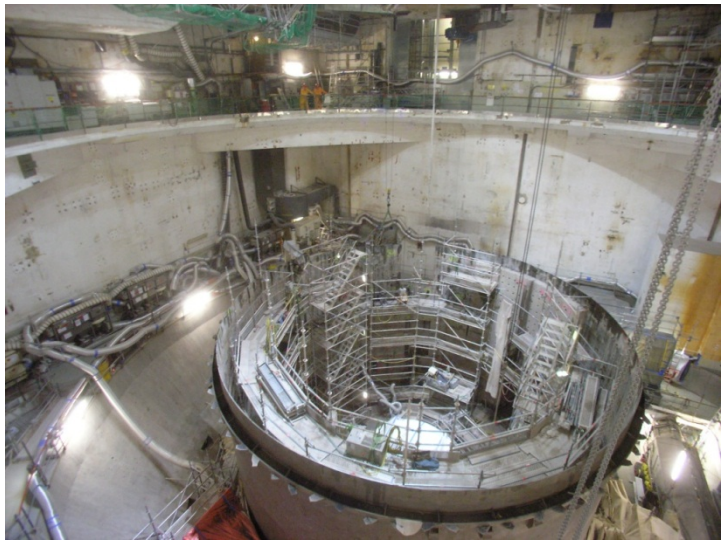


IEA NEA Nuclear Workshop
Update of the Nuclear Energy Technology Roadmap

Nuclear Decommissioning
Andreas Ehlert, January 2014

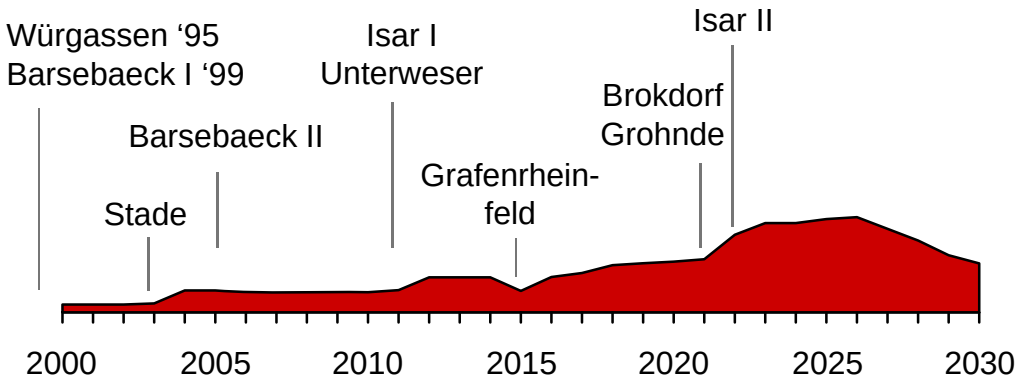
Decommissioning market is emerging and may reach up to EUR 20-30 bn cumulated until 2030 in Europe

Category

Market development
(€ millions)

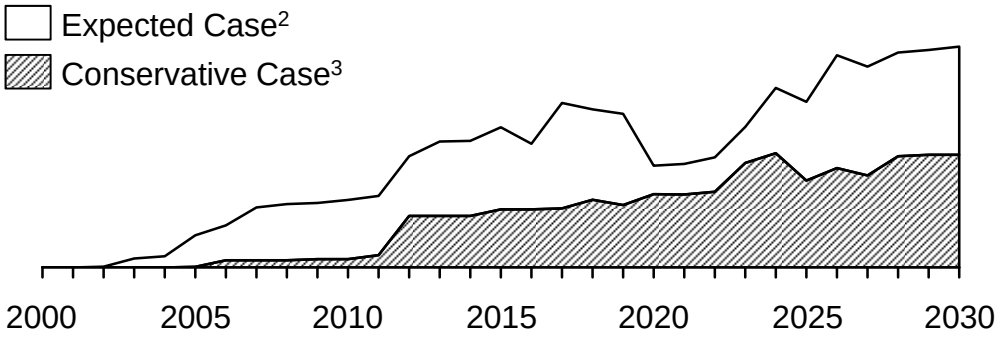
Cum. decom. volume
(2012-2030 in € billions)

E.ON plants[1]



6.6

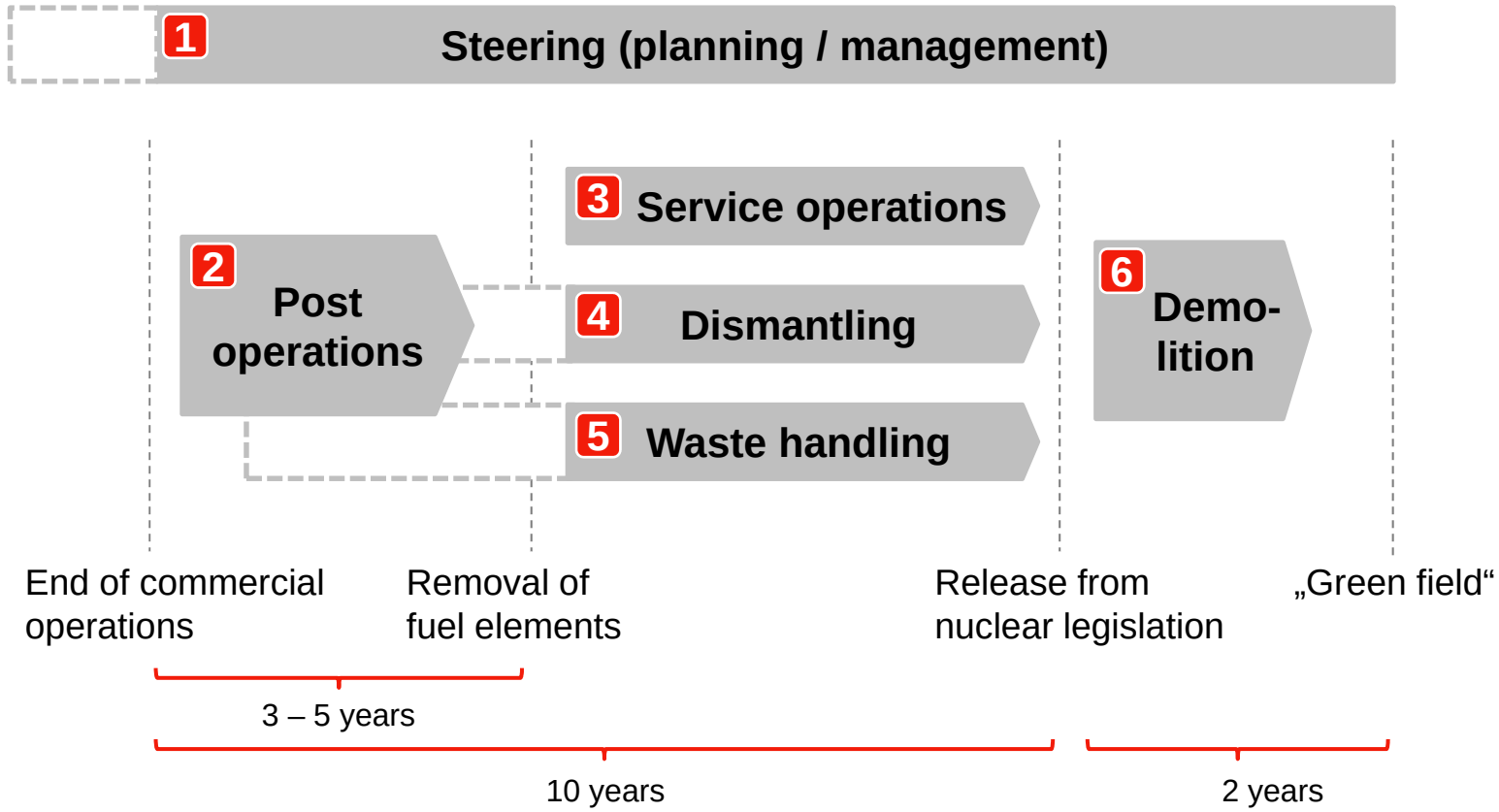
External plants
(Europe excl. Russia)



20-30

1 Based on extrapolation of historic approach to decommissioning with EON
2 Incl. other plants in Germany and 2-3 out of 10 plants that go after shut down into immed. dismantling in Belgium, Switzerland, Finland, France, Bulgaria, Czech Rep., Lithuania, Slovakia, UK
3 Incl. other plants in Germany and 1 out of 10 plants that go after shut down into immediate dismantling in Belgium, Finland, France and Switzerland

Point of departure: A nuclear decommissioning project is structured along 6 phases, duration 12yrs in Germany



E.ON gained substantial experience in the direct dismantling of Stade und Würgassen NPP

	Immediate dismantling ongoing		Immediate dismantling planned
NPPs	**Würgassen**	**Stade**	**Isar I / Unterweser**
Shut down	1995	2003	2011 / 2011
Start of dism.	1997	2005	2018e / 2018e
Dism. duration	15 yrs. (ongoing)	7 yrs. (ongoing)	10 yrs. (planned)
Examples	Unplanned shut down (start of decom. from revision)	Planned shut down on short-term notice (fuel transports and storage)	• Unplanned shut down (Moratorium) • Use of proven dismantling techniques and experience in waste treatment • Implementation based on decom. critical process • Early use of standby systems instead of established systems • Final disposal to Konrad (2019) • Convoy use of tools (KKG, etc.)
	Execution based on “small step approach” (dismantling, regulation)	Dismantling approach based on critical path assessment	
	Build-up of experience, decom. technology and process know-how	Planning started during operations phase, know-how transfer ensured	
Capacity (MW)	• 640	• 640	• 878 / 1.345
Type	• BWR	• PWR	• BWR / PWR
Status	• Decom. 2014 completed (exp.) w/o civil demolition	• Decom. 2014 completed (exp.) w/o civil demolition	• Post operations (KKI/KKU)

New Situation needs significant Change on all levels within a Nuclear Utility Organization

Operation	Decommissioning
• Highest focus on safety and quality on operation and maintenance (e.g. preventive)	• Highest focus on safety and quality for non-commercial/post/residual operation
• Fundamental safety functions (protection goals) are control reactivity, fuel cooling and to confine radioactive material	• No more generation contribution, permanent checking and testing of requirement and measures
• Well known working environment	• One-Time activities
• High radiological inventory (nuclear risk)	• Protection goal is to confine radioactive material (move to industrial risk)
• Continuous and extensive training of stafffor save operation	• Changed focus of organization to project orientation
• Commitment of staff towards long-term operation, fixed employment with routine objectives	• Dynamic „Dismantling of organization“ with visible end of employment
Preserve – Maintain – Invest	Shut-down – Reduction – Change

Source: EON's view and IAEA Tecdoc 1702, 2013: RINDAHL, Halden

We see four major areas for further technological development and improvements

1 RPV* and RPV internals

- Improve standardization
- Reuse equipment
- Simplify tools
- Improve automation

2 Waste treatment and recycling

- Improve automation of tools
- More flexible remote controlled tools
- “Intelligent tools to measure decontamination success”

3 Decontamination & release measurement of surface

- Improve automation in currently personal intensive work
- Improve techniques for decontamination
- Leverage based on total amount of surface

4 Disposal requirements

- Allow disposal of entire components
- Improve disposal capacity for med /low active waste
- Adjust release limits
- Develop recycling options
- Improve standardization

*) RPV = Reactor pressure vessel