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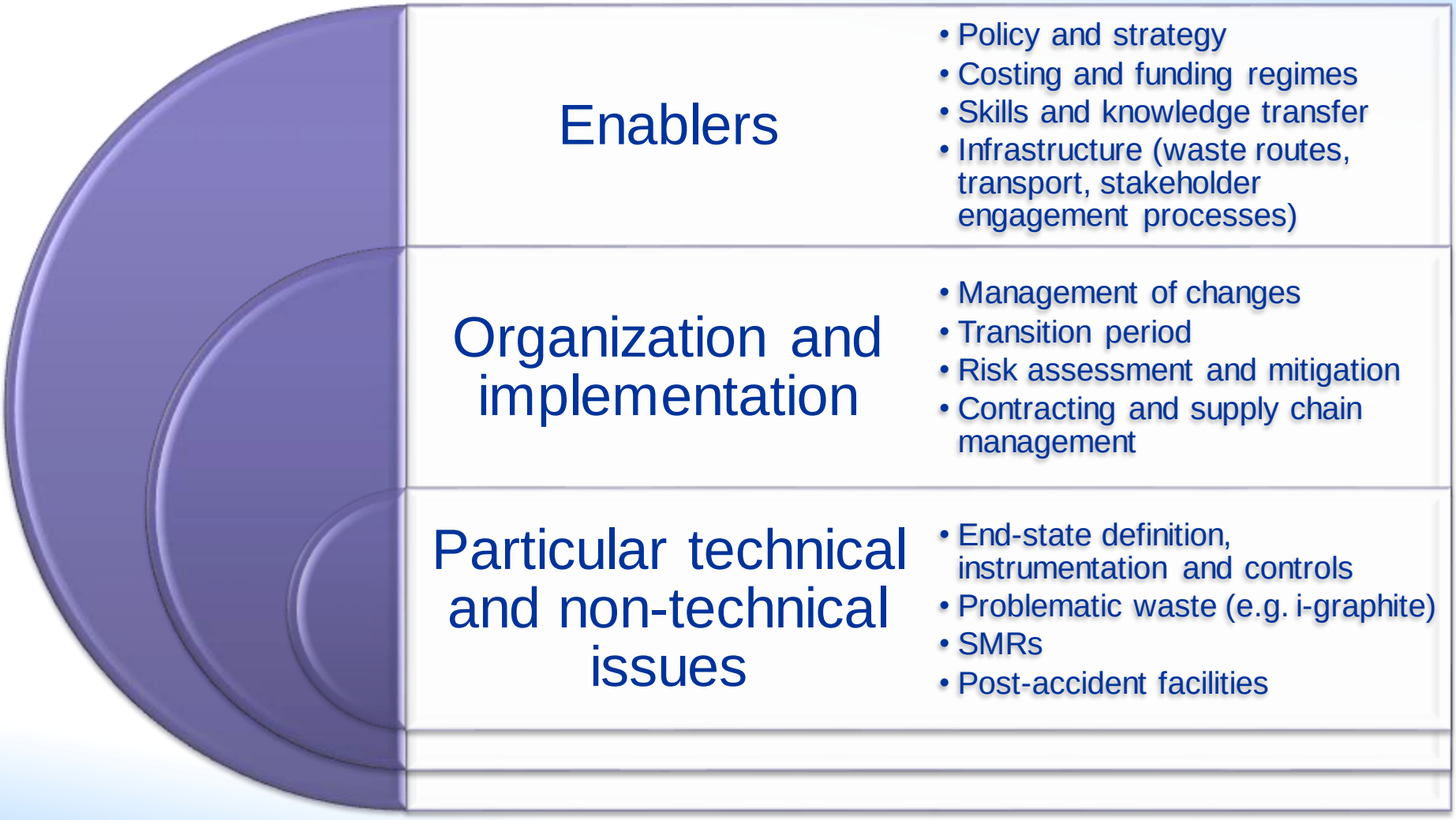
Shut down → Immediate or deferred dismantling … → End state

Interregional Workshop on Technology Selection for Decommissioning of Large and Small Nuclear Installations

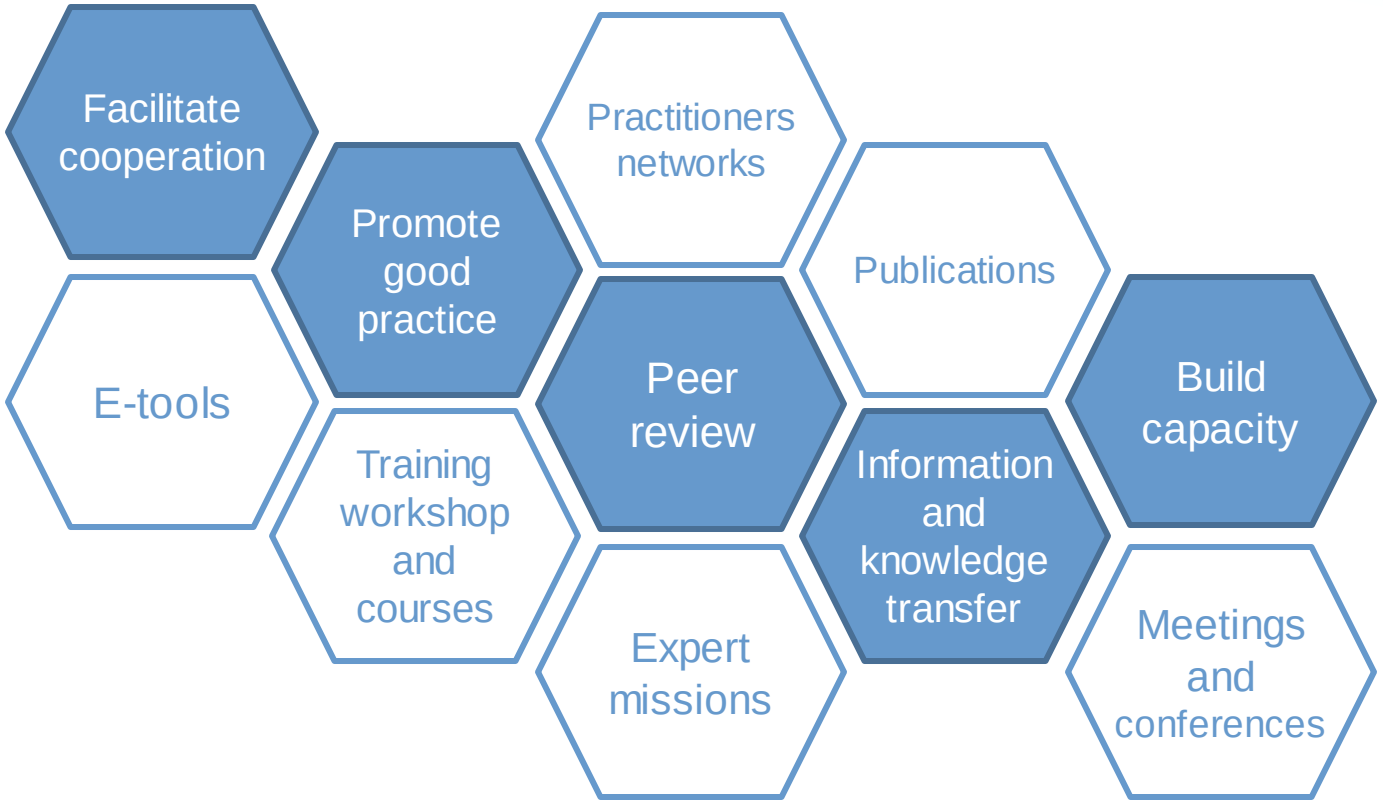
Florida International University, Miami, 9-13 September 2019

Patrick O'SULLIVAN
Decommissioning & Environmental Remediation Section | Division of Nuclear Fuel Cycle and Waste Technology | Department of Nuclear Energy

Challenges and issues in decommissioning

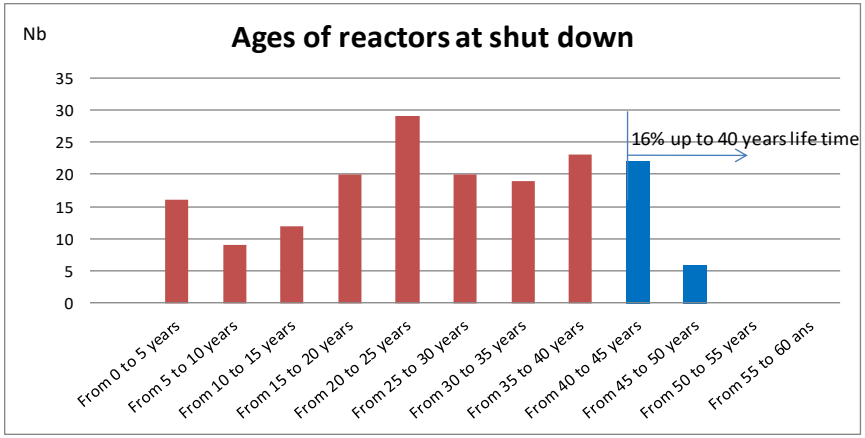


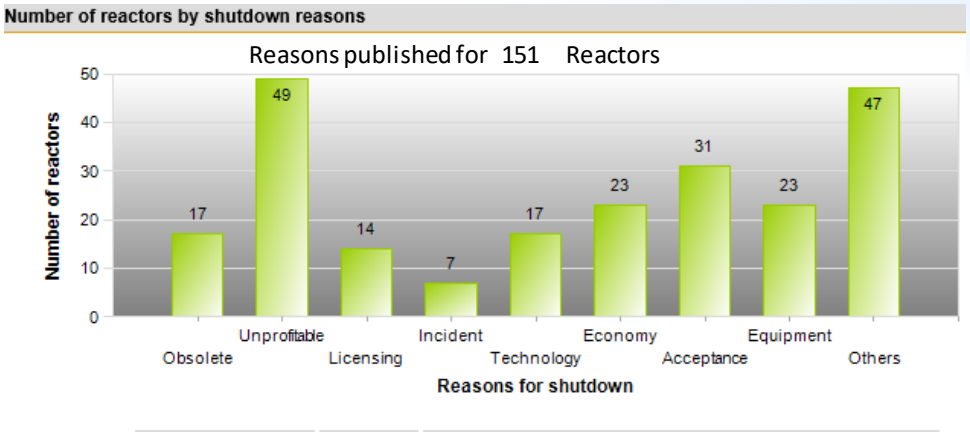
Our goals and activities



Reasons for NPP Shutdowns *[Source: IAEA PRIS Database]*

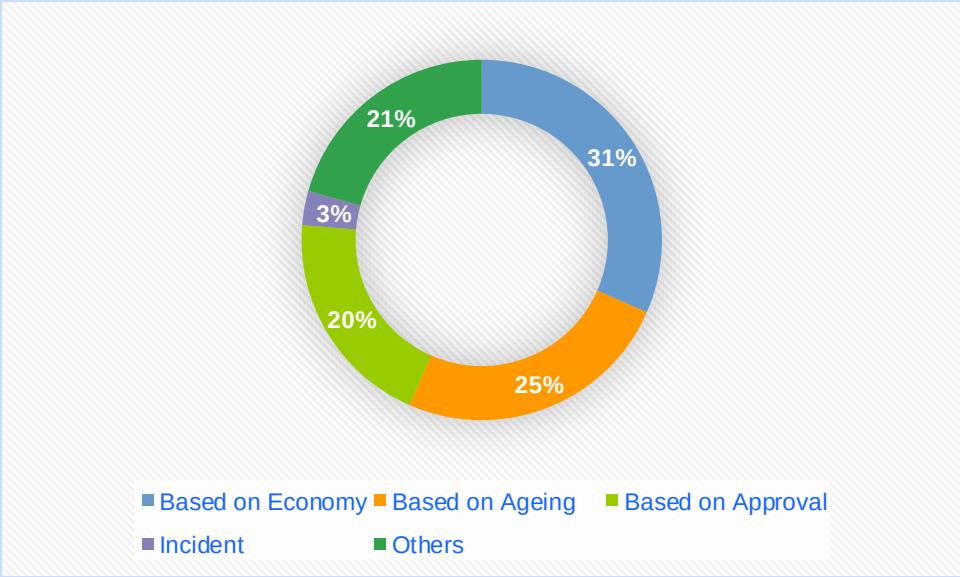
176 reactors in Decommissioning





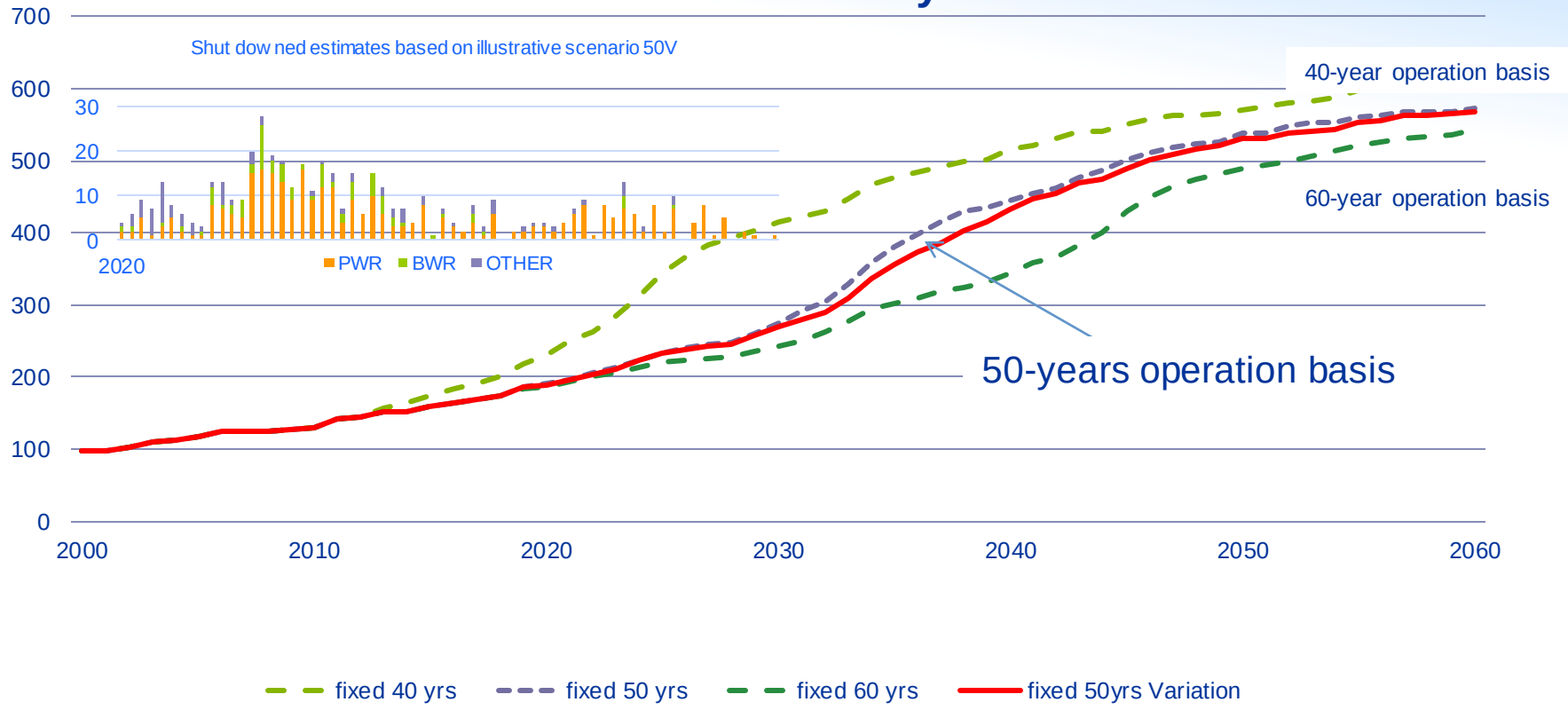
Past and currently in decommissioning	
31% PWR	26% GCR
24% BWR	6% LWGR
6% PHWR	5% FBR

Future - Reactors types currently in operation	
66% PWR	3% GCR
16% BWR	3% LWGR
11% PHWR	1% FBR



NPP Decommissioning SCENARIO : Future Prognosis

Power reator Shut down - different perspectives with life time between 40 & 60 years



451	Reactors in operation spread on 200 sites should stop in the coming years
70%	of the Nuclear Sites have more than one reactor in operation
47%	of the reactors located on a same site have been started on a range of 3 years after a predecessor

Developing a realistic ILLUSTRATIVE scenario

1) 50 years life time operation is considered when nothing have been already established - 70% of the cases
2) Consider multi reactors sites dismantling organization

NPP Decommissioning SCENARIO : Future Prognosis

Determine the decommissioning scenario is paramount

- Date of shutdown
  - Small variation have consequence on HR management
- Assumption for Implementation timing by design (if no existing Def Decom Plan)
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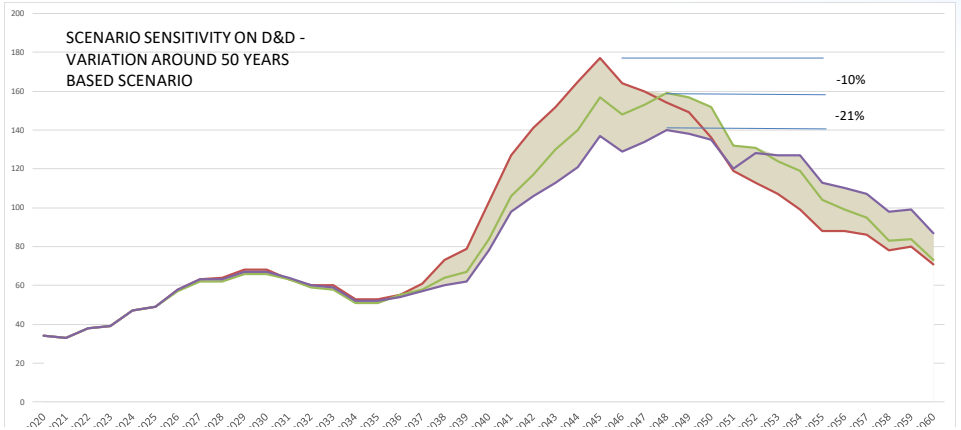
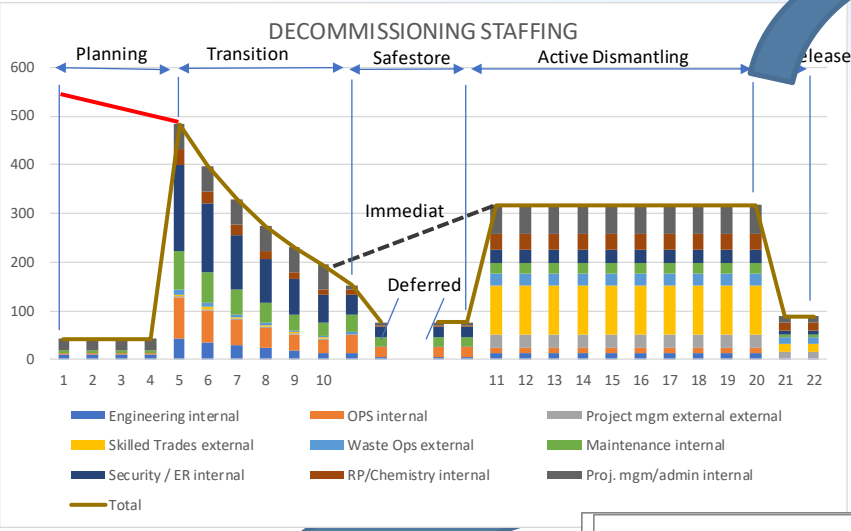
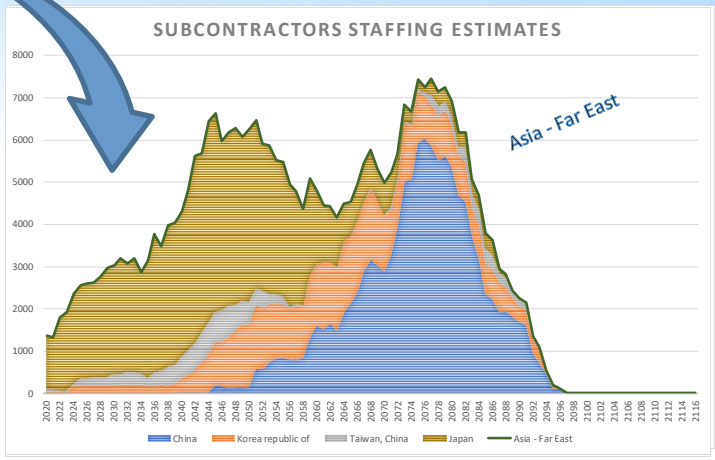
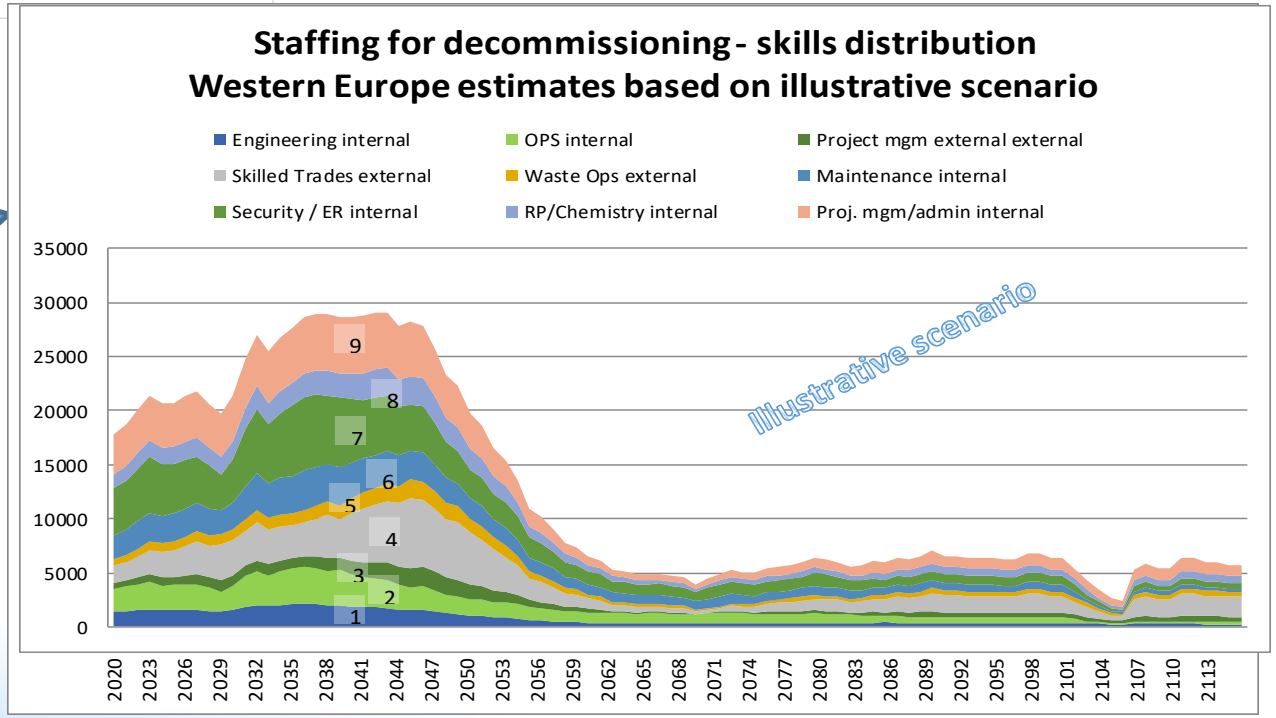


Global Resource Needs estimate for Decommissioning







Interregional Workshop on Optimization of Technology Selection for Decommissioning of Large and Small Nuclear Installations

Purpose - to discuss technology options for different decommissioning activities and the process of selecting optimal approaches in light of relevant environmental and other boundary conditions

Topics:

- Lessons Learnt from the DOE's Decommissioning Programme
- Digitalization and Robotics for Nuclear Decommissioning
- Nuclear Education and Training
- D&D Knowledge Management Information Tool (KM-IT)
- Competence Mapping and Workforce Planning for Decommissioning
- Advanced Information Management Systems / Tours of GIS Modelling Lab / Cyber Lab
- Radiation Protection Planning / Simulation / 3D Radiological Modelling
- Artificial Intelligence / Big Data applications for NPP and other Nuclear Facilities / Autonomous Mapping using UGV (Unmanned Ground Vehicles)
- Robotics Technologies for Decommissioning
- Lab Tours – Robotics Platforms and Rad Labs

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Thank you!

Extra Slides

Relevant IAEA Activities on Decommissioning

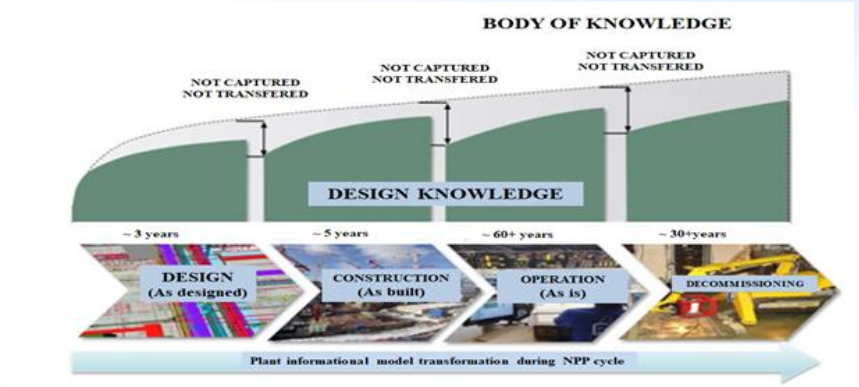
Collaborative Project: Human Resource Development for Decommissioning - 1

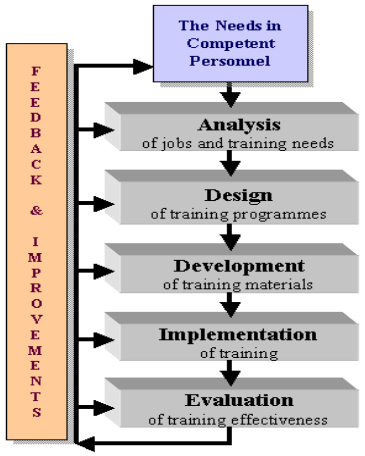
President's Report *(Extracts)*

- …Decommissioning and environmental remediation presents a work environment that is changing frequently, and so may not be fully dependent upon standardization of procedures and work plans. …it should nonetheless be recognized that transition from operators to decommissioning workers will require retraining and a different motivational approach.
- The number of ongoing decommissioning and environmental remediation projects is large, and current estimates indicate further substantial increases in the coming years. The Conference emphasises the need to promote actions and programmes aimed at ensuring the availability of personnel for future activities. In this regard the need to increase ongoing activities to attract young professionals to make these activities sustainable over time was strongly emphasized.

Collaborative Project: Human Resource Development for Decommissioning - 1

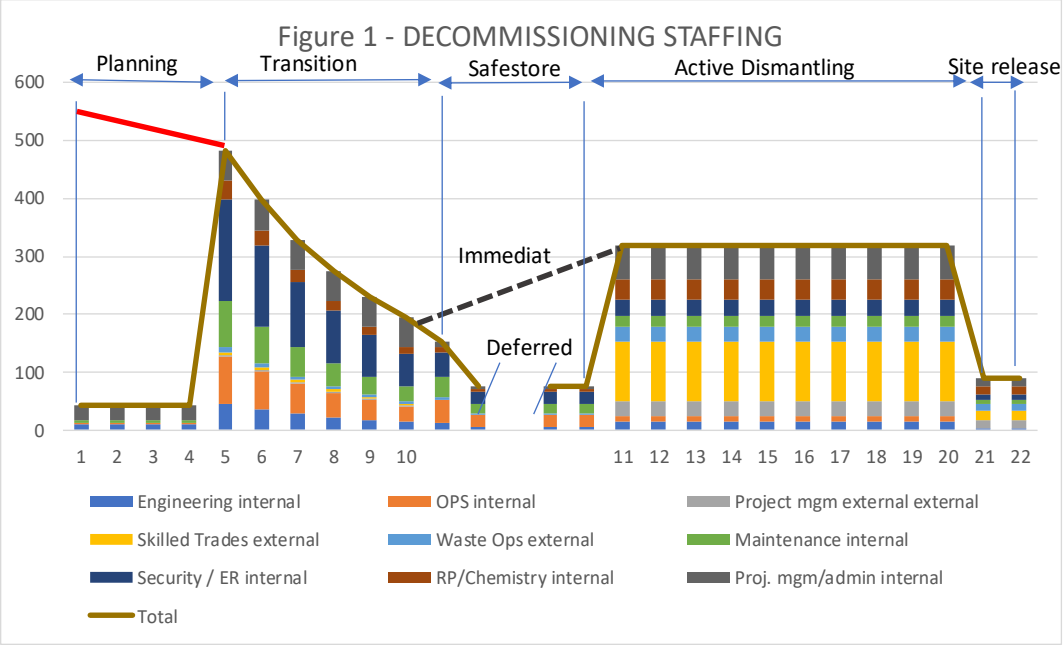
- **Objective**
  - Highlight current good practice on training and human resource management / human performance improvement for decommissioning
- **Timeframe**
  - 2018-2019
  - Technical Meeting – 1-5 July, VIC *[EVT1804578]*
- **Deliverable**
  - NE Series Report *"Training and Human Resource Considerations for Nuclear Facility Dismantling" [Early 2020]*
- **Main topics Addressed**
  - Human resource considerations in preparation for decommissioning
  - Transitioning from operations to decommissioning
  - Knowledge management requirements for decommissioning
  - Roles and responsibilities
  - Training requirements and application of the systematic approach to training (SAT)
  - Training facilities, instructors and training programmes
  - Case studies



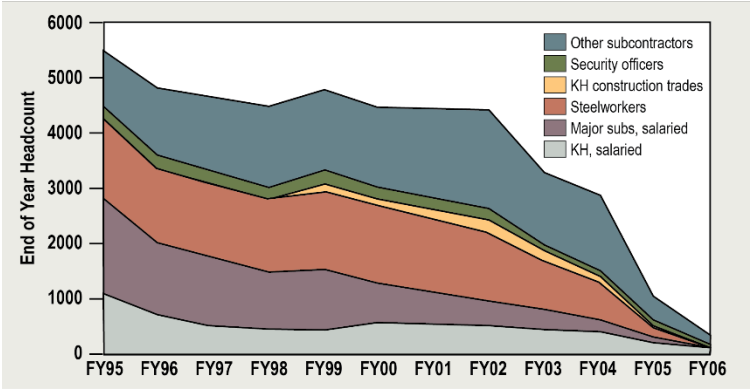


Overview of the SAT process

Collaborative Project: Human Resource Development for Decommissioning - 2



Typical staffing profile for decommissioning of light water reactors (PWR/BWR)



Case study: Rocky Flats

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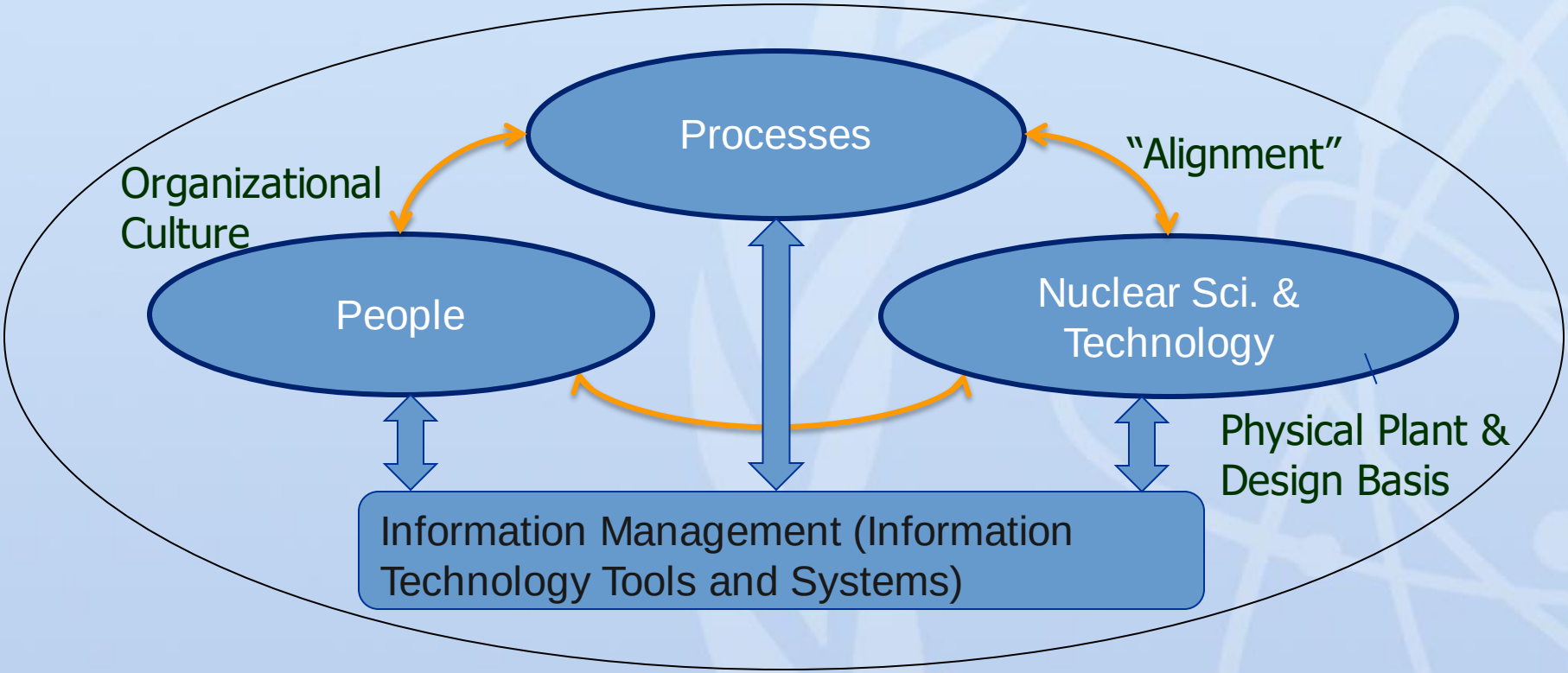
NPP Organization's Primary Knowledge Assets



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Plant Information Model (PIM)

A Knowledge-centric Plant Information Model is a semantically organized set of interlinked facility information, relationships, rules and knowledge frameworks that collectively
form digital representations of the plant throughout its life cycle

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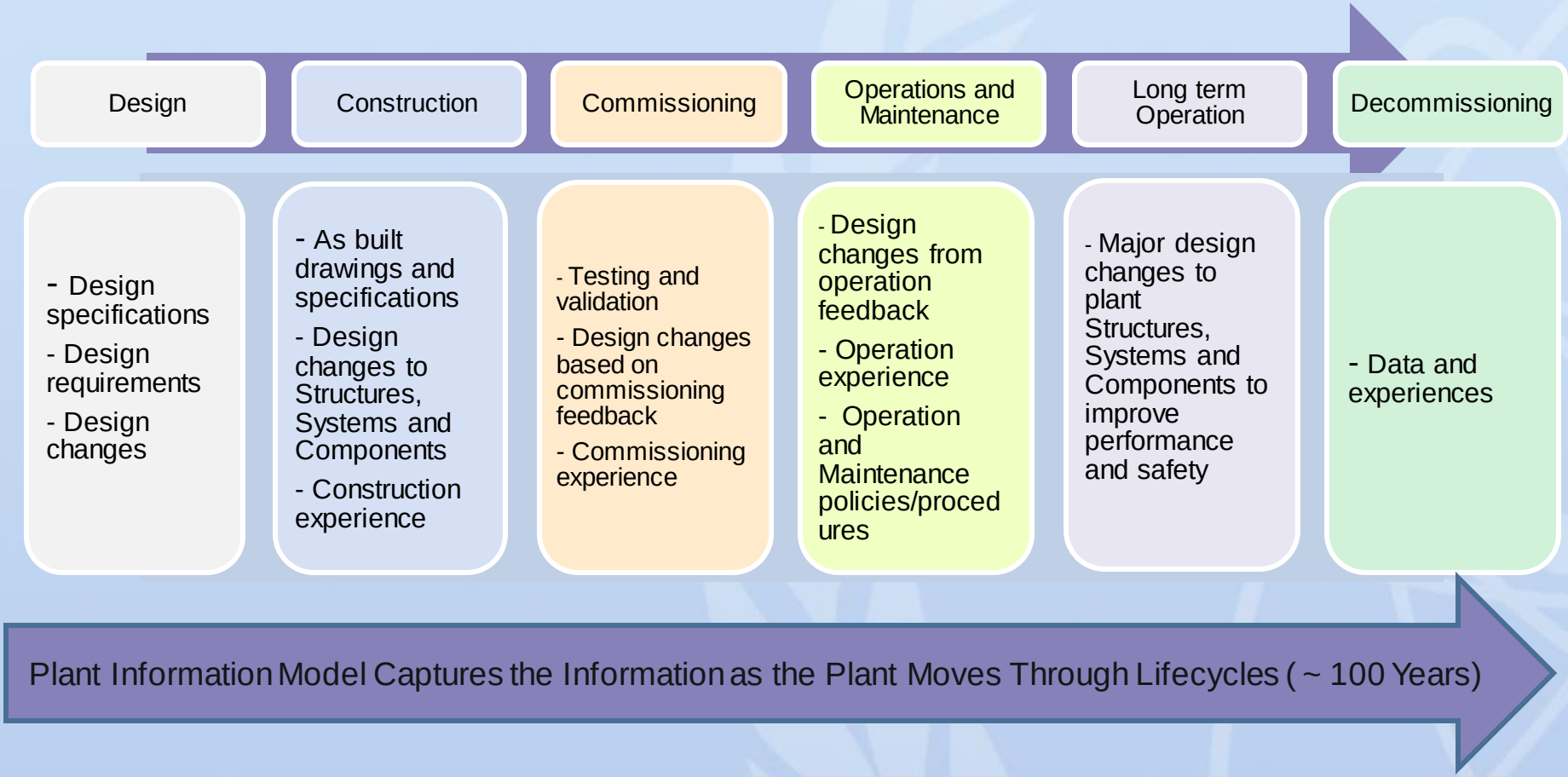
Plant Information Model (PIM) for the Plant Lifecycle



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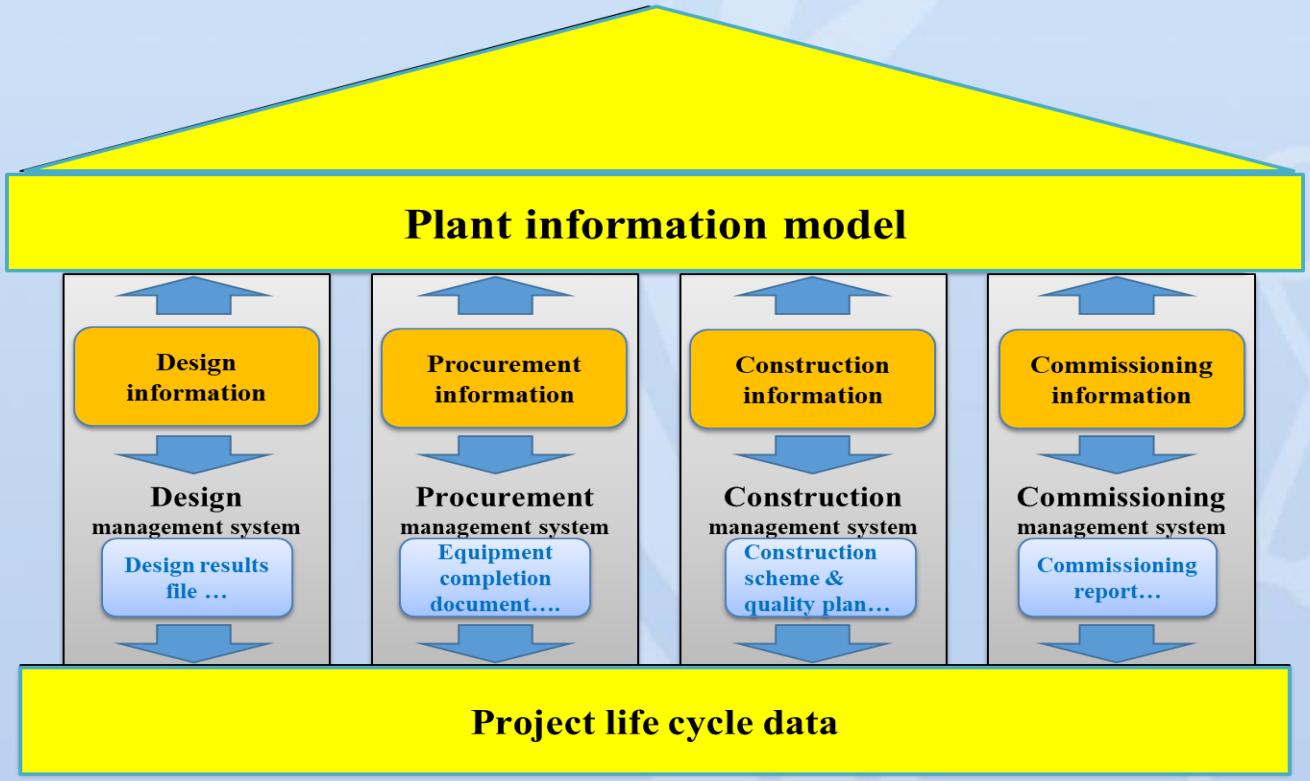
Plant information model for decision making



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Integration of PIM systems and sensors

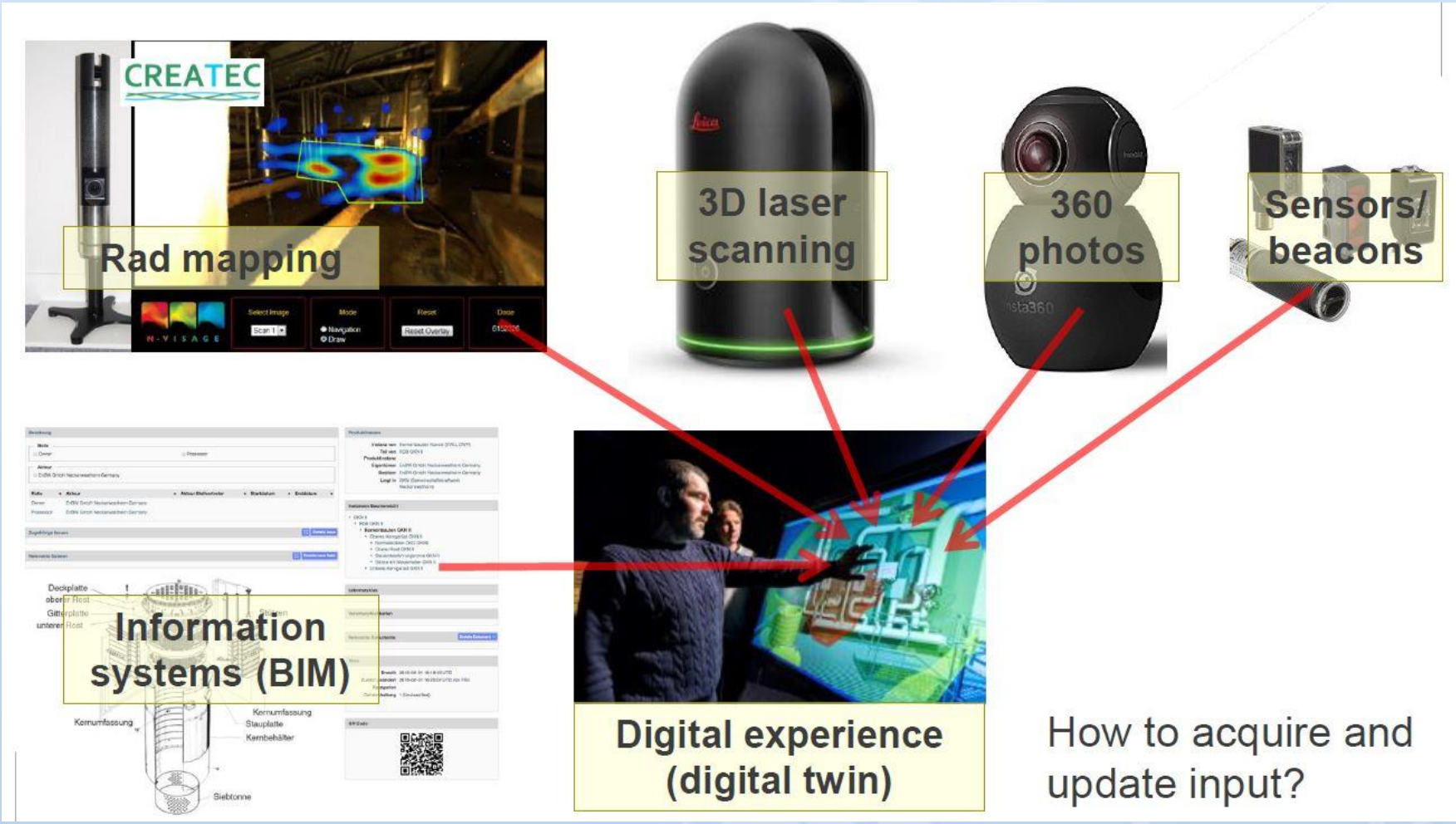

Image courtesy of István Szõke (IFE, Norway)

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Holistic Digital Support

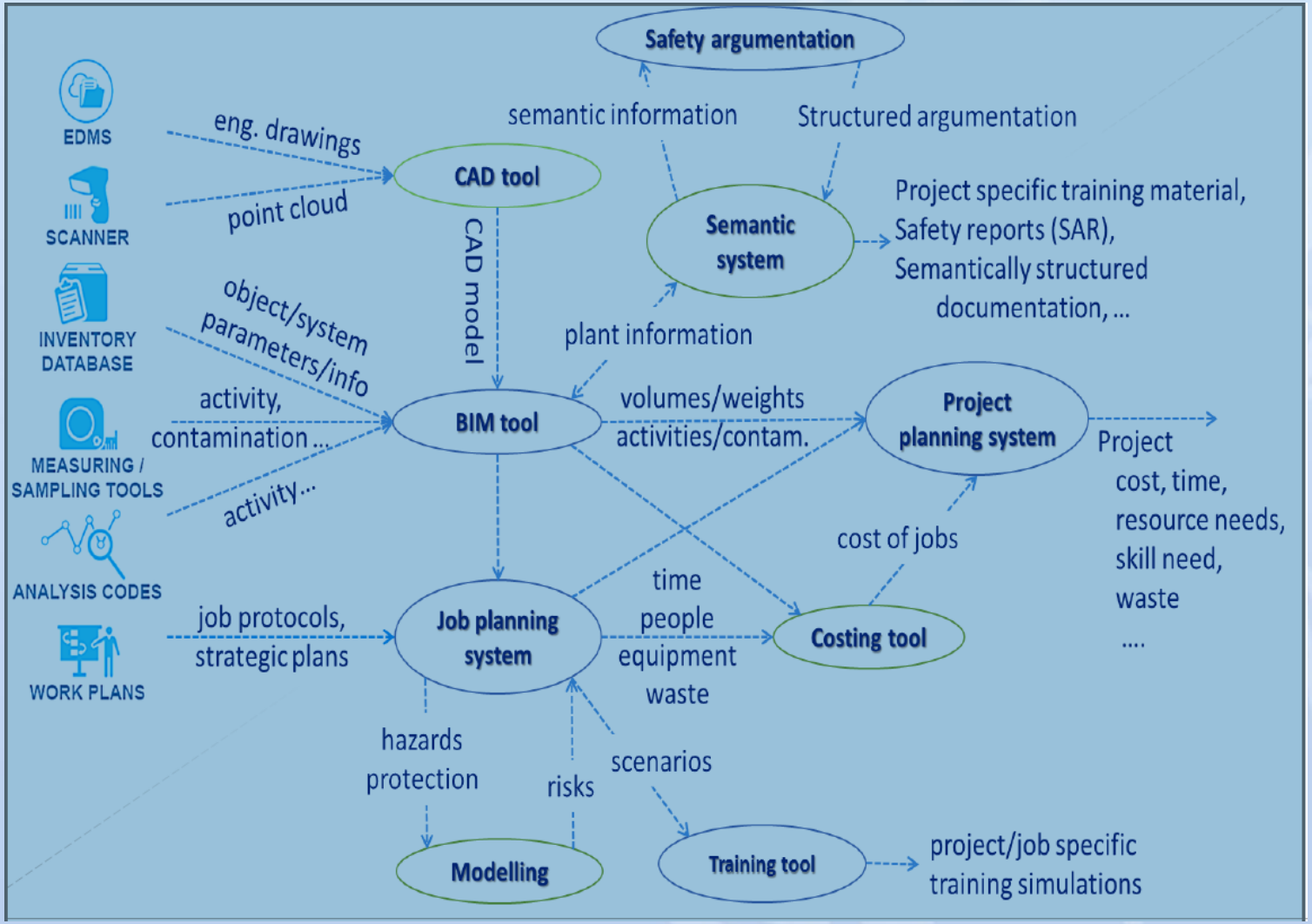


Image courtesy of István Szõke (IFE, Norway)

Capacity Building for Decommissioning

Capacity Building

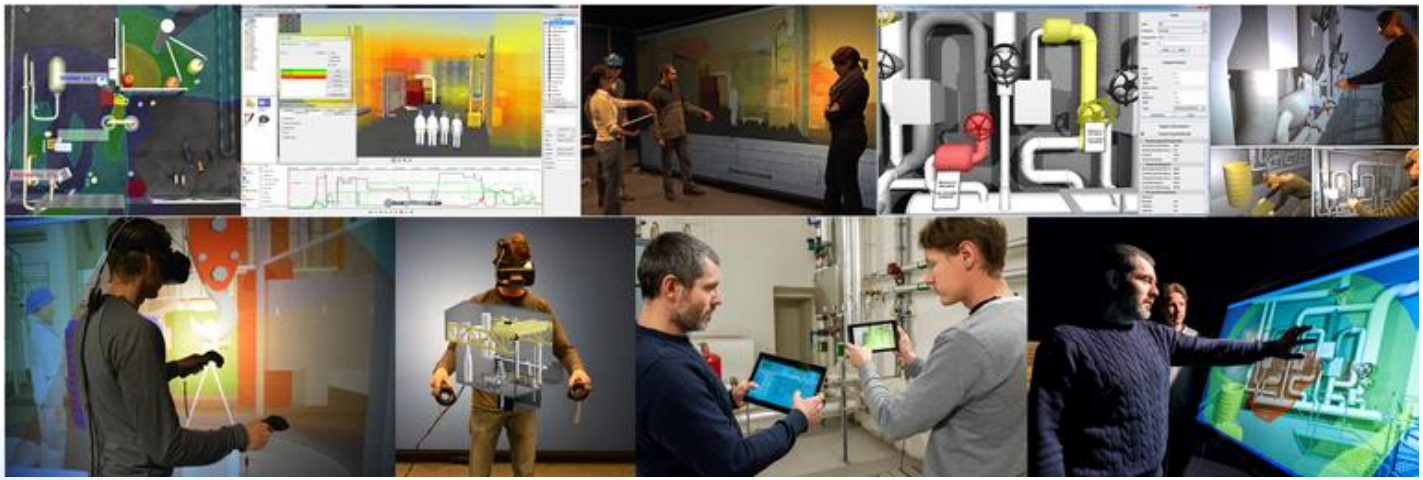
- Reports
- Expert missions & peer reviews
- Training courses/workshops
- Scientific visits & fellowships
- Conferences and technical meetings

Training Event	Host/Location
Workshop on safety assessment of sites for decommissioning and remediation [INT/9/183]	Argonne, US
Regional workshop processes for end state selection and site release criteria for NPPs [RER/9/150]	Slavutych, UA
Regional Workshop on decommissioning planning and cost estimation for decommissioning [RER/9/150]	Bratislava, SK
Regional Workshop on role of IT in knowledge management for decommissioning [INT/9/183]	Halden, NO
Regional Workshop on safety aspects of near surface disposal of radioactive waste [RER/9/150]	Kozloduy, BG
Regional Workshop on technologies for waste characterization and processing [RER/9/150]	Visaginas, Lithuania

IAEA Collaborating Centres on Decommissioning

Objectives:

- To promote innovation in decommissioning
- To facilitate knowledge sharing on current good practice
- To assist in long-term developing a qualified workforce through supporting a number of fellowships (i.e. secondments of several months' duration).



Courtesy of IFE, Norway

Encouraging Innovation Through Collaboration

- Roadmap for R&D for Decommissioning *[SHARE Project Proposal]*
- Encouraging Use of Digitalization *[3D3P Project Proposal -> PLEIADES]*
- ELINDER network of training organizations

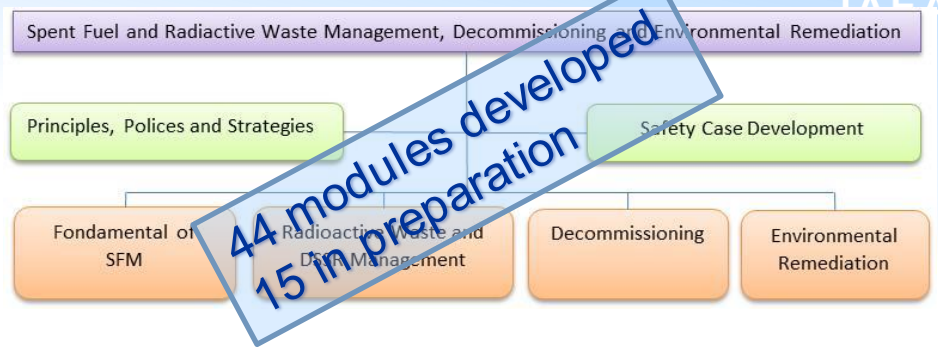
[Photo courtesy of IFE, Norway]

IAEA Supported Tools

IAEA Support: E-learning

for stakeholders and newcomers to the field

https://nucleus.iaea.org/sites/connect-members/LMS/Pages/Welcome-to-the-learning-materials-section.aspx



IAEA Data Bases

PRIS Power Reactor Information System

2 modules for NP Reactors; in Operation - in Decommissioning

http://prisweb.iaea.org/Home/Pris.asp

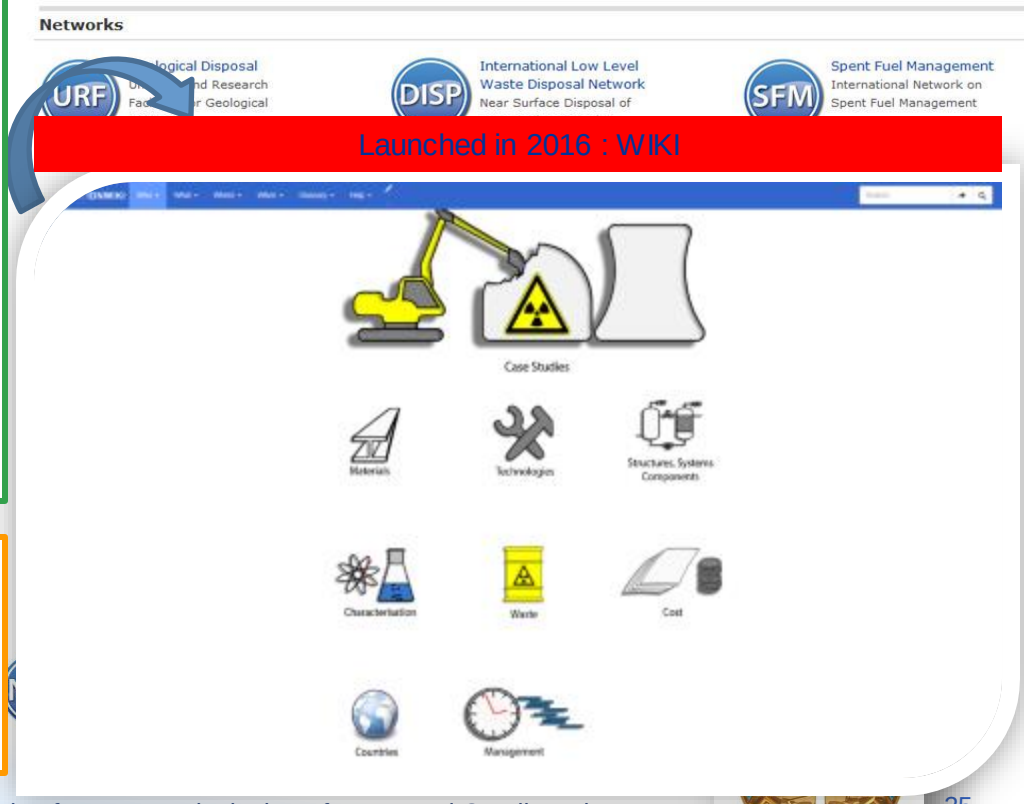
RRDB Research Reactors Data Base

http://nucleus.iaea.org/RRDB

INFCIS Nuclear Fuel Cycle Information System

https://infcis.iaea.org/NFCIS/Facilities

Specifics

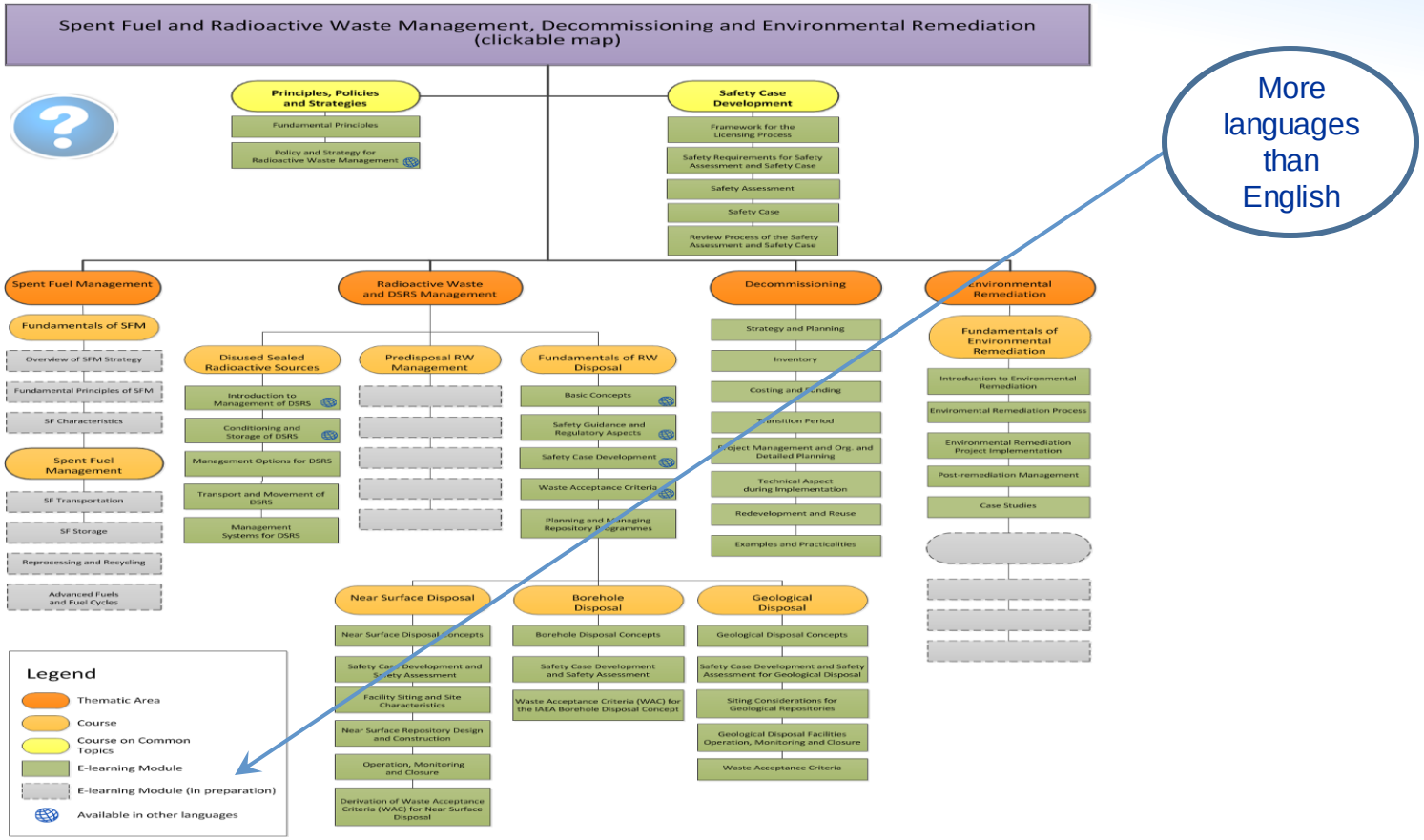


IAEA Support

14 Networks - Web Based Tools to support information sharing

https://nucleus.iaea.org/sites/connect/Pages/default.aspx

E-learning / Briefing Material For Stakeholders and Professionals



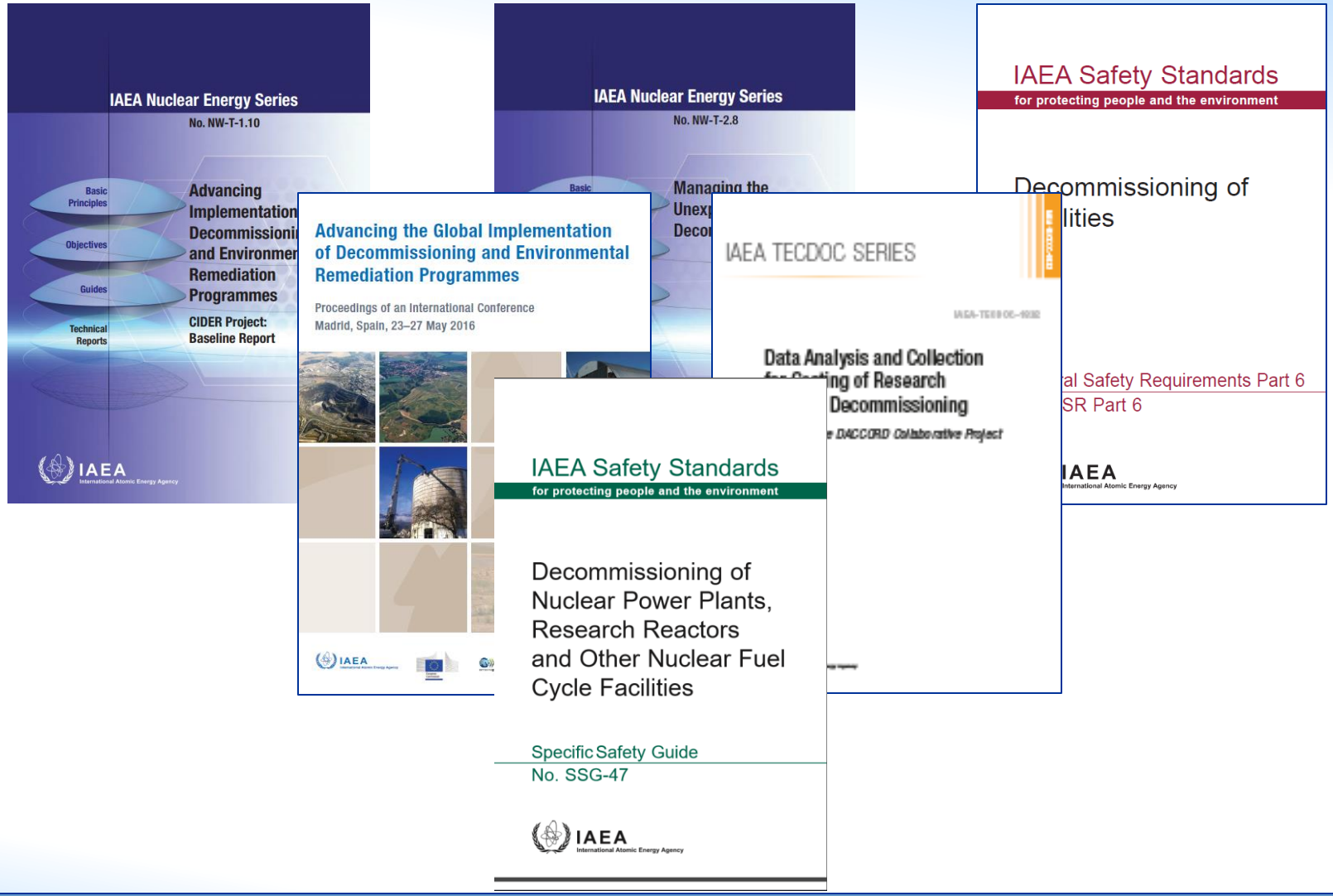
CLP4Net - Agency wide Learning Management System

Peer Reviews – ARTEMIS

- Main objectives: to provide independent expert opinion and advice to MS
  - IAEA forms a team of international experts
- Intended for facility operators and other implementing organizations, regulators, government agencies, policy makers

- Scope can include facilities and activities related to:
  - Spent nuclear fuel and RW management
  - Decommissioning
  - Environmental remediation

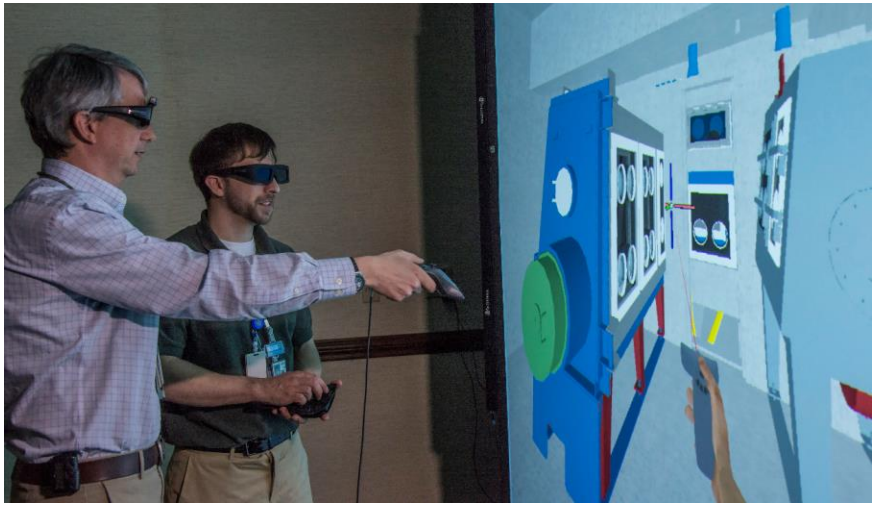
Recent Technical and Policy Publications



http://www-pub.iaea.org/MTCD/publications/publications.asp

Future Outlook

- Finalize current report by the end of 2019
- HRD for Decommissioning remains an ongoing key topic of interest for IAEA
- Ideas on further relevant activities to promote collaboration and sharing of experience and knowledge is this field are very welcome



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Thank you!

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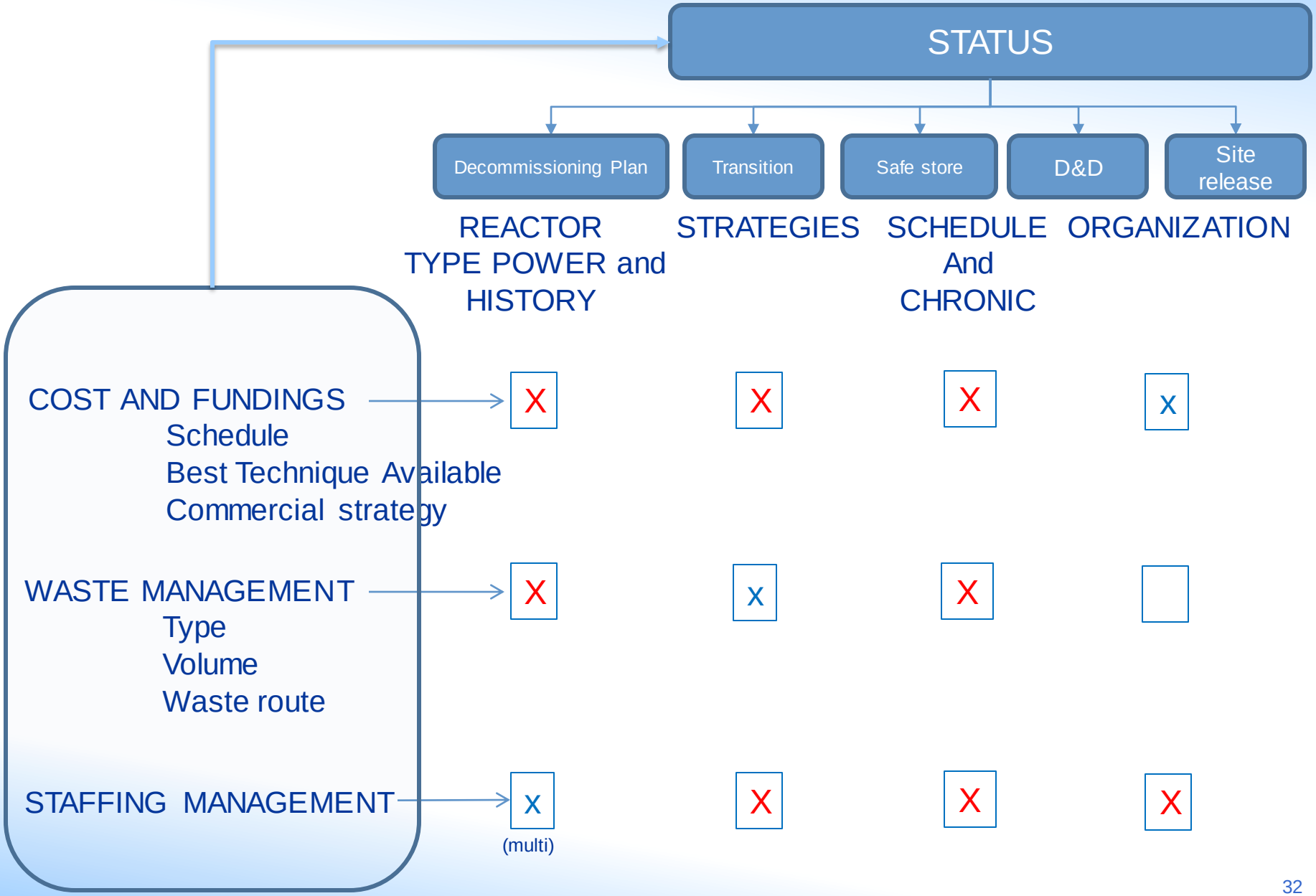
Shut Down → Immediate or differed decommissioning → End state

Decommissioning scenarios Analysis

Worldwide NPP decommissioning program – analysis and prognosis

Mr Christian GLORENNEC
Decommissioning and Environment Remediation Section | Division of Nuclear Fuel Cycle and Waste Technology| Department of Nuclear Energy

DECOMMISSIONING CHALLENGES AND CHARACTERISTICS



Reasons for NPP Shutdowns *[Source: IAEA PRIS Database]*

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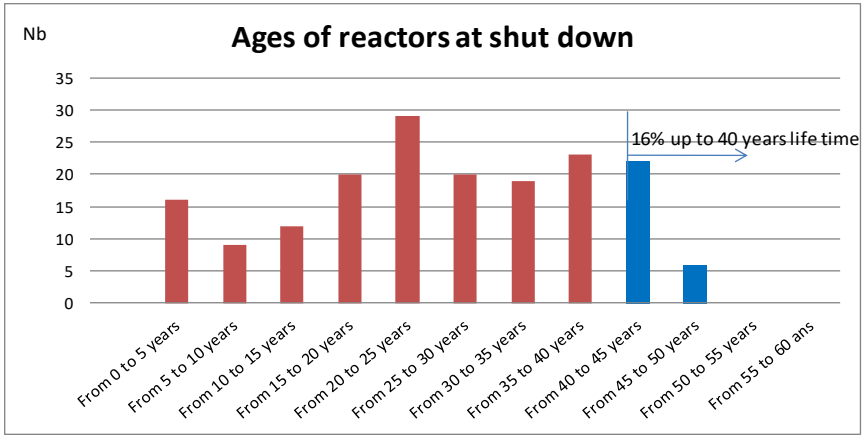

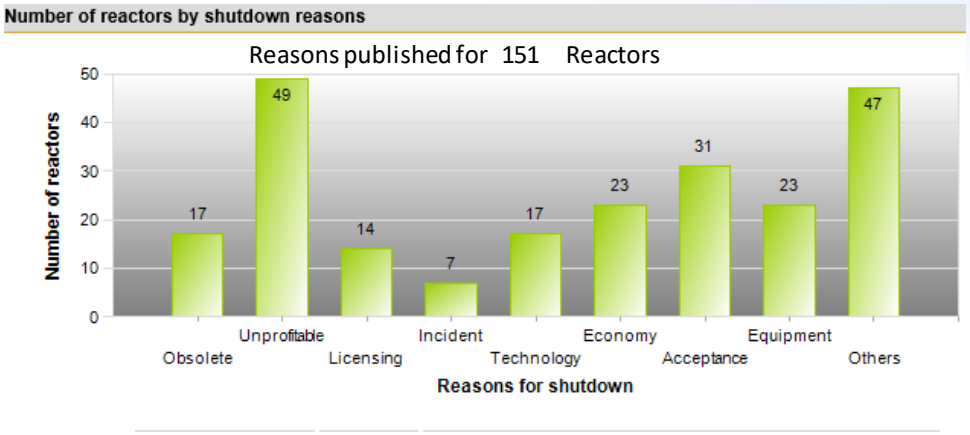

Past and currently in decommissioning	
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Ageing is the only reason which can be measured

And also the 2nd reason pointed for definitive shut down in America Northern and in Western Europe

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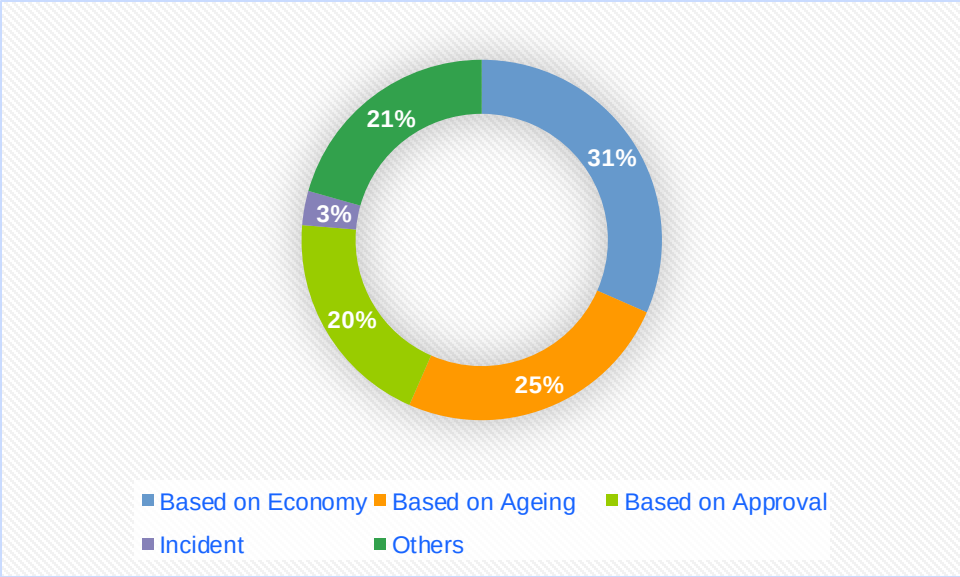

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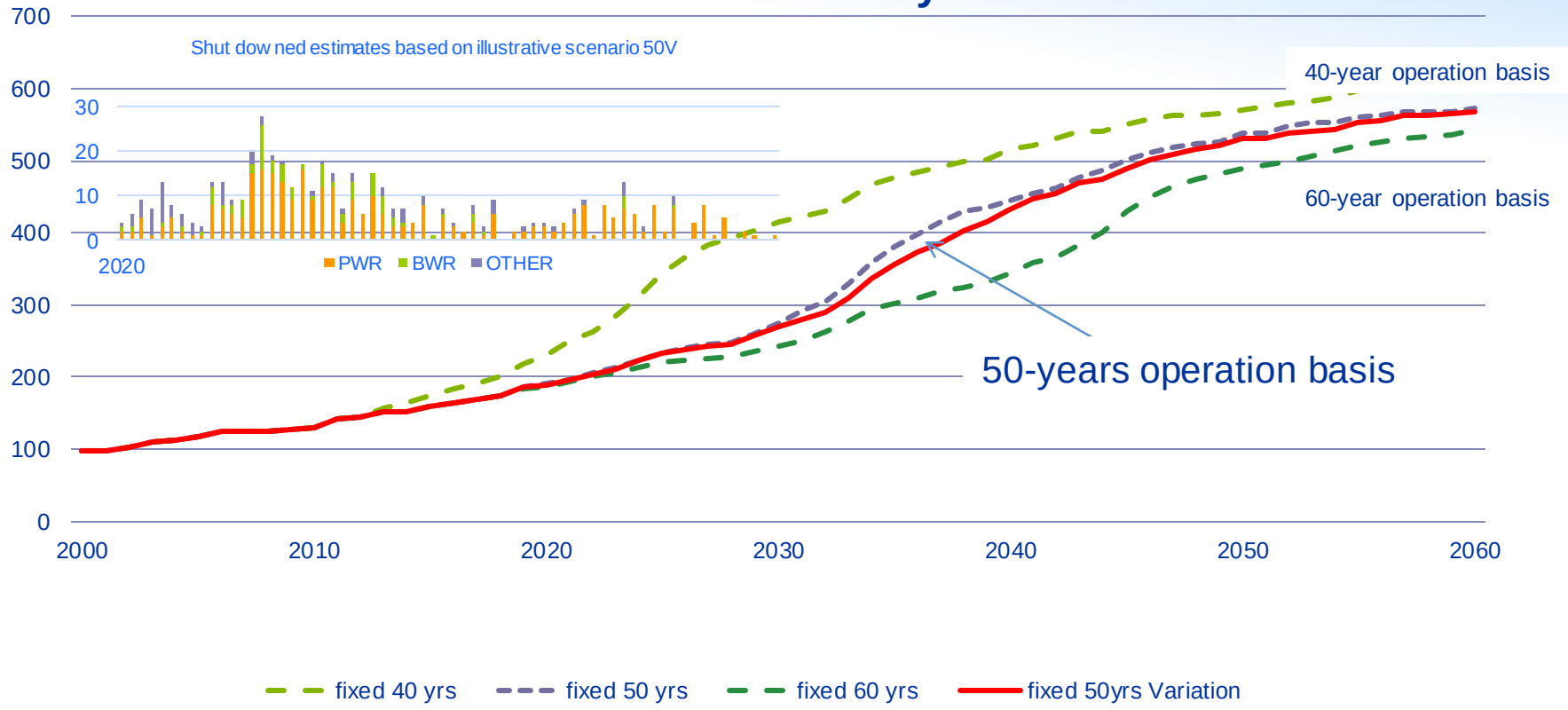

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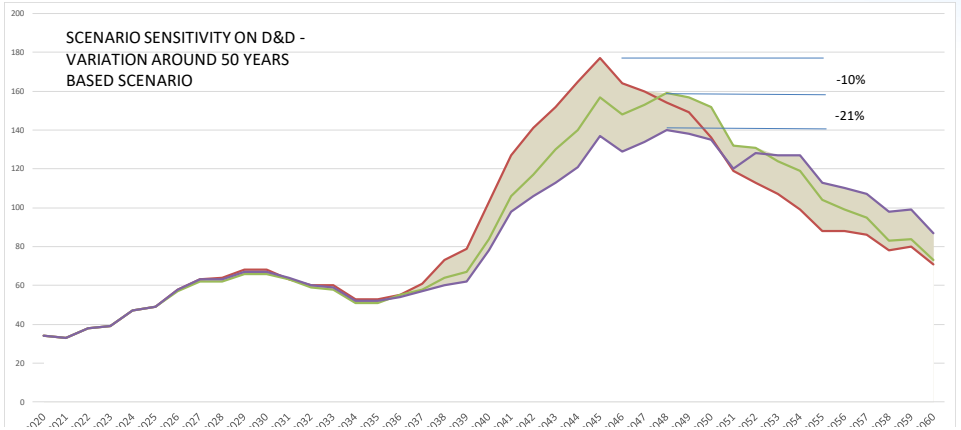
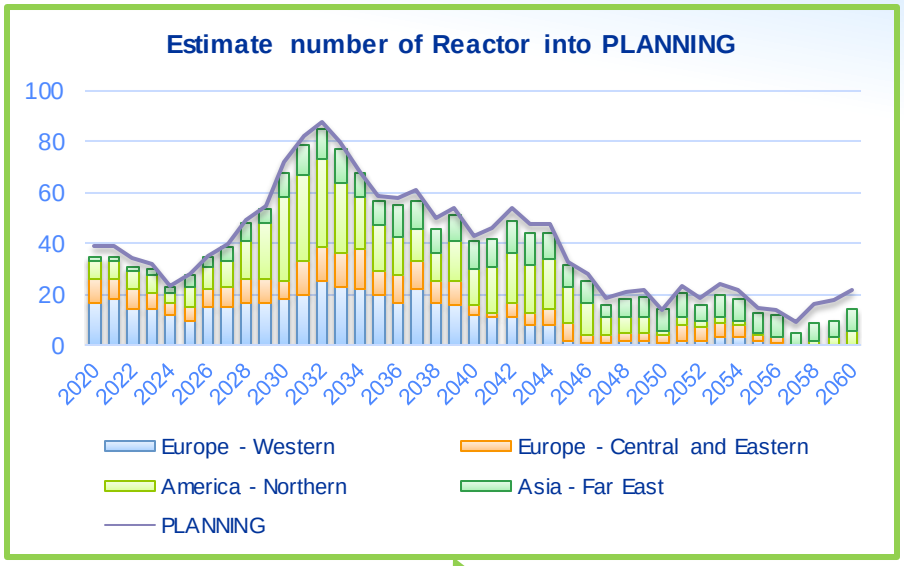
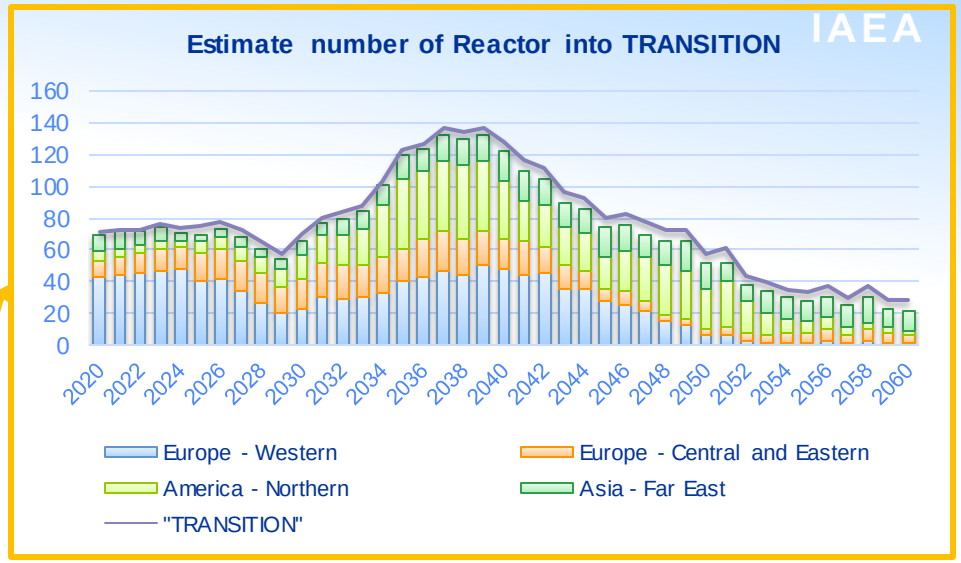
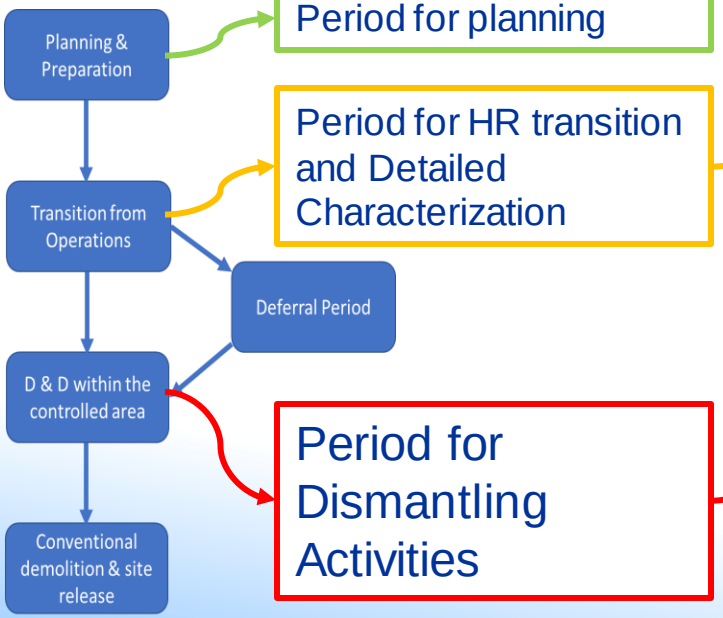
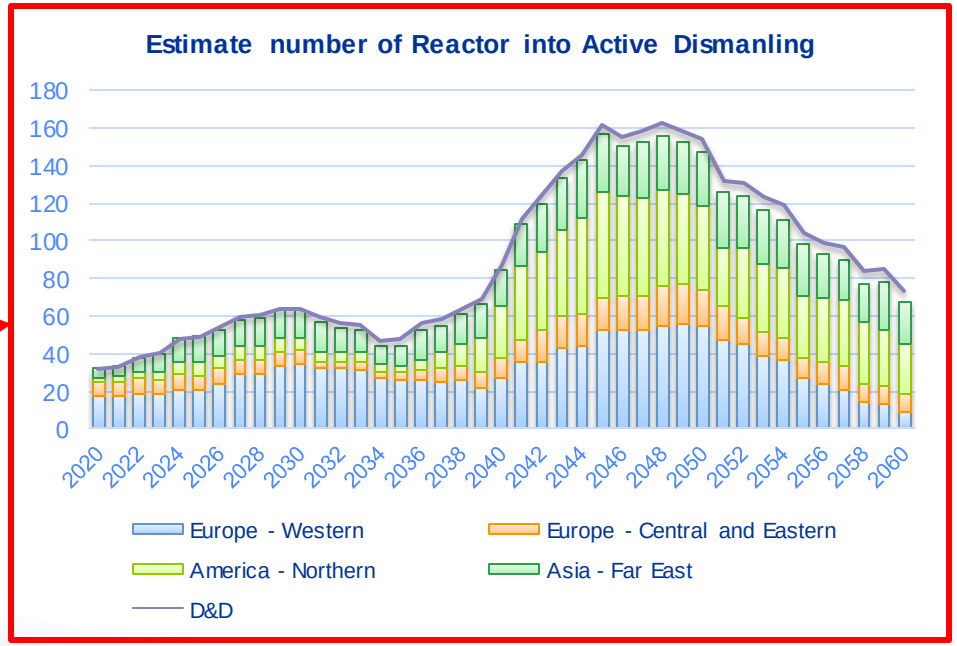


NPP Decommissioning: Status Prognosis









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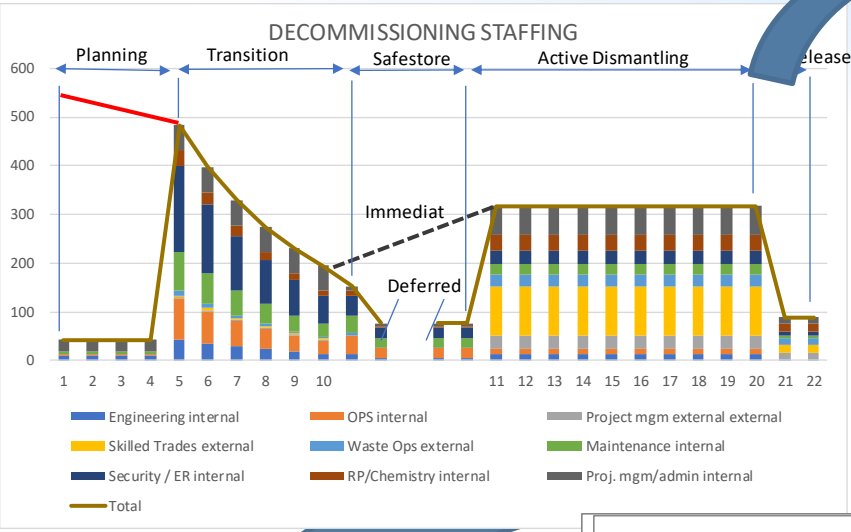
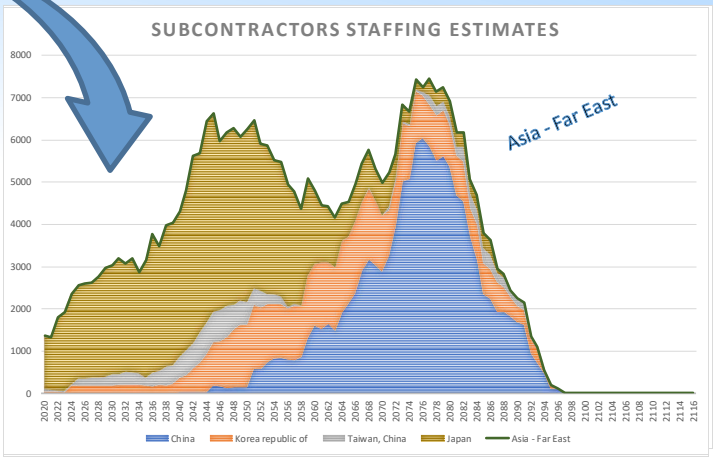
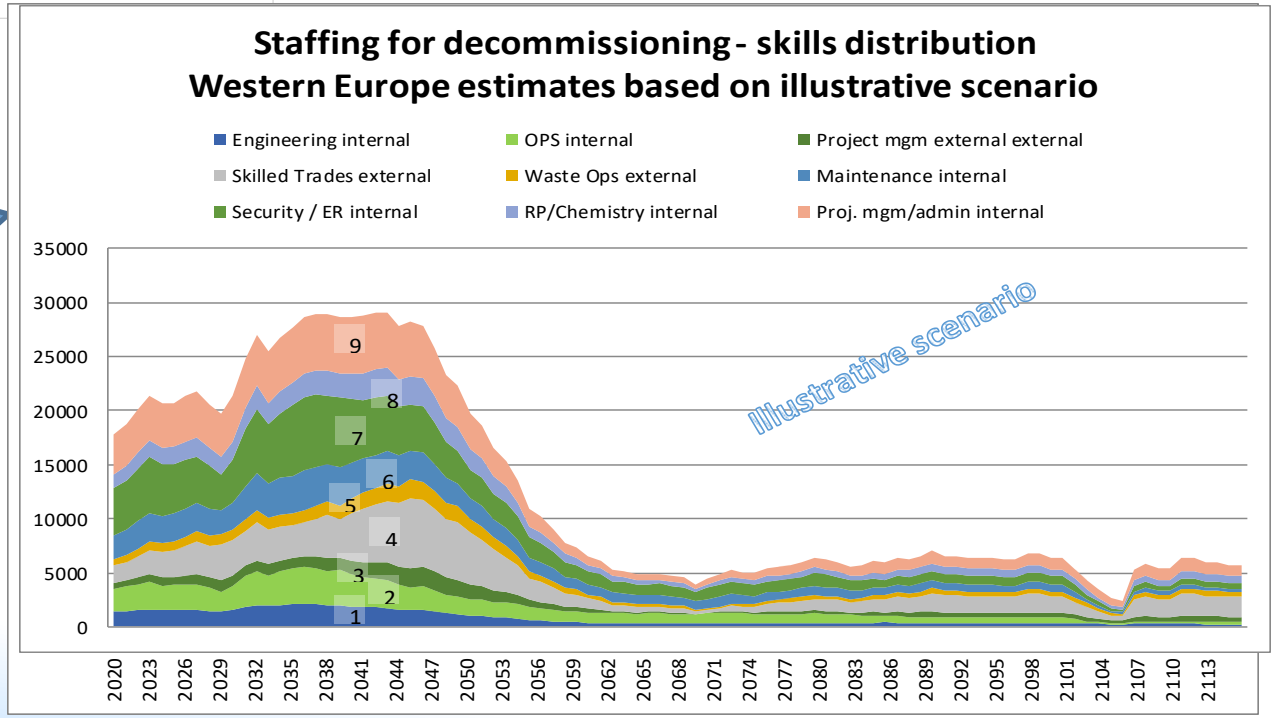
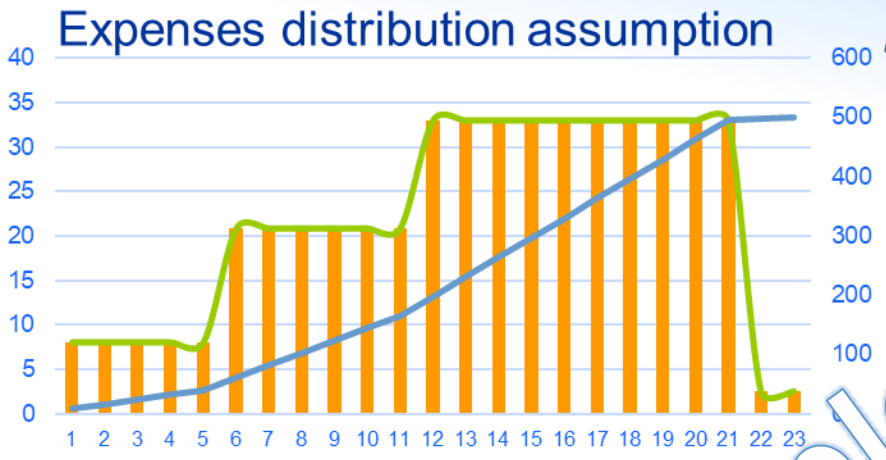
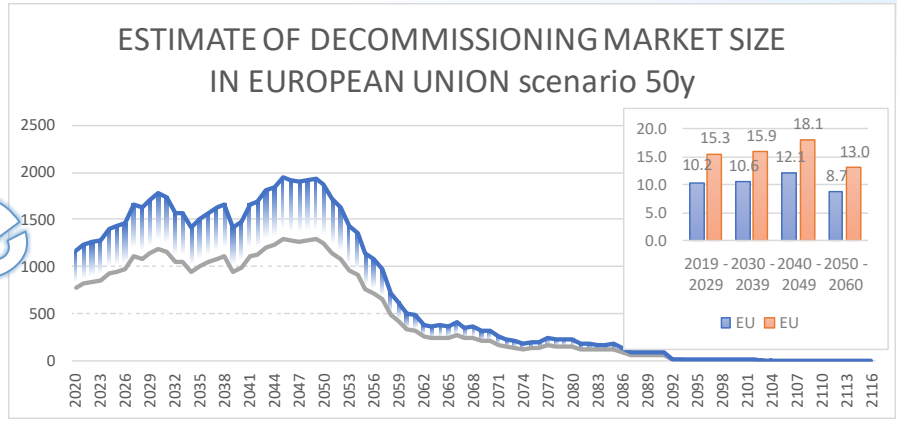




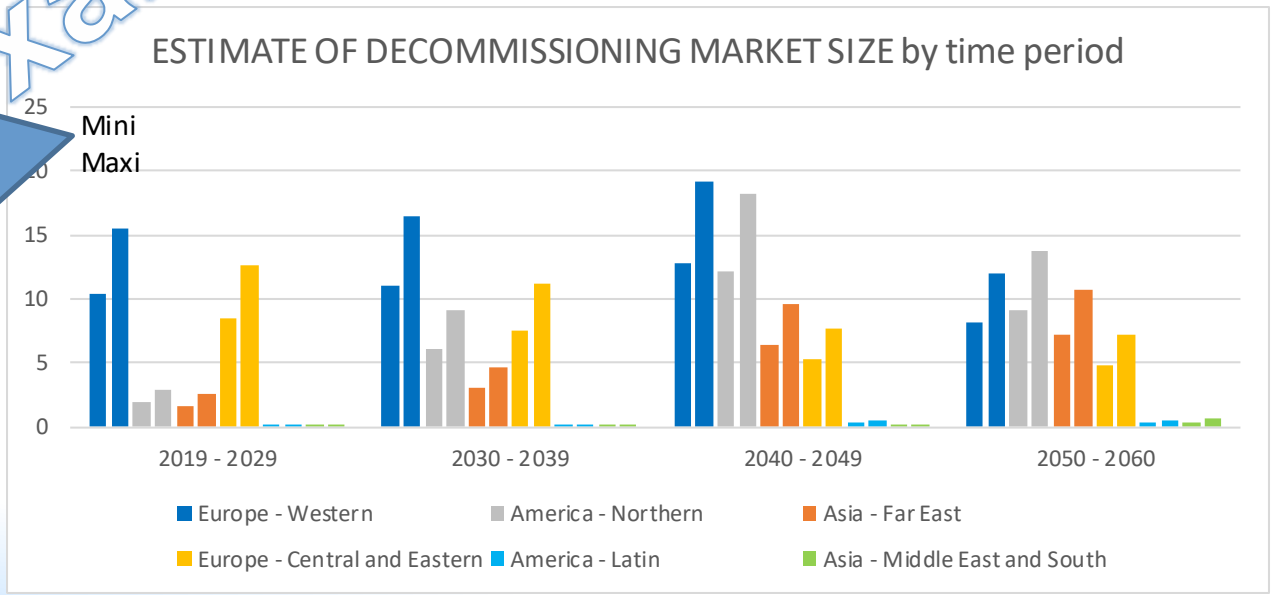


Decommissioning Funds estimate for Decommissioning



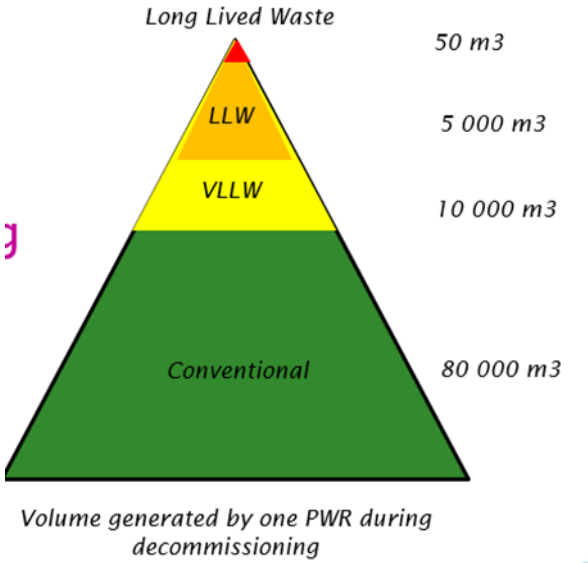


Just an example



WASTES PRODUCTION PROGNOSIS

For a 1000 Mwe PWR



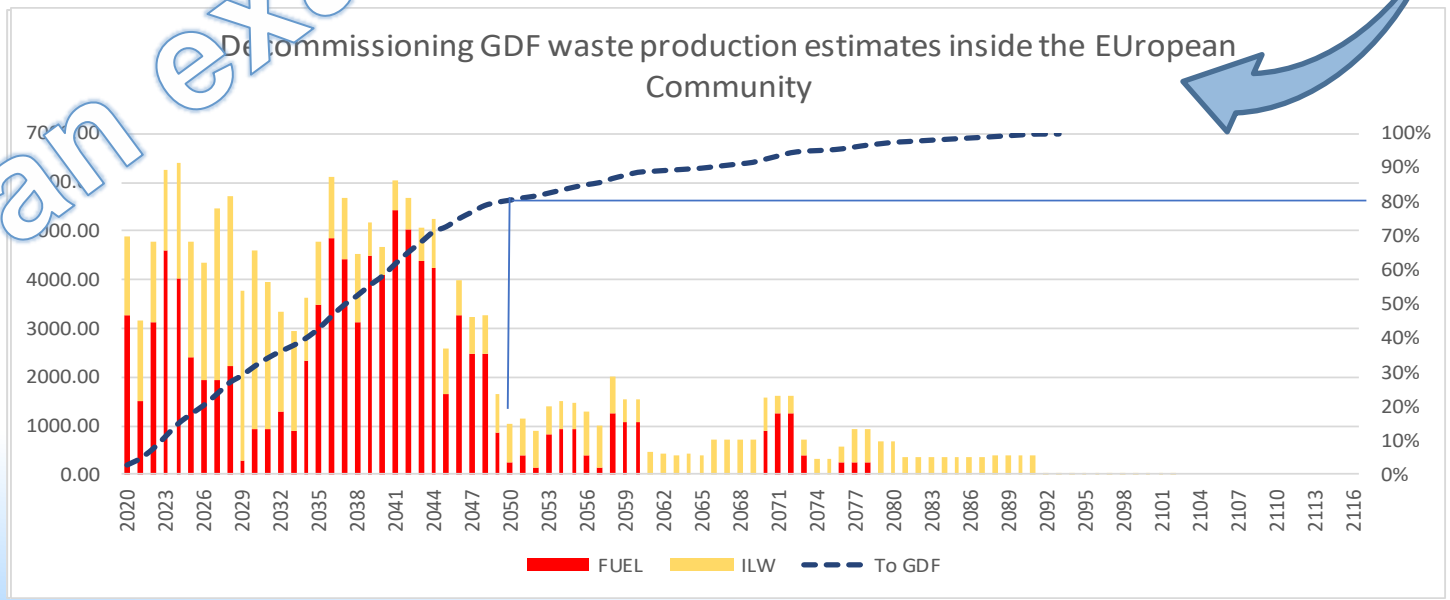
Volume generated by one PWR during decommissioning

TOTAL VOLUME			
1000 Mwe	VLLW	LLW	ILW
PWR	10 000.00	5 000.00	50.00
VVER			
BWR	15 000.00	6 000.00	150.00
GCR	300 000.00	77 000.00	10 000.00
LWGR	300 000.00	70 000.00	9 000.00
PHWR	10 000.00	5 000.00	100.00
FBR	50 000.00	10 000.00	9 000.00

fuel/Tons	
100	To be adapted
100	
100	
100	
100	
100	

	PLAN	TRANSITION	D&D	DEMOLITION &SITE RELEASE	
WLLV	-	20%	80%		Equally distributed
LLW		10%	90%		Equally distributed
ILW	-		100%		Equally distributed
[illegible]		100%			3 first years of transition

Just an example



Decommissioning scenarios Analysis

BASED ON REAL AND ESTIMATES

PRIS data improvement

- Country (*analyze by country region*)
- Reactor design (*design effect*)
- Date of grid connection (*age*)

- Power (*size effect*)

- Date of shutdown (*start decommissioning*)
- Decommissioning Strategy (start *D&D*)
- Decommissioning milestone (*decommissioning status*)

Next steps for analysis – Forecasts and prognosis

BASED ON ASSUMPTION AND MODEL

Develop Modeling

For staffing	For cost and annual expenses	For waste production and distribution

Results

TO PROVIDE STANDARD ANALYSIS
TO THE MS Country/region/time scale

- Number of NPP within a dedicated status
- Estimates of expenses
- Estimates of staffing/skills
- Estimates of wastes produced

IAEA
International Atomic Energy Agency
Atoms for Peace and Development

Thank you!

Questions?