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Les Entretiens Européens: Investments in nuclear energy in Europe

Investmenting in Decommissioning

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Agenda

- 1. Decommissioning Market
- 2. D&D Fund
- 3. Decommissioning Cost Calculation
- 4. Decommissioning Program: Business Model



1. Decommissioning Market



Operating Reactors by Age





Market Trend: A wave of retirements of nuclear power plants is approaching!

Retirements of nuclear power capacity 1990-2040



🗖 European Union 🔎 United States 📃 Japan 📮 Others

 "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 <u>fixed</u> 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
 - Avalability of waste storage and disposal routes
 - Number of plants per site





Standard International Cost Calculation



	Cost group							
Cost item	Labour		Capital	Expenses	Contingency	Total		
	Hours	NCU		NCU		NCU		
01 Pre-decommissioning								
02 Facility shutdown								
03 Additional activities for safe enclosure								
04 Dismantling activities within the controlled area								
05 Waste processing, storage and disposal								
06 Site infrastructure and operation								
07 Conventional dismantling demolition and site restoration								
08 Project management, engineering and site support								
09 Research and development								
10 Fuel and nuclear material								
11 Miscellaneous expenditures								
Total								

NCU = National currency unit.

The *"International Structure for Decommissioning Costing (ISDC) of Nuclear Installations"* from 2012 (OECD/NEA structures) is the preferred international approach for reporting decommissioning costs.



Forsmark 1-3 and Oskarshamn 1-3 results – Decommissioning Cost

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

Major contributor!

4. Decommissioning Program: Business Model



Supplier Vs Utility Involvement





Variety of D&D Business approaches





Business Model Overview: Few examples by countries (not exhaustive)

