize costs

EDF capability to provide generic decommissioning studies, applicable on all plants

Optimized HR and external providers management
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EDF FLEET APPROACH

A opportunity for EDF ...

• The specificities of EDF PWR Fleet + centralized organization enable to:
  ✓ Optimize the works:
    o Previous feedback integration
    o Knowledge of the plant
    o Investment on tools and studies
  ✓ Reduce the costs
    o Productivity improvements after the fleet lead reactor
    o Diminution of risks and uncertainties
    o Fixed costs to be shared across the whole fleet

... with important challenges

• Anticipative action to be launched to secure the positive economical impact of the fleet effect
• Need to estimate properly the fleet effect through feedbacks analysis, with a prudential approach
• Necessity to take into account the specificities of each site