Decommissioning Worldwide and NEA Activities

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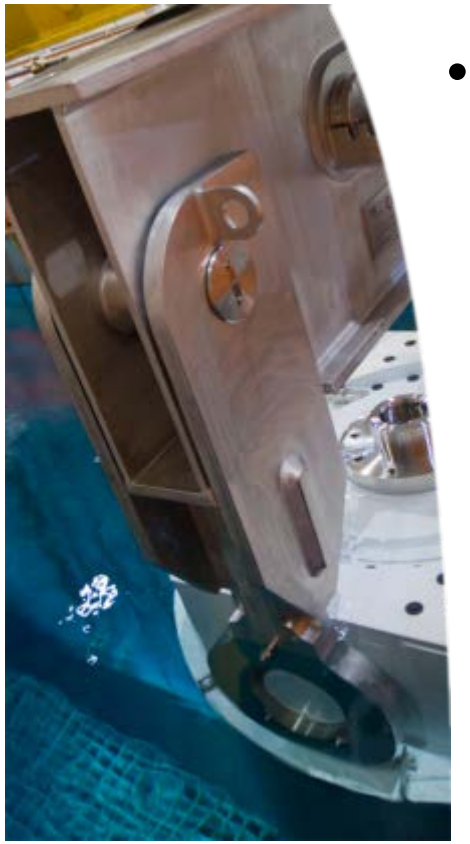
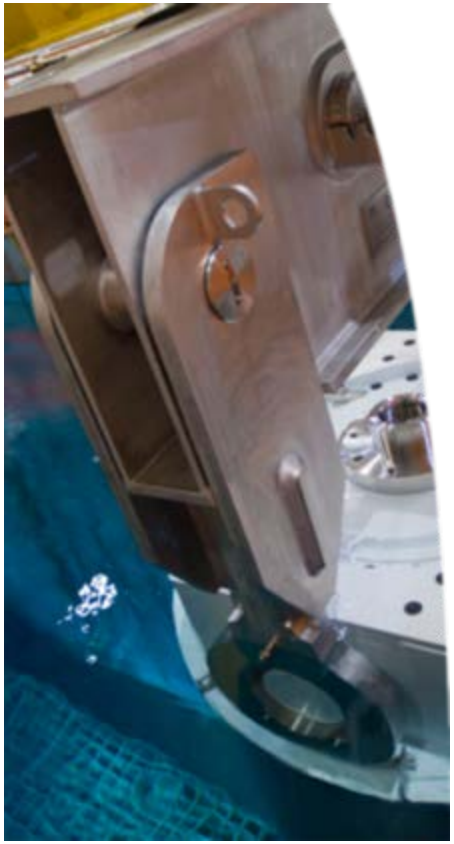
Decommissioning: what does it mean / entail ?



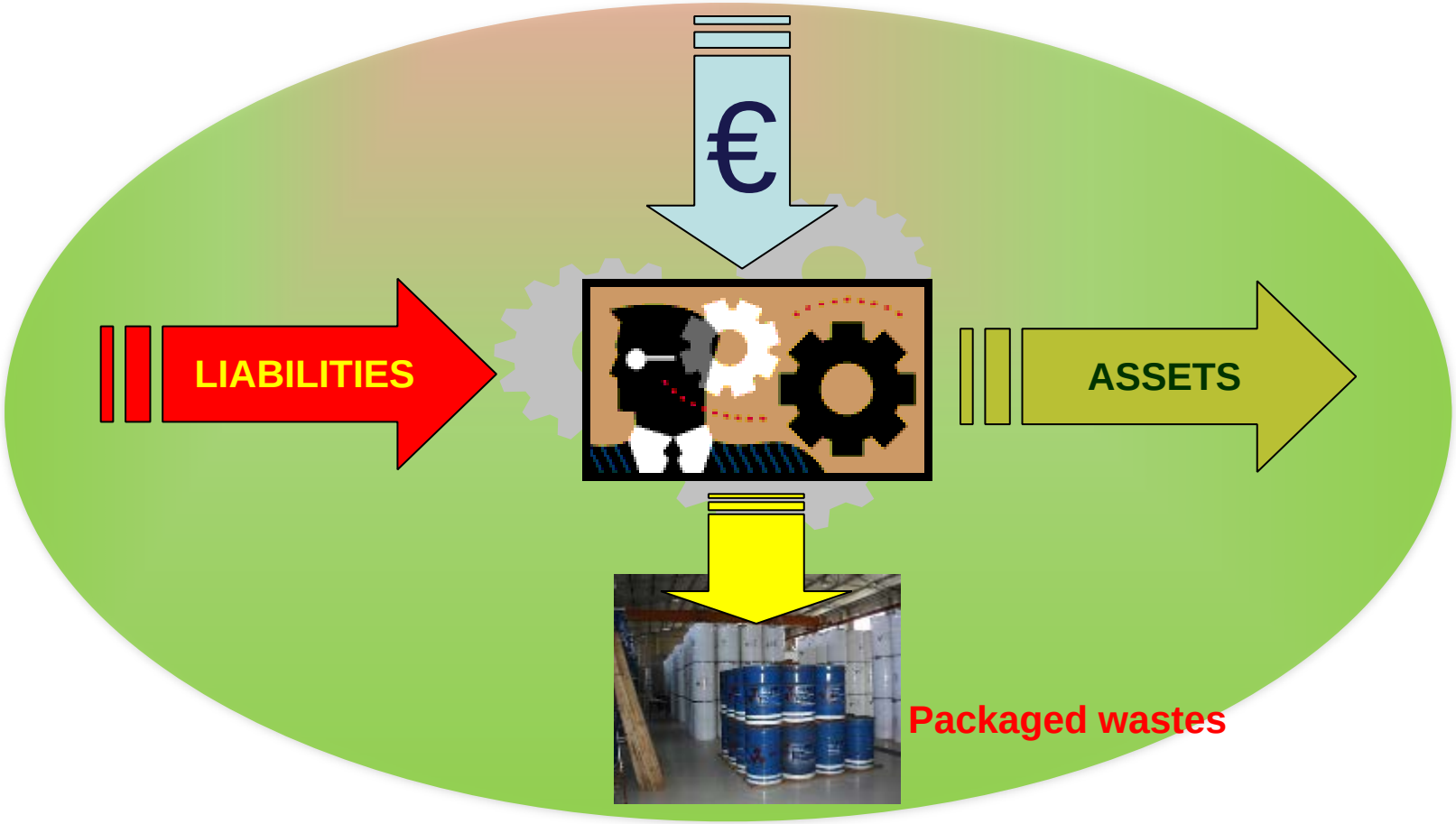
- The term decommissioning describes all the management and technical actions associated with ceasing operation of a nuclear licensed installation and its subsequent dismantling to facilitate its removal from regulatory control (de-licensing)
  - A Decommissioning Plan is now a requirement starting at licensing, but this is FOR operation to be possible
  - Physical decommissioning actions include: decontamination of structures and components, dismantling of components and demolition of buildings, remediation of contaminated ground and removal of the resulting waste

Decommissioning: when does it end ?



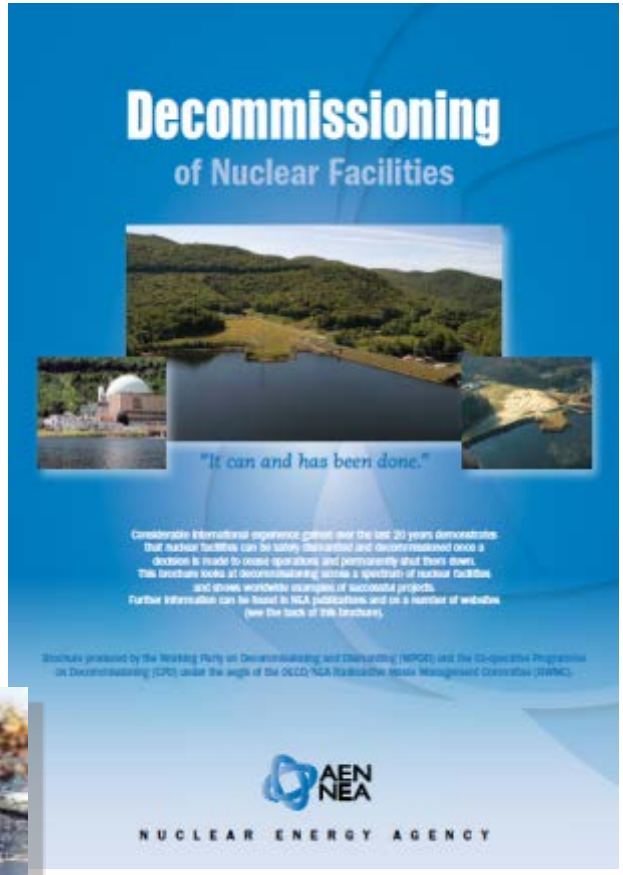
- Decommissioning activities are concluded when the site reaches a condition (end state) that is pre-established and that may be “green field” or “brown field”

The "Decommissioning Machine"



Decommissioning has a long story

- Decommissioning can and has been done
- There exist successfully completed projects of all sort of plants
- Progress in decommissioning is not finished, though

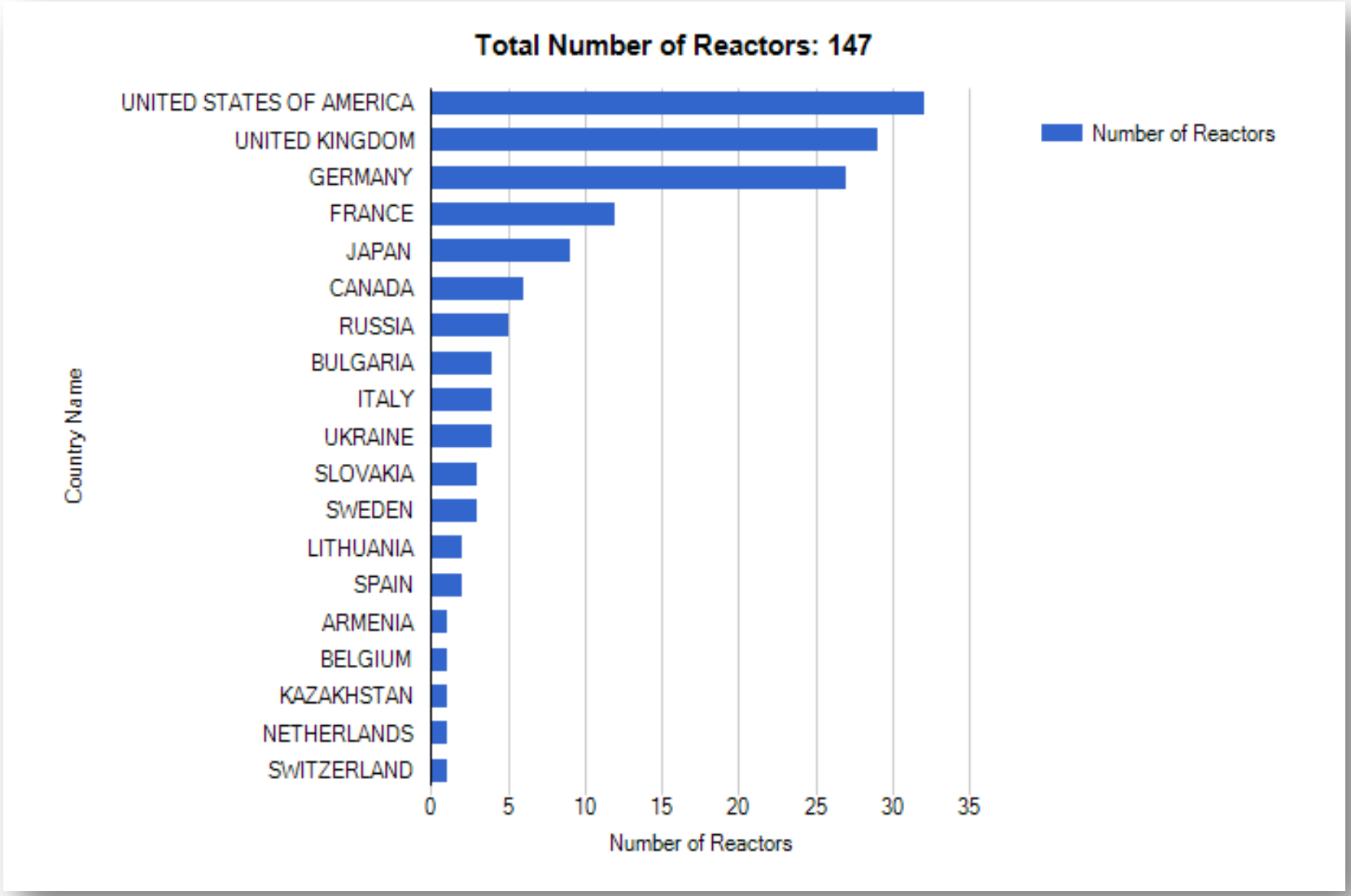


- First decommissioning : 1964 **R-I research reactor, Idaho, USA**

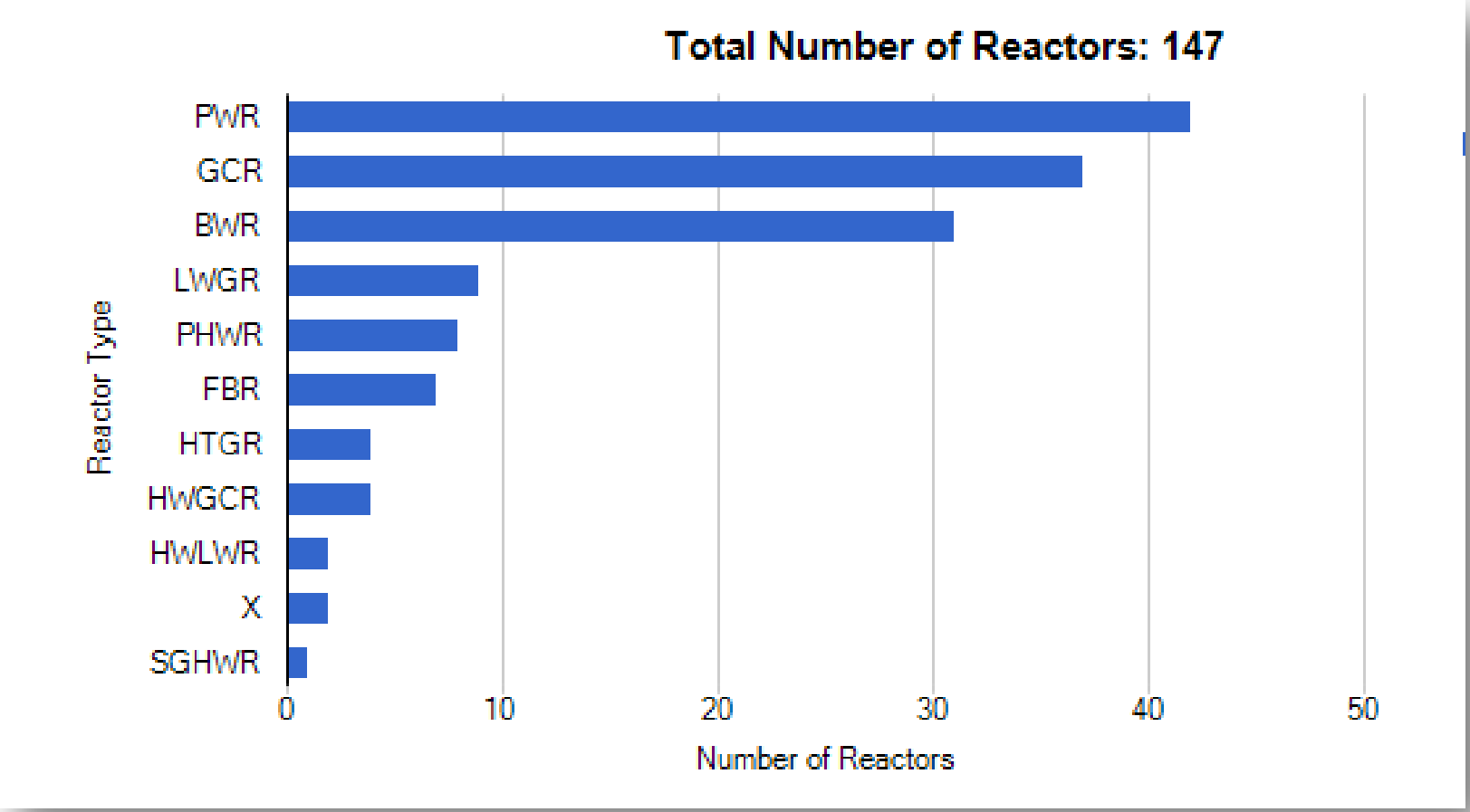
became a U.S. "National Historic Landmark"

- First commercial nuclear plant decommissioned: 1984-1989 **Shippingport, Pennsylvania, USA**

NPP's under decommissioning by country (2013)



NPP's under decommissioning by type (2013)



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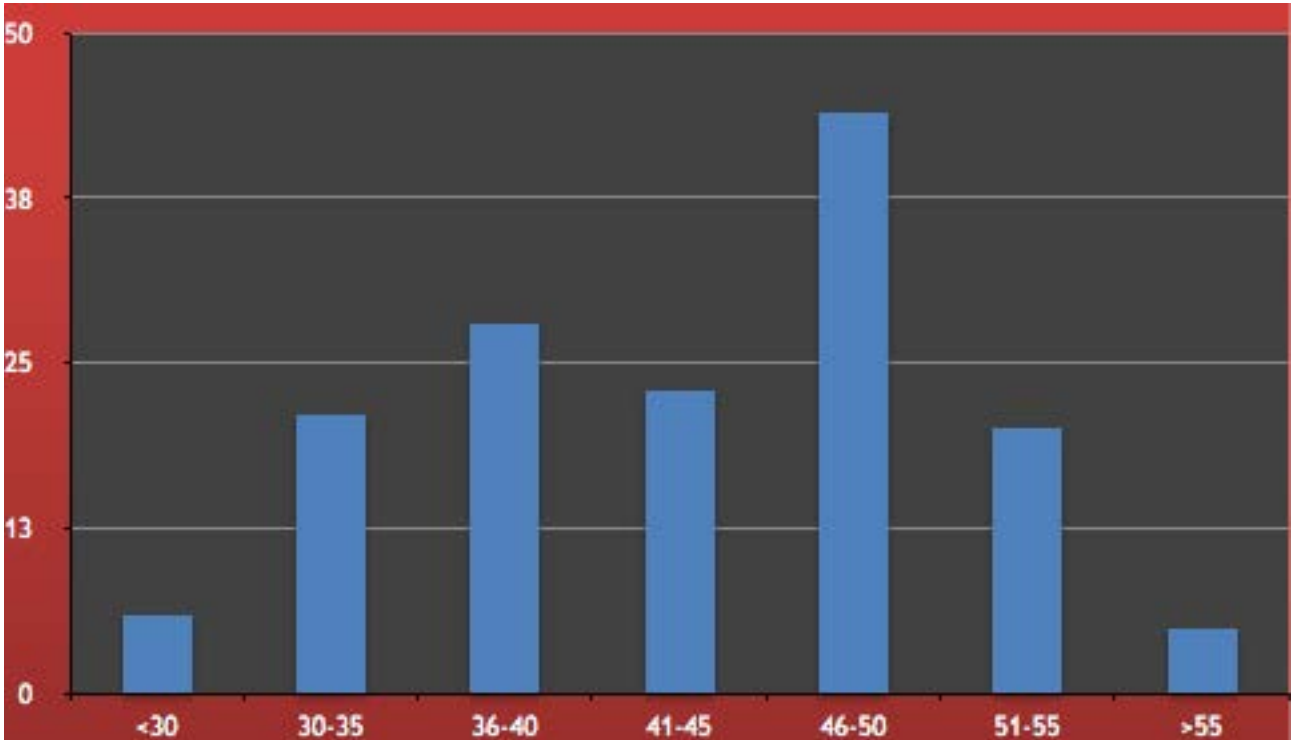
Decommissioning by age

- The histogram below shows the age of reactors that have entered decommissioning till 2012.



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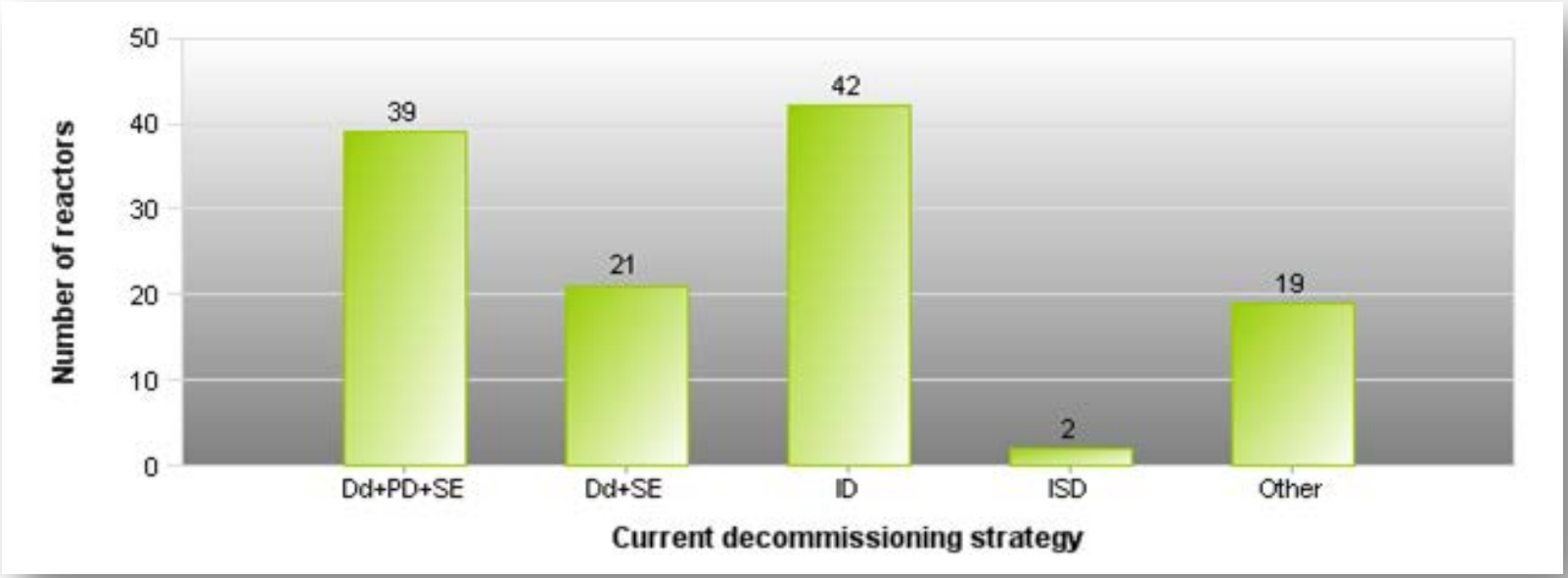
Decommissioning strategies



Strategy	Description
Dd+PD+SE	Deferred dismantling, including partial dismantling and placing remaining radiological areas into safe enclosure
Dd+SE	Deferred dismantling, placing all radiological areas into safe enclosure
ID	Immediate dismantling and removal of all radioactive materials
ISD	In situ disposal, involving encapsulation of radioactive materials and subsequent restriction of access
Other	None of the above

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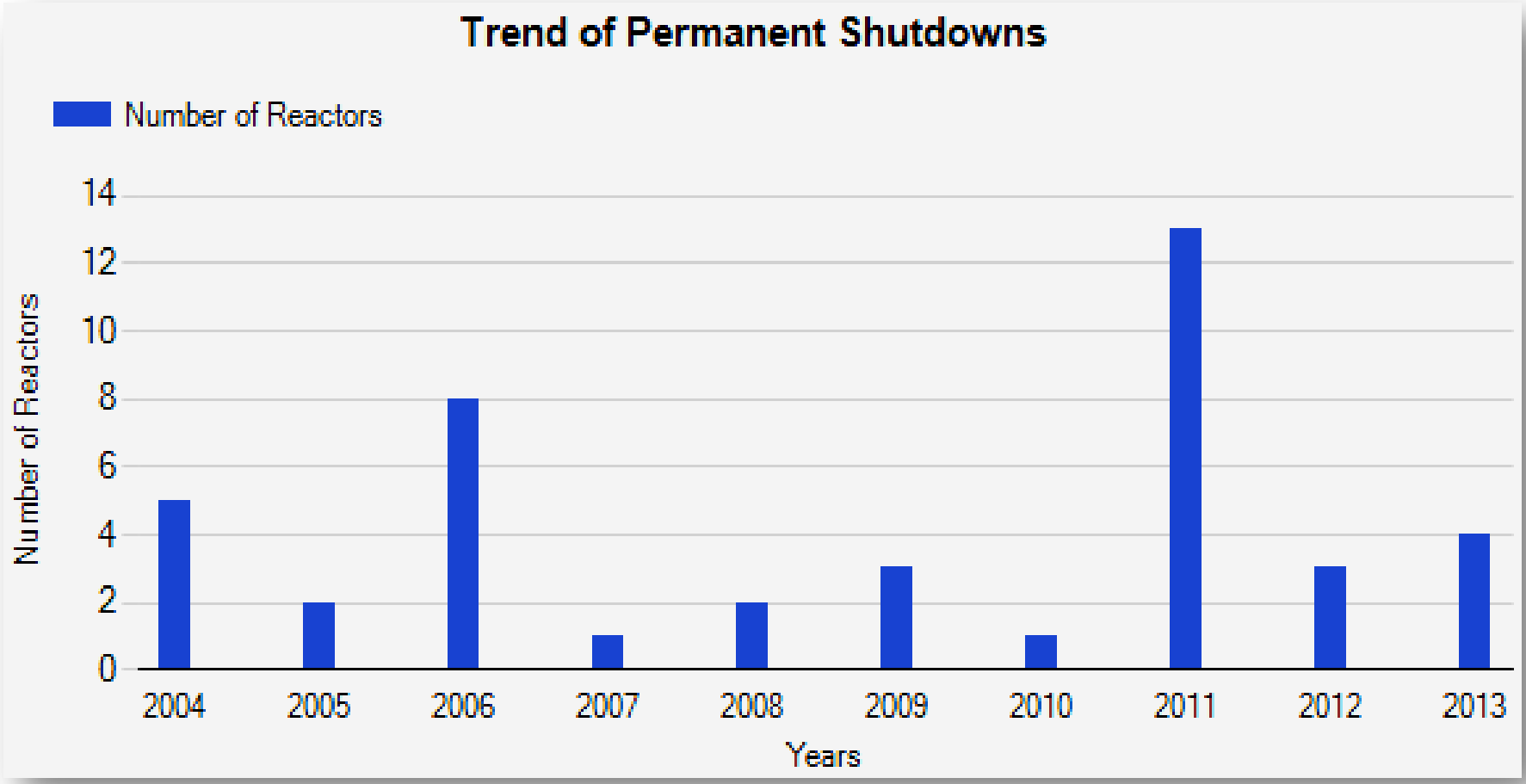
NPP's entering decommissioning in last 10 y



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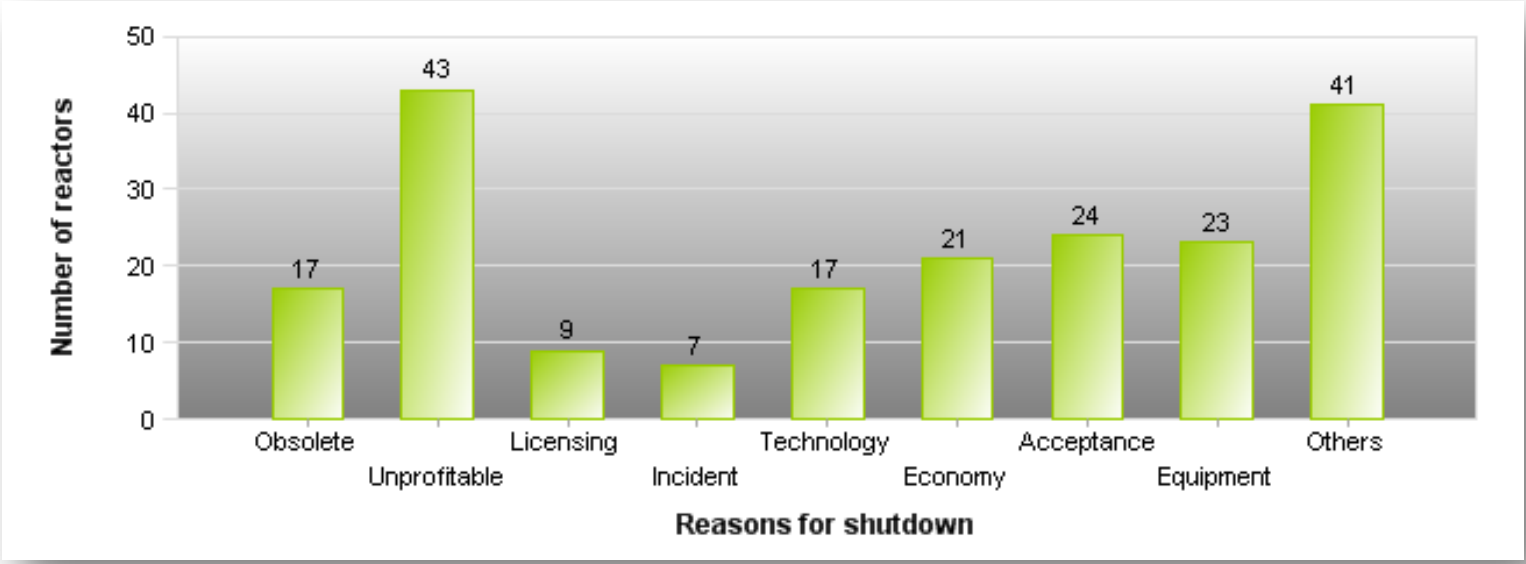
Reasons for decommissioning



Reason	Reason ID	Description
Obsolete	1	The technology or process being used became obsolete
Unprofitable	2	The process was no longer profitable
Licensing	3	Changes in licensing requirements
Incident	4	After an operating incident
Technology	5	Other technological reasons (please mention them below)
Economy	6	Other economical reasons (please mention them below)

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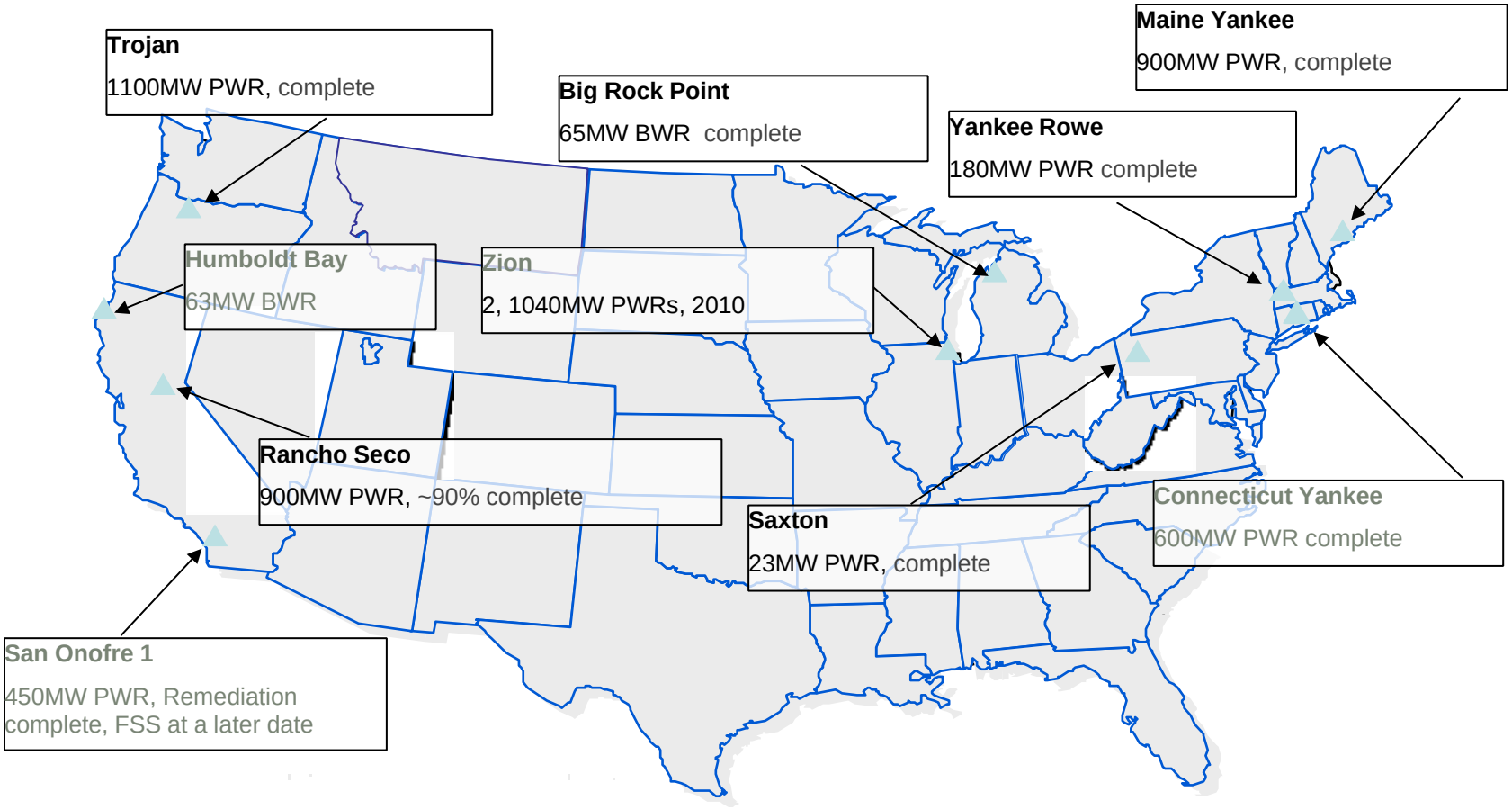
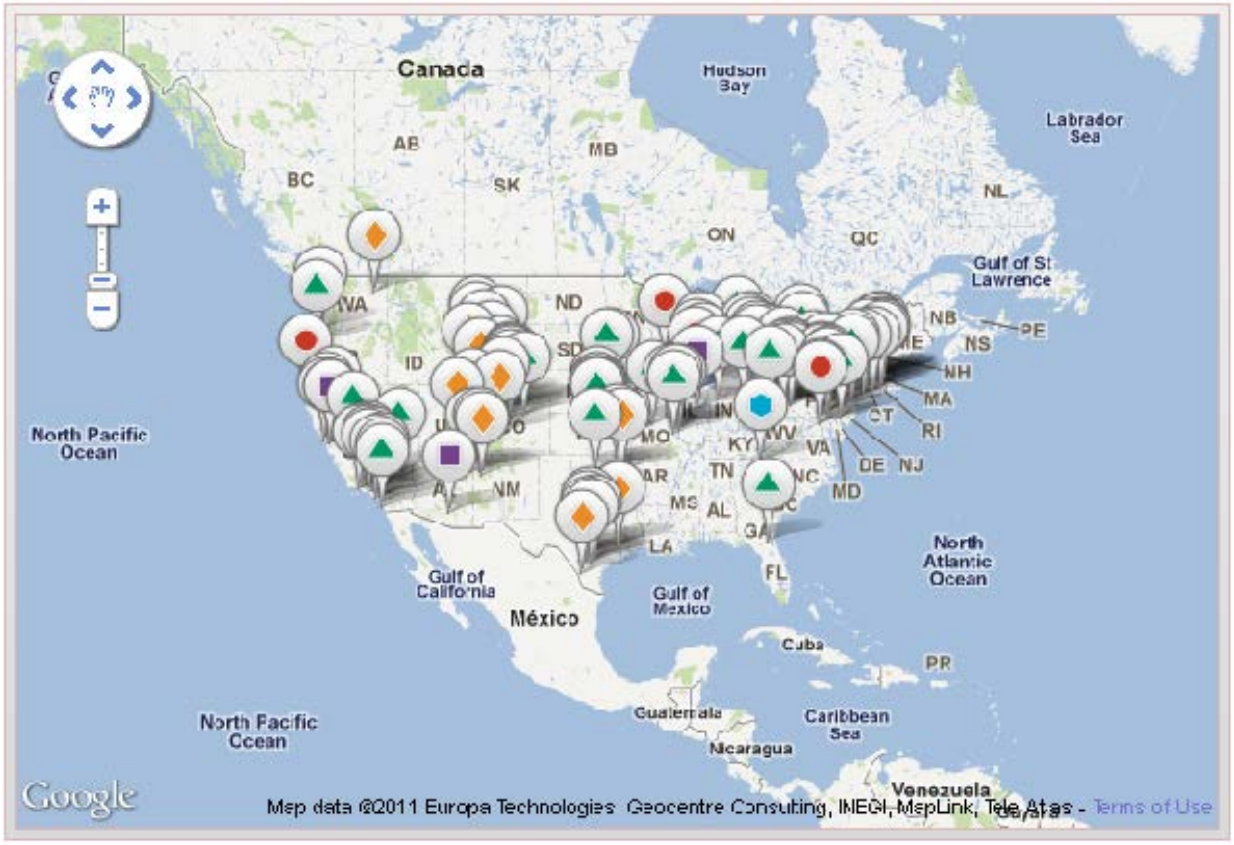
10 NPP completely (or nearly completely) decommissioned in the US. (fuel in dry storage)



NRC regulated decommissioning sites



Complex Materials

Power Reactors

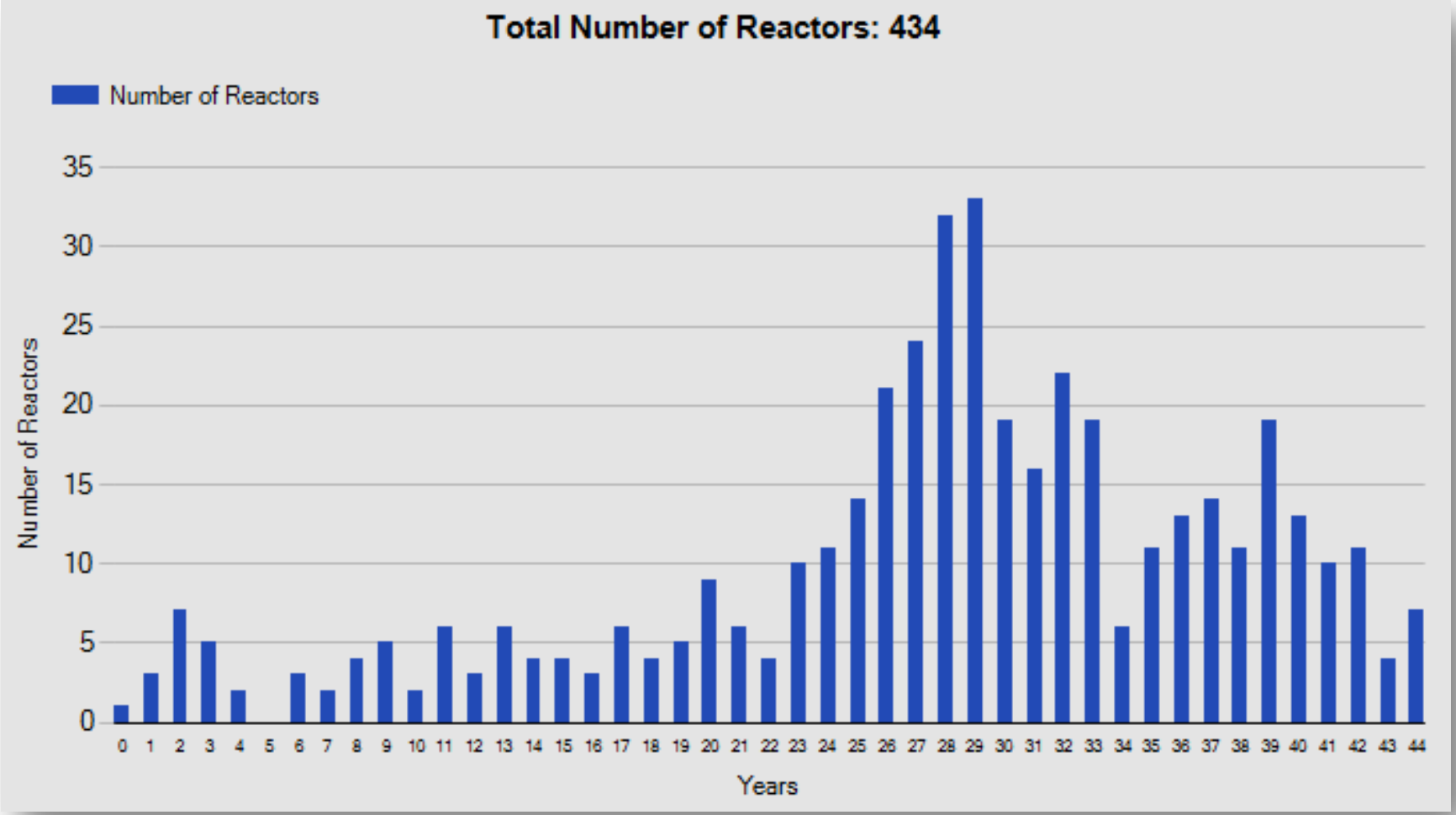
Research & Test Reactors

Uranium Recovery Sites

Fuel Cycle Facilities

Source NRC Website

A look into the future - Age of operating reactors



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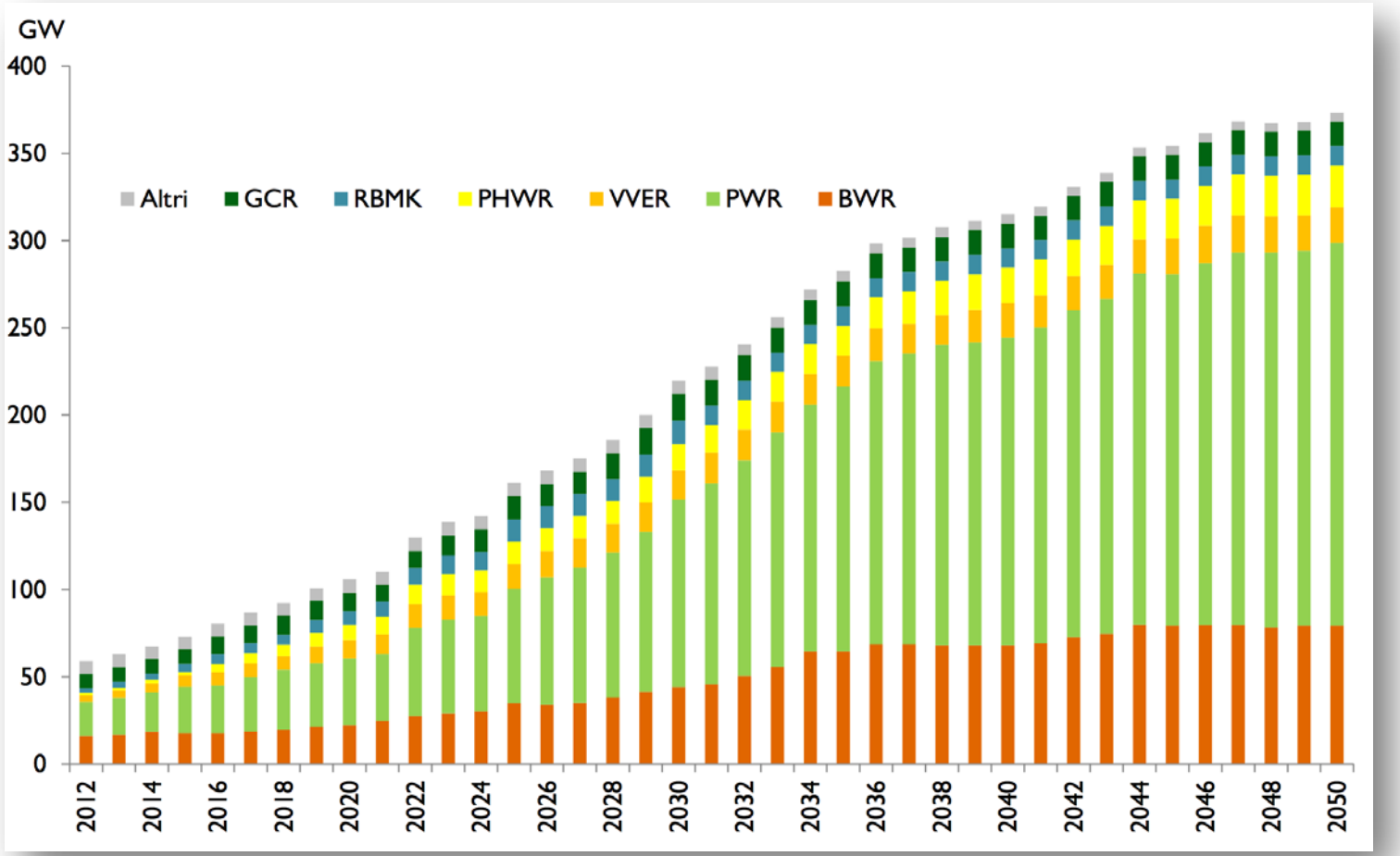
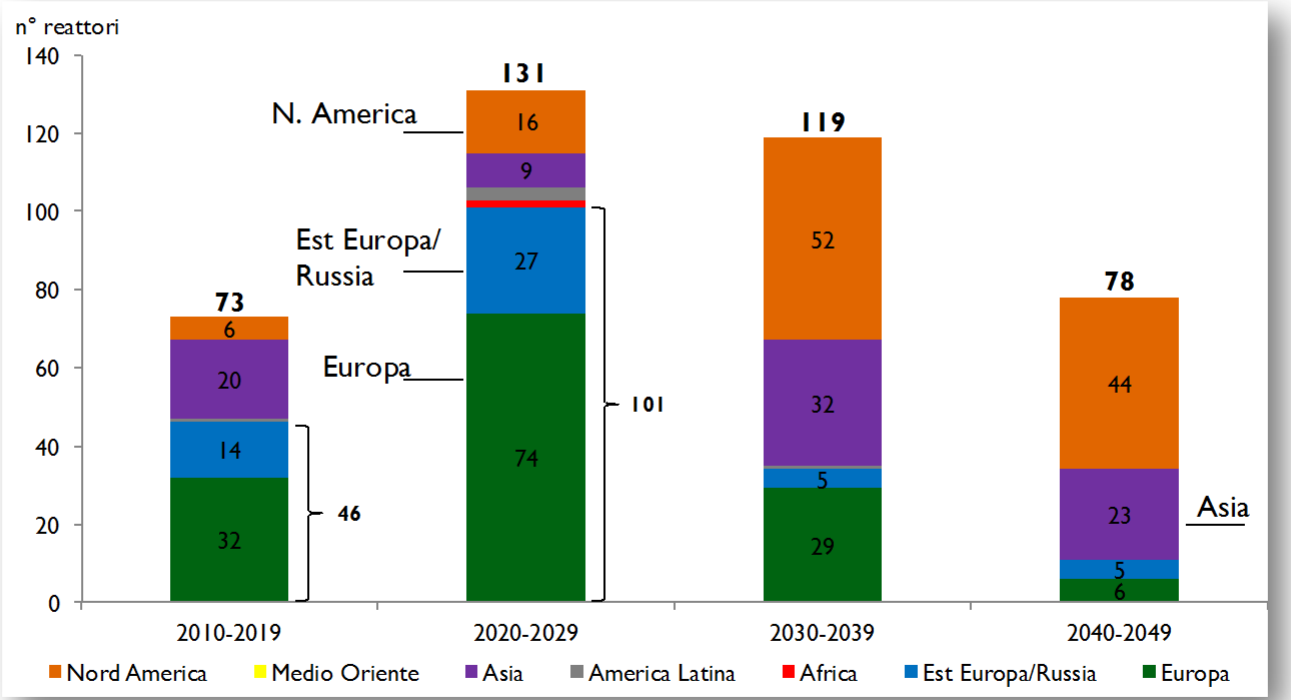
Projections of NPP's entering decommissioning



OECD BETTER POLICIES FOR BETTER LIVES
Nuclear Energy Agency
NEA NUCLEAR ENERGY AGENCY

Future NPP's decom by region



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Decommissioning of other nuclear installations

- The Decommissioning industry has to take care not only of NPP's, but also of a large number of other nuclear facilities or radiologically contaminated sites. In some case these are more complex and challenging projects than NPPs
- Figures in the tables are obsolete (2003 data) and **actual values may be more than double**

	Total 2000-2050 Billion US$
Nuclear Power Plants	185
Fuel Cycle Facilities	71
Research Reactors	6.3
Research Facilities	3.4
Industrial Facilities	0.04
Cold War Legacy	640

Facility type	Estimated decommissioning cost (US 10^6 in 2003)
Power reactors	350
Research reactors	1/MW
Uranium conversion	150
Uranium enrichment	600
Fuel fabrication	250
Fuel reprocessing	800
Industrial facilities	0.200
Particle accelerators	0.100

Ref. IAEA 2006

Military installations (ex. Nuclear submarines)

In Service	Out of Service	Disposed
USA		
72	117	100
Russia		
29	274	180*
UK		
12	17	0
France		
10	6	3*

Source: UK Mod public consultation

*Reactor compartments removed, not dismantled

The Nuclear Expert factor

- Shortage of nuclear experts is expected worldwide
- In Europe the European Commission estimates that 40.000 nuclear experts will be hired by 2020 to cope with the expected activities and the retirement of aged employees
- Of those about 10.000 will be involved in decommissioning and waste management activities

The OECD/NEA (1)

- The Nuclear Energy Agency of the Organization for the Economic Cooperation and Development is actively working in every nuclear energy aspect

The Radioactive Waste Management Committee is a standing Committee dedicated to waste management and decommissioning

- The WPDD or Working Party on Decommissioning and Dismantling is a Working Party (discipline-oriented permanent standing group) of the Radioactive Waste Management Committee (RWMC) since 1999

The OECD/NEA (2)

- The WPDD is composed of nominees from NEA Member countries with responsibility, overview, and/or experience in the field of decommissioning and takes advantages of a mixed regulator/implementer/researcher membership

- The activities are complementary to those of the IAEA

- WPDD web (publications):

  http://www.oecd-nea.org/rwm/wpdd/

Recent Achievements of the WPDD (1)

Future R&D and Innovation Needs for Decommissioning

- Reference book, over 260 page in print

Areas with greatest potential for future improvements through R&D - 5 themes

- Characterization and survey prior to dismantling
- Segmentation and dismantling
- Decontamination and remediation
- Materials and waste management
- Site characterization and environmental monitoring

For each theme:

- Theme overview (summary of current practices and guidance, summary of R&D challenges and needs)
- Suggested additional research and development
- Suggested areas of collaboration

Recent Achievements of the WPDD (2)

Future R&D and Innovation Needs for Decommissioning - Suggested areas of collaboration

Characterization and survey prior to dismantling

- Developing an international approach or standard for statistical sampling (representativeness, grid density, defining an acceptable level of uncertainty)
- Method and hardware to develop characterization of contamination intrusion along concrete cracks
- Technologies for rapid alpha and beta non-destructive measurements on structures before dismantling, especially for difficult-to-access structures
- International approach for scaling factors between easy to measure and hard-to-measure nuclides
- Developing an international approach or standard for estimating the level of impurities in metals and concretes, especially for new reactors

Recent Achievements of the WPDD (4)

Future R&D and Innovation Needs for Decommissioning - Suggested areas of collaboration

Materials and waste management

- Managing problematic wastes -chemical (PCBs, asbestos, etc.) and mixed waste
- Treatment/removal (including mineralization) of organic materials (bituminized waste, resins, oils, nitrates) and activated sodium
- Conditioning of waste (different grouts, foam concrete, etc.; improving waste incorporation)
- Long-term performance of waste-forms (e.g., concrete, impact of superplasticisers on radionuclide migration)
- Treatment of reactive metals (high temperature processes, melting) and managing gas generation
- Clearance and recycling of low contaminated materials

Recent Achievements of the WPDD (6)

Radiological Characterization and Decommissioning (Sept 2013)

- Best practice on selection and tailoring of strategies for radiological characterisation for decommissioning at various stages of nuclear facility's life cycle, addressing also key issues of characterisation and lessons learned
- The Report available on

http://www.oecd-nea.org/rwm/docs/2013/rwm-wpdd2013-2.pdf

Recent Achievements of the WPDD (7)

Decommissioning Cost Estimation Group (DCEG)

- Cost Control Guide (Feb 2013)
  - A survey showed a lack of use of cost controls, frequent budget and time overruns in decommissioning projects
  - The Guide establishes a framework for structuring a program for preparing cost controls, training and certifying, based on the internationally recognized standard, Earned Value Management System (ANSI, 2007).
  - The Guide available on http://www.oecd-nea.org/rwm/docs/2012/rwm-r2012-10.pdf

Recent Achievements of the WPDD (8)


ESTIMATION OF NUCLEAR FACILITY DECOMMISSIONING COSTS
CURRENT STATUS AND PROSPECTS

It is now common practice to prepare decommissioning plans and associated cost estimates for nuclear power plants and other nuclear facilities even before the start of construction. Typically these plans and estimates are updated regularly during plant operation, in the transition period after shut down, and during decommissioning. Specific requirements on contents of the plan are usually set out in regulation, which has its basis in national legislation.
Transparent, underpinned cost estimates have a number of important functions. They provide a rationale for the chosen decommissioning strategy, a basis for assessing the cost-effectiveness of the decommissioning activities, and a basis for ensuring the necessary funds are available when needed to cover the actual cost of decommissioning. Practices for estimating decommissioning costs vary across countries and projects. Efforts are being made to improve cost comparability.

Status of cost estimation for decommissioning

Most countries have established requirements for cost estimation and reporting. For nuclear power plants and other commercial facilities, legal requirements include the preparation of a decommissioning plan and associated cost estimates, with periodic updates - usually every three to five years.

National regulations include both administrative and substantive requirements. Substantive requirements generally relate to explaining and justifying boundary conditions and assumptions used to calculate cost estimates. Examples of boundary conditions include the year of the estimate, possible site end states, characteristics of the facility or waste clearance limits, as well as the expected decommissioning activities. The latter may include facility characterisation, transitioning from operation to dismantling, waste processing, legacy waste disposition, spent fuel disposition, storage, transportation and other materials management activities. Assumptions regarding contingency costs and the labour market are also to be reported. In some countries, substantive requirements stipulate the use of present value costs and means for handling escalation.

Periodic updates and reviews are carried out in light of the fact that the timeframe for active decommissioning comes several years or even decades after the initial estimate is made.

The nuclear safety regulator plays an important role in the review and approval of decommissioning plans and, in some cases, decommissioning cost estimates and funding plans. Some regulators require a cost-benefit analysis or the equivalent for assessing alternative decommissioning technologies and techniques. Reviewing cost estimates regularly and comparing them with the actual cost of decommissioning activities ensures the quality of these estimates.

Most countries have adopted an internally consistent formal structure for estimating and reporting costs. There is variability from country to country, however, in the methodology.

To structure their estimates, many countries have adopted a breakdown into activity-dependent and period-dependent costs. These cost breakdowns can be used to divide decommissioning financing into tranches; it is likely that there is greater confidence in the more immediate tranches. Several countries reflect the degree of confidence by specifying different contingency factors for different tranches of the project.

Contingencies and uncertainties

In order to comprehend and address cost escalation two concepts are important: "contingency" and "uncertainty".

In preparing and managing cost estimates the concepts of "contingency" and "uncertainty" are important.
"Contingency" addresses potential increases in the defined cost of an activity item and is specific to that item. When increases occur these are mainly due to the novelty of some of the tasks. However, the overall contingency of completed projects is usually limited to between 10 and 30 %.
"Uncertainty" is the word used to refer to cost variations from causes outside the control of the project, such as currency exchange rate fluctuations, unex- →

Please consult our website: www.oecd-nea.org/rwm/wpdd

Decommissioning Cost Estimation Group (DCEG)

- It is unadvisable at this stage to compare decommissioning costs of entire projects (WPDD Statement of 2012)
- Comparability of cost of only specific activities is possible – ISDC is a recommended tool
- In general, a stable and accurate estimation of cost requires:
  - fixing regulatory standards during planning phase,
  - avoiding changes in the project scope,
  - assuring accurate inventory through (materials and soils) characterisation
- The Statement available on http://www.oecd-nea.org/rwm/wpdd/documents/WPDD-flyer-mar2012.pdf

Plans of the WPDD - Topics of WPDD focus

- **Site restoration/remediation**
- **Transition from reactor shutdown to decommissioning**
- **Decommissioning costing**

  (uncertainties and risk assessment in decommissioning costing)
- **Knowledge and record management**

  (i.e. knowledge & experience retain and transfer; training and education in decommissioning; record keeping for decommissioning)
- **Nuclear installations after severe accident, large contaminated areas**

  (technologies applicable in harsh environment and associated R&D)

Co-operative Programme on Decommissioning (CPD)

- CPD was established by OECD/NEA in 1985 on an initiative from US Department of Energy (US DOE)
- Joint Undertaking between participating organizations, overseen by a Management Board (MB) and regulated by an Agreement signed by all participants
- Sharing, on a “Give & Take” principle, technical and scientific information amongst major international decommissioning projects in the Technical Advisory Group (TAG)
- Confidentiality
- Agreement renewed every five years (currently 2014-2018)

Co-operative Programme on Decommissioning (CPD)

62 Projects, 25 Organisations, 14 Countries

All stages of decommissioning:

- Category 1: Planned and Ongoing
- Category 2: Dormant
- Category 3: Terminated

- 37 NPP's and Research Reactors (26 cat. 1)
  - PWR, BWR
  - GCR, AGR, HTGR, VVER
  - FBR
- 25 Fuel Cycle Facilities (20 cat. 1)
  - Radio-chemical labs, fuel storage bay,
  - Reprocessing facilities
  - Fuel material plants

Co-operative Programme on Decommissioning
Information Exchange, Topical Issues

- Utilisation of Remote Systems and Robotics
- Release of Alpha Contaminated Areas
- Dismantling of Large Components
- Stepwise De-licensing
- Partial Plant Dismantling
- Industrial/Project Re-organisation
- Contract management
- Different aspects on characterisation
- Waste packaging systems
- Site remediation

Co-operative Programme on Decommissioning
Task Group Reports and Publications

- Decontamination Techniques in Decommissioning Activities
- Radioactive Measurements at Regulatory Release Levels
- Recycling and Reuse of Scrap Metals
- The NEA Co-operative Programme on Decommissioning: *Twenty-five Years of Progress*
- Decontamination and Dismantling of Concrete Structures
- Experience with Remote Handling Techniques

Major non-technical challenges

- Decommissioning projects are not only complex projects requiring technical and managerial high level competences and experience
- Significant non-technical challenges have to be managed successfully, i.e.
  - Assuring adequate funding when needed
  - Obtaining support by local population and authorities
  - Motivating the workers and assuring safety culture levels

Next use - Stakeholder preferences

Conclusions

- Decommissioning has gained and will gain more focus nationally and internationally
- Decommissioning can and has been done. A lot of experience is available. Challenges do remain!
- Decommissioning is a long term project management and engineering challenge. Progress can still be made!
- Regulations must be proportionate and deliverable
- New reactors need to consider decommissioning needs (this may also improve plant maintenance)
- A lot of good decommissioning techniques are available. R&D/Innovation is still important, though
- Comparability of costs is an issue on which progress is being made
- Public shows much interest in decommissioning and becomes a more active player affecting decisions