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Les Entretiens Européens: Investments in nuclear energy in Europe

Investmenting in Decommissioning

J. BOUCAU
Director, D&D Business Development

Brussels, October 20, 2016
Agenda

1. Decommissioning Market
2. D&D Fund
3. Decommissioning Cost Calculation
4. Decommissioning Program: Business Model
1. Decommissioning Market
Operating Reactors by Age

Total of 442 reactors in operation worldwide

273 reactors with more than 30 years of operation (end Jan. 2016 status)
Market Trend: A wave of retirements of nuclear power plants is approaching!

Retirements of nuclear power capacity 1990-2040

- “Almost 200 reactors are retired in the period to 2040; industry will need to manage this unprecedented rate of decommissioning, while also building substantial new capacity for those reactors that are replaced” (IEA 2014)
- “It is estimated that more than 50 of the 129 reactors currently in operation in the EU are to be shut down by 2025” (PINC, Communication on a Nuclear Illustrative Programme 2016).
2. D&D Fund
Decommissioning Fund in EU Member States

- Principle: Funding has to be accumulated by the operators from the early years of operation.
- Typically, these assets are collected in dedicated funds, often combined for decommissioning and radioactive waste management.
- The most frequently used method to collect funds is a fixed contribution based on the electricity produced by the relevant nuclear power plants.
- PINC 2016: “European nuclear operators estimated that €253 billion will be needed for nuclear decommissioning and radioactive waste management until 2050, with
  - €123 billion for decommissioning and
  - €130 billion in spent fuel and radioactive waste management, as well as deep geological disposal.”
- The current assets backing these expected investments, amounted to ~€133 billion.
Funding Challenges

- Capital market: today’s low investment return
- Method for calculating decommissioning and waste disposal costs
- Today’s electricity price, nuclear taxes, post-Fukushima requirements: impact on profitability of nuclear producers
- Early nuclear power plant shutdown (e.g. Germany)
- Decommissioning cost uncertainties in some countries due to lack of waste disposal routes (e.g. graphite) or inaccurate plant data (e.g. old plants)
- Difficulty to predict cost of future deep geological disposal facilities
3. Decommissioning Cost Calculation
Evaluation of Decommissioning Cost

- A Decommissioning Plan should be developed early in the design stage and must be periodically updated by the licensee and reviewed by the regulatory body periodically through the plant life.

- Main content of the Decommissioning Studies:
  - Introduction and methodology
  - General description of the nuclear power plant
  - Dismantling and waste management techniques
  - Material inventory, radioactivity inventory and resulting waste amounts
  - Decommissioning program
  - Decommissioning cost estimates
  - Summary, results and conclusions

- Cost estimate depends on:
  - Reactor type
  - Mass & radiological inventory
  - Decommissioning strategy
  - Availability of waste storage and disposal routes
  - Number of plants per site
The "International Structure for Decommissioning Costing (ISDC) of Nuclear Installations" from 2012 (OECD/NEA structures) is the preferred international approach for reporting decommissioning costs.
## Decommissioning Cost

### ISDC Matrix Elements

<table>
<thead>
<tr>
<th>Cost Estimates</th>
<th>Oskarshamn MSEK</th>
<th>%</th>
<th>Forsmark MSEK</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>01 Pre-decommissioning activities</td>
<td>80</td>
<td>2%</td>
<td>67</td>
<td>1%</td>
</tr>
<tr>
<td>02 Facility shutdown activities</td>
<td>135</td>
<td>3%</td>
<td>91</td>
<td>2%</td>
</tr>
<tr>
<td>03 Additional activities for safe enclosure</td>
<td>-</td>
<td></td>
<td>0%</td>
<td></td>
</tr>
<tr>
<td>04 Dismantling activities within the controlled area</td>
<td>2 363</td>
<td>45%</td>
<td>2 686</td>
<td>45%</td>
</tr>
<tr>
<td>05 Waste processing, storage and disposal</td>
<td>513</td>
<td>10%</td>
<td>522</td>
<td>9%</td>
</tr>
<tr>
<td>06 Site infrastructure and operation</td>
<td>332</td>
<td>6%</td>
<td>327</td>
<td>5%</td>
</tr>
<tr>
<td>07 Conventional dismantling, demolition and site restoration</td>
<td>911</td>
<td>17%</td>
<td>1 366</td>
<td>23%</td>
</tr>
<tr>
<td>08 Project management, engineering and support</td>
<td>900</td>
<td>17%</td>
<td>905</td>
<td>15%</td>
</tr>
<tr>
<td>09 Research and development</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 Fuel and nuclear material</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11 Miscellaneous expenditures</td>
<td>37</td>
<td>1%</td>
<td>23</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>5 271</td>
<td>100%</td>
<td>5 986</td>
<td>100%</td>
</tr>
</tbody>
</table>

**Major contributor!**
4. Decommissioning Program: Business Model
Supplier Vs Utility Involvement

- **Outsourcing**
- **Partnership**
- **Self Performance**

- **Supplier’s involvement**
- **Utility’s involvement**

- **Small Experience**
- **Medium Experience**
- **High Experience**

Utility’s D&D Experience
Variety of D&D Business approaches

- Outsourcing
- Partnership
- Self Performance

Supplier’s involvement vs. Utility’s involvement

- Plant Acquisition
- License Stewardship
- M&O
- Partnership
- EPC Work Package
- Self Perform
Business Model Overview: Few examples by countries (not exhaustive)

Today

Tomorrow?

... It’s all about risk perception and experience in D&D