IAEA 60 Years

Atoms for Peace and Development

IAEA Perspectives and Supported Innovation Initiatives

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International Atomic Energy Agency

23 March 2021

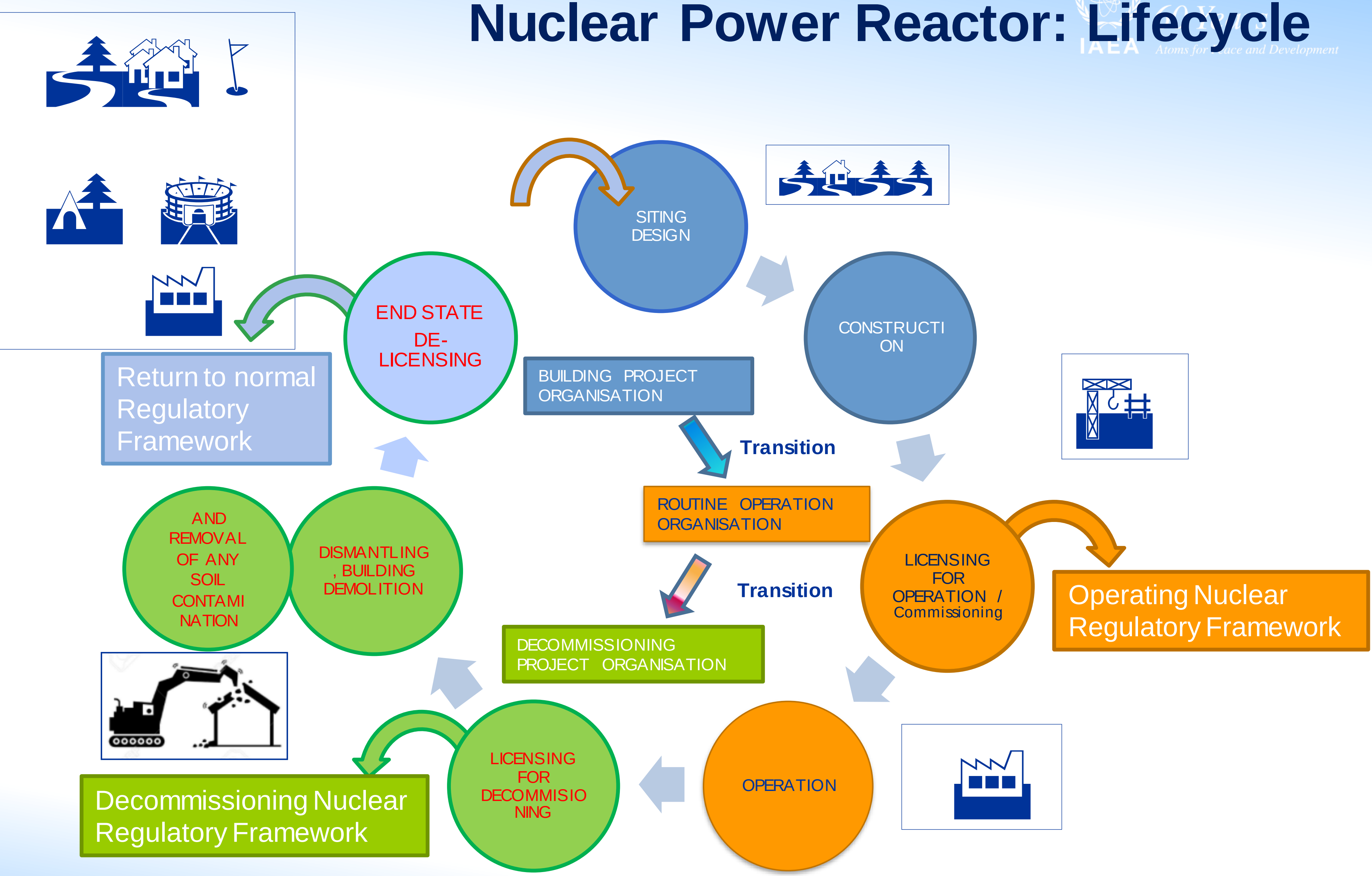
DigiDecom 2021 – DIGITAL

23-25 March 2021

Plan of Presentation

- Global Status of Decommissioning
- IAEA Activities to Support Decommissioning
- Useful Links

Nuclear Power Reactor: Lifecycle



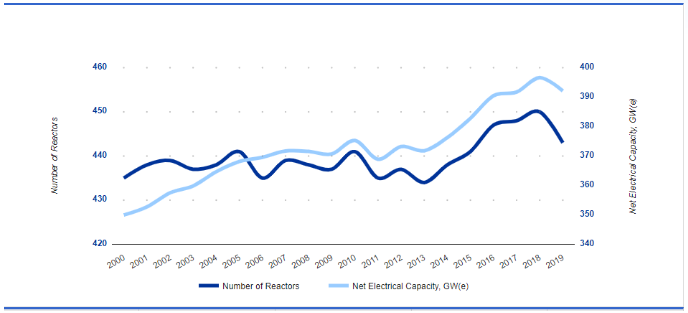
Decommissioning - part of the normal lifecycle of a Nuclear Power Plant

Background: Nuclear Power Reactors

[as of 7 March 2021]

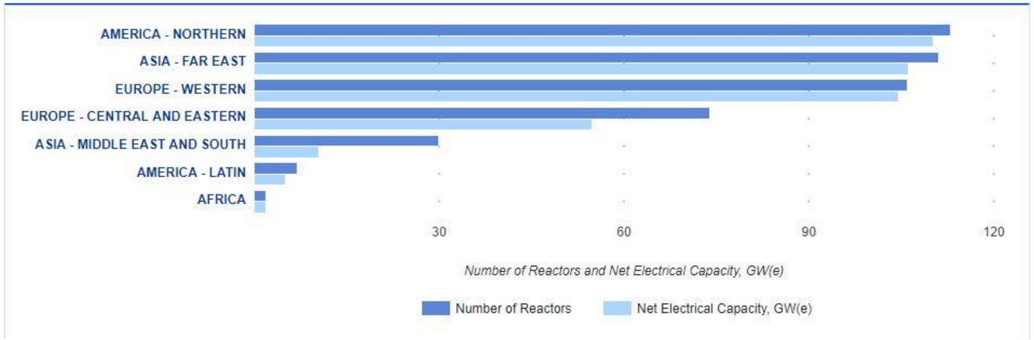
443 in operation

393 GW(e) Capacity



50 under construction (60% in Asia)

Regional Distribution of NPPs



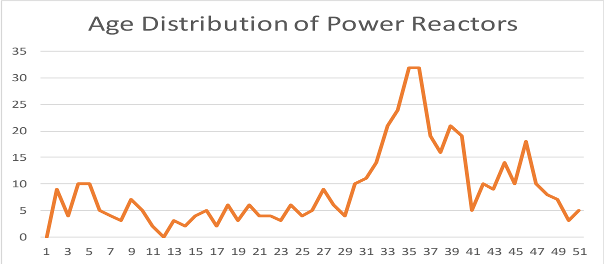
Permanently Shutdown (2020): Duane Arnold-1 [600 MWe BWR]; Indian Point-2 [1000 MWe PWR; Fessenheim-1&2 [2x880 MWe PWR]; Leningrad-2 [925 MWe RBMK]; Ringhals-1 [881 MWe BWR]

Global Status of Nuclear Facilities

[Sources: IAEA 03/21: PRIS, Research Reactor, and INFCIS databases]

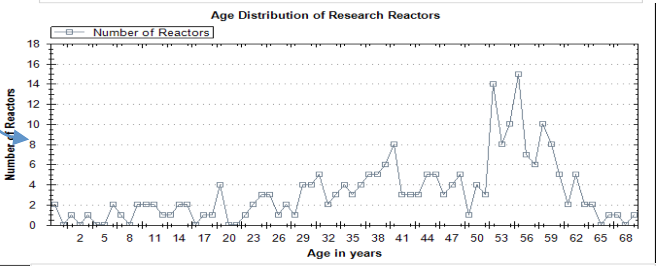
Power Reactors

Under construction	50
in operation	443
Permanent Shutdown, in decommissioning / Decommissioned	174/18
	685



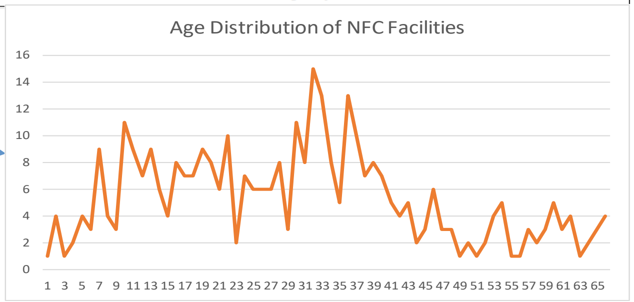
Research Reactors & critical assemblies

Under construction	11
in operation	220
Long-term / temporary Shutdown	28
Permanent Shutdown, in decommissioning / Decommissioned	125/444
	828



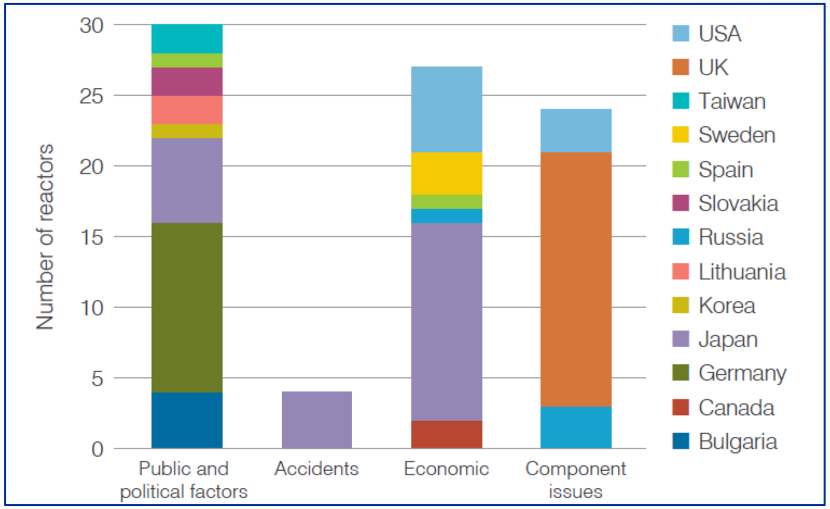
Nuclear Fuel Cycle Facilities

Under construction/commissioning	23/4
in operation	334
Long-term / temporary Shutdown	27
Permanent Shutdown, in decommissioning / Decommissioned	158/131
	704

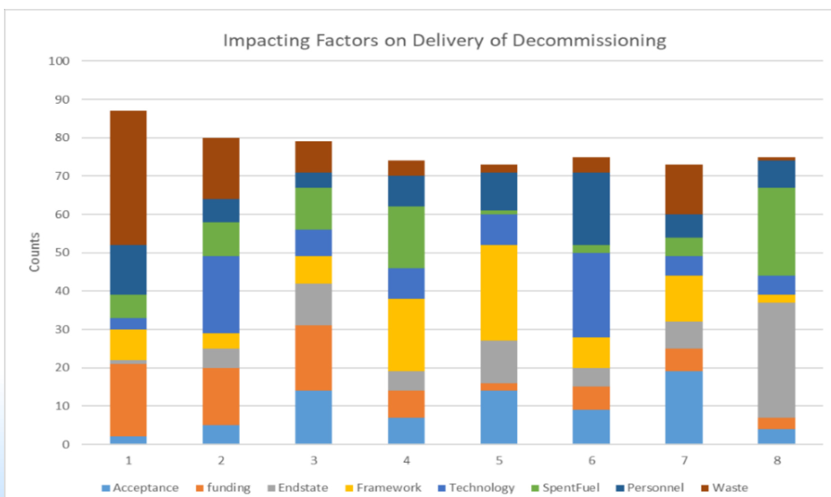


Small industrial facilities using radioactive material: several '000s

Collaborative Project – Global Status of Decommissioning



Source: World Nuclear Association



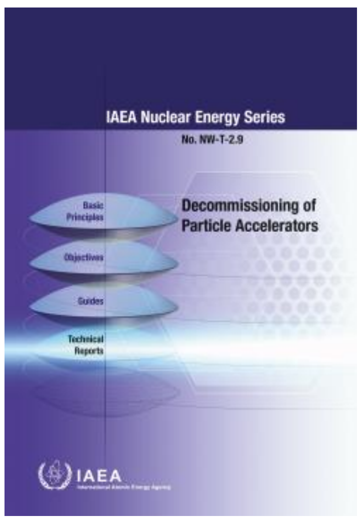
- ❑ Project Timeframe :
  - 2019 – 2021
  - Technical Meeting – October 2020
- ❑ Report Contents:
  - envisaged decommissioning strategies and timeframes
  - current status of programmes and foreseen challenges
  - resource needs, both in terms of human resources and technology.
- ❑ Support ongoing development of the decommissioning modules of IAEA database systems, including:
  - PRIS (Power Reactor Information System),
  - INFCIS (Integrated Nuclear Fuel Cycle Information System) and,
  - RRDB (Research Reactor Database)

IAEA Activities to Support Decommissioning

NES Publications – New & Upcoming

New

2020



2021

Now in final editing (pre-publication draft available):

- Data Analysis and Collection for Costing of Research Reactor Decommissioning (DACCORD Report Phase 2)
- Training and Human Resource Considerations for Nuclear Facility Decommissioning: NG-T-2.3 (Rev.1),
- Integrated Approach to Decommissioning within a Multi-Facility Site

IAEA International Conferences

Conference Website:
www.iaea.org/events/international-conference-on-radioactive-waste-management-2021
Abstract Submission Date: **6th April 2021**

International Conference on Nuclear Decommissioning: Addressing the Past and Ensuring the Future

- Objective: sharing information on achievements, challenges and lessons learnt as well as on the strategies and approaches that can enable and enhance safe, secure and cost-effective implementation of national decommissioning programmes
- 15-19 May 2023, VIC, Vienna, Austria
- Joint endeavour of NE and NS departments
- Programme Committee to meet 8-10 December 2021
- **Ideas, inputs and cooperation are much welcome**

Peer Reviews – ARTEMIS

- Main objectives: to provide independent expert opinion and advice to MS
  - IAEA put together a team of international experts
  - policy, regulatory and implementation experiences are combined
- Intended for facility operators and other implementing organizations, regulators, government agencies, policy makers
- Scope can include facilities and activities related to:
  - SNF and RW management and disposal,
  - ***Decommissioning,***
  - Environmental remediation

2021 – ARTEMIS mission to review JAEA Back End Road Map – planned for April

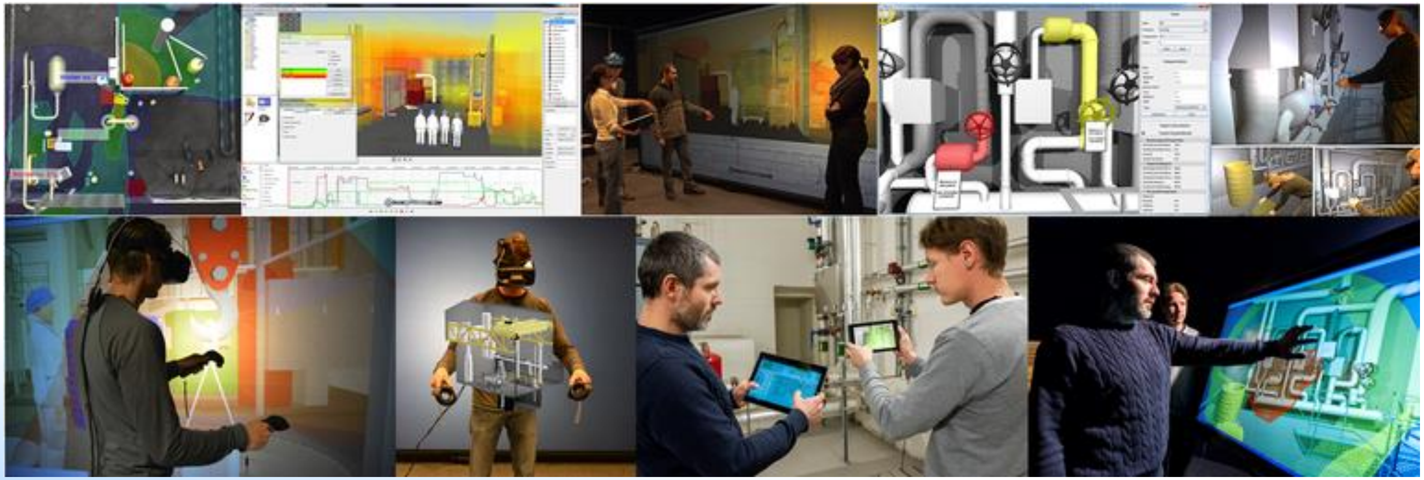
IAEA Collaborating Centres on Decommissioning

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).

Starting a network of Collaborating Centres:

- IFE (Institute for Energy Technology), Norway – targeting issues of digitalization of knowledge management for decommissioning
- Sogin, Italy – targeting knowledge management and training for decommissioning
- JAVYS, Slovakia – targeting WWER decommissioning and project management
- EDF/DP2D (Graphite Reactor Decommissioning Demonstrator) – targeting graphite reactor decommissioning



[Photos Courtesy of IFE, Norway]

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Home / News / New Crowdsourcing Challenge: Decommissioning and Environmental Remediation 2020

New Crowdsourcing Challenge: Decommissioning and Environmental Remediation 2020

Irena Chatzis, IAEA Department of Nuclear Energy

APR
21
2020

The IAEA is inviting professionals under age 35 to present technical or non-technical concepts, novel applications under development or prototype techniques in testing phase. (Photo: Institute of Energy Technology (IFE), Norway)

The IAEA is inviting young professionals from around the world to propose an original concept or project outline for advancing the decommissioning of nuclear facilities or environmental remediation of radiologically contaminated sites. The winners will be invited to present their entries at the IAEA General Conference in September.

Professionals under age 35 are invited to present technical or non-technical

Related Stories

- Expanding Partnerships: IAEA Designates 7 New Collaborating Centres
- IAEA and UK's National Nuclear Laboratory to Cooperate on Sustainability of Nuclear Power
- IAEA Showcases Successful Environmental Remediation Initiatives
- IAEA Workshop Highlights Novel Trends in Decommissioning
- IAEA, Florida International University Expand Cooperation on Decommissioning and Environmental Remediation

Related Resources

- IAEA Challenge: Decommissioning and Environmental Remediation 2020
- E-learning on Spent Fuel and Radioactive Waste Management,

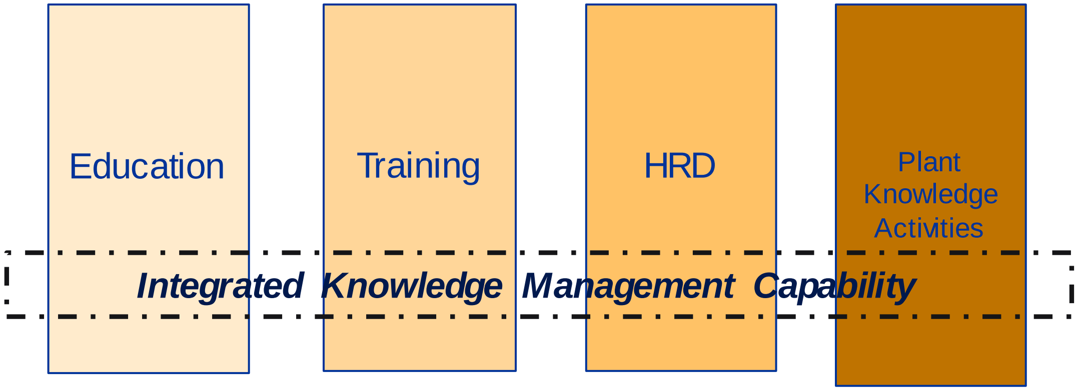
26 submissions from 12 Member States (in America, Europe and Asia) → selected projects promoted via IAEA communication channels

Crowdsourcing Challenge: Finalists

- Characterisation toolkit to enable accelerated decommissioning activities (Ms Erin Holland et al., University of Bristol)
- MAUD project, Portable Alpha/Beta camera for dismantling operations (Mr Sylvain Leblond, GANIL – CNRS, France)
- Development of hybrid approach to identify Fukushima Daiichi fuel debris (Mr Ryo Yokoyama, University of Tokyo)
- Robotics, Artificial Intelligence, Digitalization, Virtual Reality – the next generation of disruptive technologies for D&D of nuclear facilities (Mr Daniel Martin et al., FIU / IFE, Norway/US)
- Robot for mapping and monitoring of contamination areas (Ms Zeni Anggraini et al., BATAN, Indonesia)

Nuclear Knowledge Management for Decommissioning

Current Approach to NKM across the Nuclear World



Because the nuclear organisations know what to do, and understand to add value NKM must be integrated across people and plant activities

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

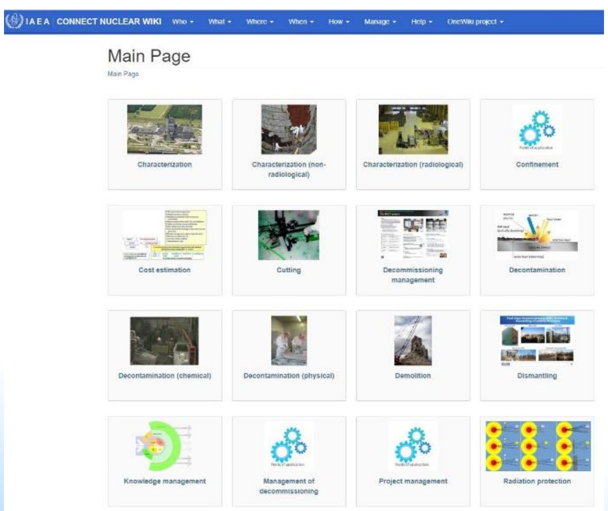
IAEA Support: Networks
Web Based Tools to support information sharing

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

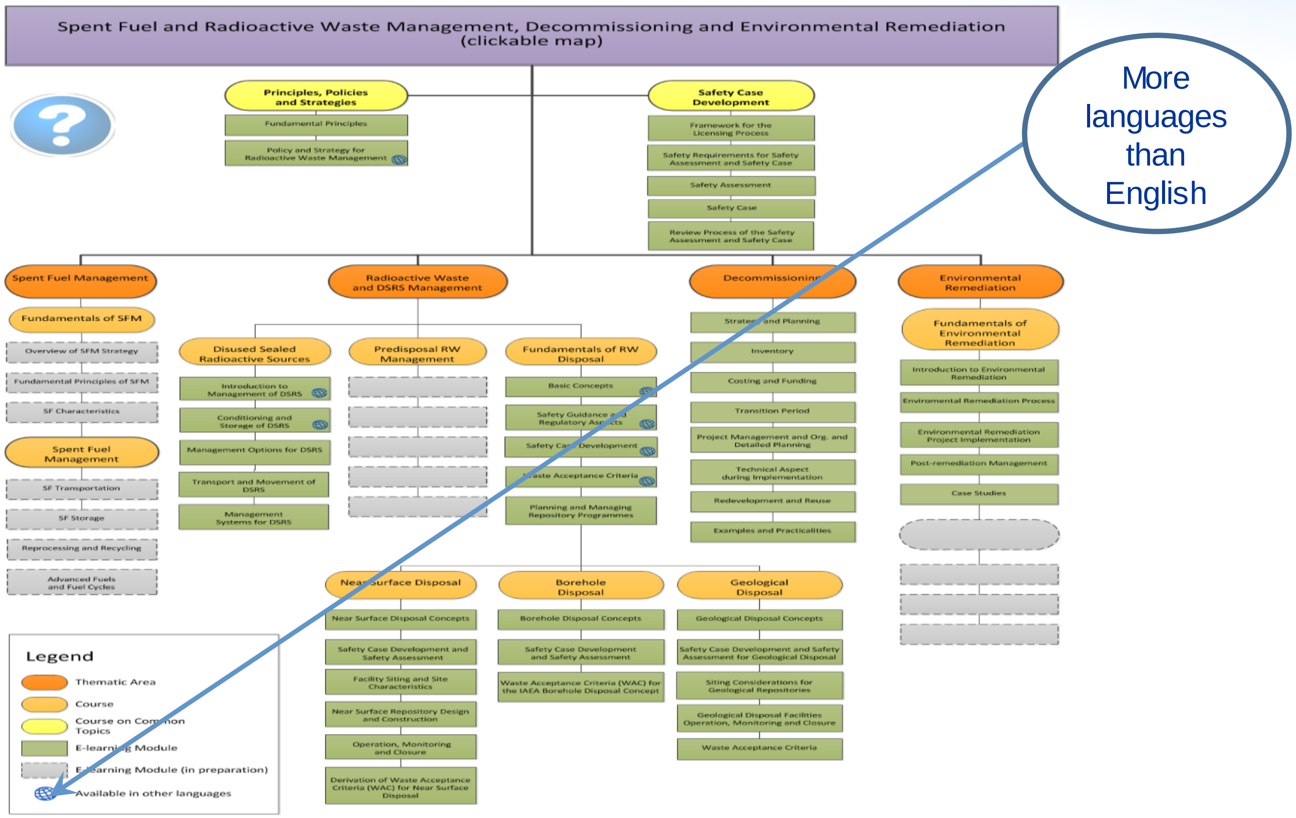
Networks

- **URF** – Geological Disposal Underground Research Facilities for Geological Disposal. Learn More / Join URF
- **DISP** – International Low Level Waste Disposal Network. Near Surface Disposal of Low Level Radioactive Waste. Learn More / Join DISPONET
- **SFM** – Spent Fuel Management. International Network on Spent Fuel Management. Learn More / Join SFM
- **IDN** – International Decommissioning Network. Decommissioning of Nuclear Facilities. Learn More / Join IDN
- **CGULS** – Coordination Group for Uranium Legacy Sites. Coordination Group for Uranium Legacy Sites. Learn More / Join CGULS
- **ICT** – I&C Technologies. Instrumentation and Control Technologies Network. Learn More / Join ICT
- **MSN** – Management System Network of Excellence. Management System Network. Learn More / Join MSN
- **LAB** – International Network of Laboratories for Nuclear Waste Characterization. LABONET - International Network of Laboratories for Nuclear Waste Characterization. Learn More / Join LABONET
- **NKM** – Nuclear Knowledge Management Network. Nuclear Knowledge Management Network. Learn More / Join NKM
- **ENV** – Network on Environmental Management and Remediation. ENVIRONET - Environmental Remediation and NORM Management Network. Learn More / Join ENVIRONET
- **bDN** – beta-Delayed Neutron Emission. beta-Delayed Neutron Emission. Learn More / Join bDN
- **IPN** – International Predisposal Network. forum for the sharing of practical and international experience/developments on radioactive waste management activities before disposal.
- **NNE** – Networking Nuclear Education. Community of Practice
- **RSLS** – Regulatory Supervision of Legacy sites. International Working Forum

Launched in 2016 : WIKI



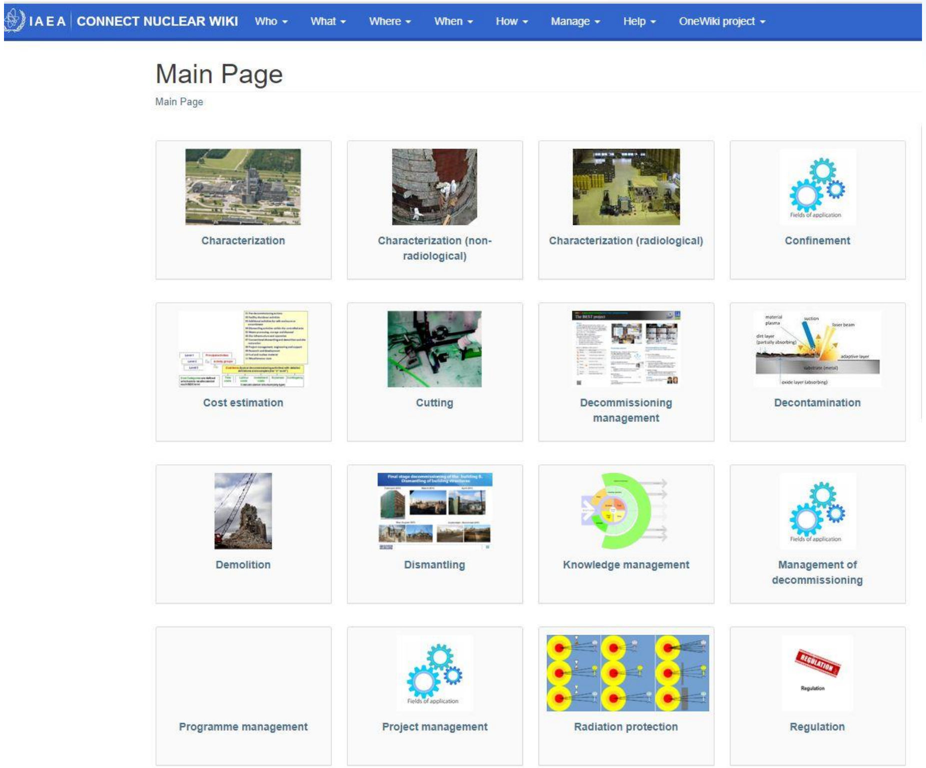
E-learning / Briefing Material For Stakeholders and Professionals



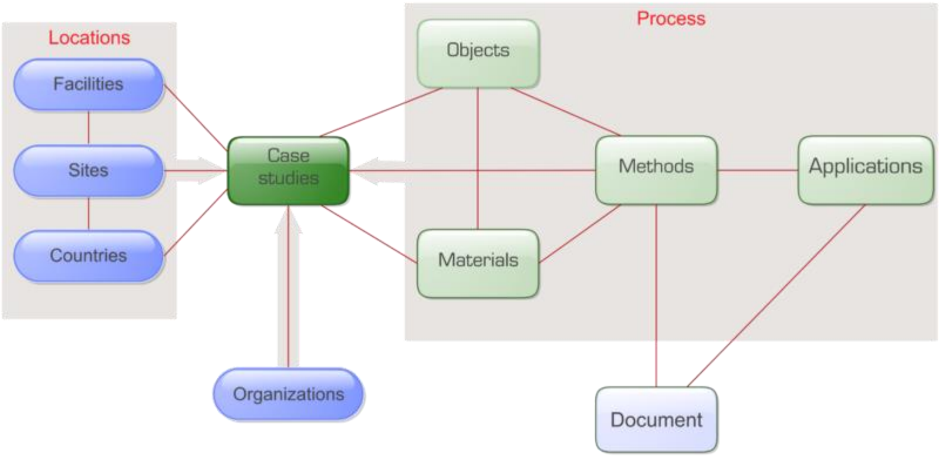
CLP4Net

- Agency wide Learning Management System
- External Users: Regional Education networks and Co-operation partners
- Over 22,000 registered users
- https://www.iaea.org/resources/databases/cyber-learning-platform-for-network-education-and-training-clp4net

IAEA Nuclear Wiki



Semantic MediaWiki platform – relational database functionality



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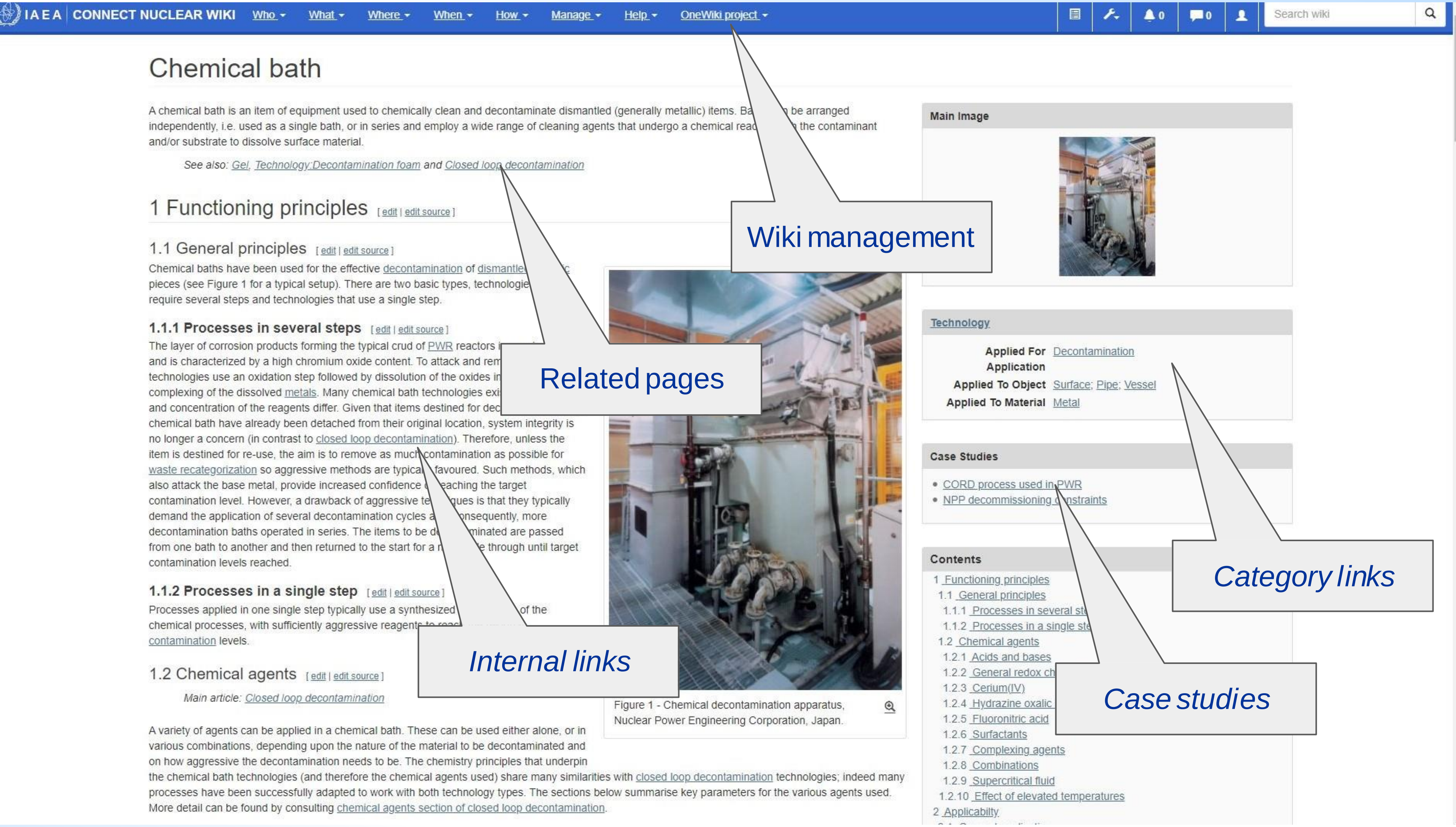
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Chemical bath
A chemical bath is an item of equipment used to chemically clean and decontaminate dismantled (generally metallic) items.
independently, i.e. used as a single bath, or in series and employ a wide range of cleaning agents that undergo a chemical rea
and/or substrate to dissolve surface material.
See also: Gel, Technology:Decontamination foam and Closed loop decontamination
1 Functioning principles [edit | edit source]
1.1 General principles [edit | edit source]
1.1.1 Processes in several steps [edit | edit source]
1.1.2 Processes in a single step [edit | edit source]
1.2 Chemical agents [edit | edit source]
Main article: Closed loop decontamination
Figure 1 - Chemical decontamination apparatus, Nuclear Power Engineering Corporation, Japan.
Main Image
Technology
Applied For Application: Decontamination
Applied To Object: Surface; Pipe; Vessel
Applied To Material: Metal
Case Studies
CORD process used in PWR
NPP decommissioning constraints
Contents
1 Functioning principles
1.1 General principles
1.2 Chemical agents
1.2.1 Acids and bases
1.2.3 Cerium(IV)
1.2.5 Fluoronitric acid
1.2.6 Surfactants
1.2.7 Complexing agents
1.2.8 Combinations
1.2.9 Supercritical fluid
1.2.10 Effect of elevated temperatures
2 Applicabilty
Wiki management
Related pages
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Case studies

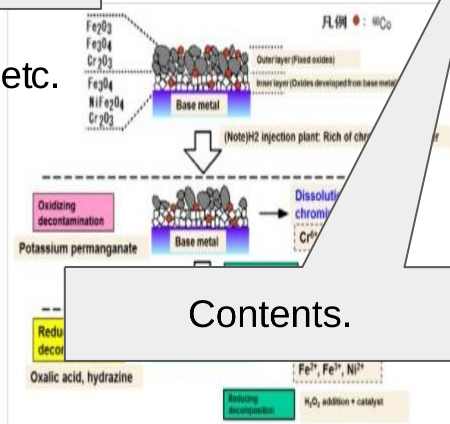
transport for example in tubes.

3. The third step is the effluent trea... te the reaction products from the carrier solution. In some cases the effluent stream can be treated in a way that the agent is recycled, in som... me part of the waste stream.

The selected decontami... ne micrometres. Depending on construction materials used and the ... ts of Fe, Ni and Cr. The Cr content is the determining factor for th...

Technologies, Applications etc.

In PWR conditions, the ... in Fe. In BWR environments the oxide film consists mainly of Fe and Ni and is depleted in Cr. The oxides of these eleme... become soluble by adding chelating agents to decontamination solutions (e.g. complexing organic acids: oxalic, citric acids, EDTA and NTA). An alternative to chelating agents would be to lower pH, but the risk of base metal corrosion limits exist with the use of this method (except if corrosion inhibitors are added). In most cases the most crucial step for successful chemical decontamination is to remove the Cr enriched layer of oxide. This decontamination process requires oxidation of these Cr ions from trivalent to hexavalent state, which form more easily soluble species.



Contents.

Fig. 2 - Example of chemical decontamination attacking various corrosion layers (Closed loop decontamination process in this case)

After removal the protective Cr layer, the next is the decontamination step during which the Fe and Ni rich oxide layers are removed. Figure 2 illustrates the two phases of attack, in this case using Hydrazine oxalic acid potassium permanganate (Closed loop decontamination) (details below) as the example process.

After the oxide removal, the surface needs to be passivated properly in order to prevent the degradation of the base material.

Note that many of the chemical agents described here can be applied to closed loops using foam (as opposed to using bulk liquids). This has the advantage of greatly reducing the liquid volume used while still allowing the agent to wet all of the internal surfaces. This technology is covered in more detail in Technology:Decontamination foam. Liquids containing abrasives can also be used.

1.2.1 Acids and bases [edit | edit source]

(Mineral acid) and bases remove the surface layer of materi... acids and bases, their acidic or basic strength and additional effects such ... and include or exclude the surface of the basis material.

Wanted pages

The strong mineral acids used in decontamination are:

- hydrochloric acid: HCl
- nitric acid: HNO_3
- sulfuric acid: H^2SO^4
- phosphoric acid: H^3PO^4

These acids can be used by themselves as dilute solutions, in formulation mixtures with acid salts and other compounds, and in combination with each other -

Meta

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Created	2020-07-09 21:20:11 CEST
Last Modified	2020-12-03 21:02:57 CET by John day
Categories	Technology
Maturity Level	45622
Content Issues	Missing references

Article quality and metadata

Standard Taxonomy/Ontology for Organization of Knowledge on Decommissioning

01 Pre-decommissioning actions

02 Facility shutdown activities

03 Additional activities for safe enclosure or entombment

04 Dismantling activities within the controlled area

05 Waste processing, storage and disposal

06 Site infrastructure and operation

07 Conventional dismantling and demolition and site restoration

08 Project management, engineering and support

09 Research and development

10 Fuel and nuclear material

11 Miscellaneous costs

International Structure for Decommissioning Costing (ISDC) – List of Principal Activities
[Joint NEA/ IAEA/ EC Initiative - NEA Report 7088 (2012)]

- ❑ Joint Initiative:
  - IAEA
  - OECD Nuclear Energy Agency
  - European Commission
- ❑ Approach:
  - Starting point – ISDC cost structure
  - Focus on knowledge organization - distinguish ‘core’ activities (e.g. dismantling) and ‘cross-cutting’ activities (e.g. project management)
- ❑ Timeframe:
  - Concept paper by end of April (Decision milestone)
  - Project completion during 2021

- ✓ Taxonomy: Hierarchical listing of core activities involved in decommissioning, with agreed definitions of each term in the hierarchy
- ✓ Ontology: Definition of main knowledge ‘categories’ (e.g. concepts, processes or things) and the relationship between each category in the knowledge management system

Useful Links

- Wiki : https://idn-wiki.iaea.org/wiki/Main_Page
- Networks : https://nucleus.iaea.org/sites/connect/Pages/default.aspx

- eLearning: https://nucleus.iaea.org/sites/connect-members/LMS/Pages/Module-Mindmap.aspx
- INIS information repository: https://inis.iaea.org/search/
- Back-End webinars: https://www.iaea.org/about/organizational-structure/department-of-nuclear-energy/division-of-nuclear-fuel-cycle-and-waste-technology/nuclear-back-end-webinar-series

Technical Meetings (1/2)

2021

Decommissioning of Small Facilities (MIRDEC)
EVT2100622 2021-05-24 to 2021-05-28 Virtual

Municipalities with Nuclear Facilities
EVT2003211 2021-06-02 to 2021-06-18 Virtual

Completion of Decommissioning (COMDEC)
EVT110852 2021-06-21 to 2021-06-25 Virtual

Advancing Human Resources Development and Competence Building for Decommissioning EVT2003930 2021-07-05 to 2021-07-09

Achievements & challenges in radioactive waste characterization
EVT1904419 2021-08-02 to 2021-08-06 Vienna, Austria

Addressing Irradiated Graphite in Decommissioning Projects
EVT2003938 2021-08-02 to 2021-08-06

Management of Hazardous Waste Arising from the Operation & Decommissioning of Research Reactors & Other Nuclear Installations EVT2004126 2021-08-09 to 2021-08-13 Vienna, Austria

Technical Meetings (2/2)

2021

Global Status of Decommissioning EVT2003960 2021-07-12 to 2021-08-06

Workshop on Implementation of Characterization for Radioactively Contaminated Land
EVT2003427 2021-10-18 to 2021-10-22, VIC, Vienna, Austria

Biennial Forum of ENVIRONET
EVT2003504 2021-12-06 to 2021-12-10, VIC, Vienna, Austria

Biennial Forum of IDN
EVT2003676 2021-12-13 to 2021-12-17, VIC, Vienna, Austria

Integration of Circular Economy Principles into Nuclear Decommissioning
EVT2003940 Q4 2021

International WS on Lessons Learnt from Implementation of Decommissioning Projects for WWERs EVT2003933 Q4 2021, Trnava, Slovakia

SMR Design for Decommissioning
EVT2003505 Q4, VIC, Vienna, Austria

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60 Years

Atoms for Peace and Development

Thank you!

@IAEANE

www.iaea.org/nuclearenergy

Global Decommissioning Prognosis

IAEA 60 Years
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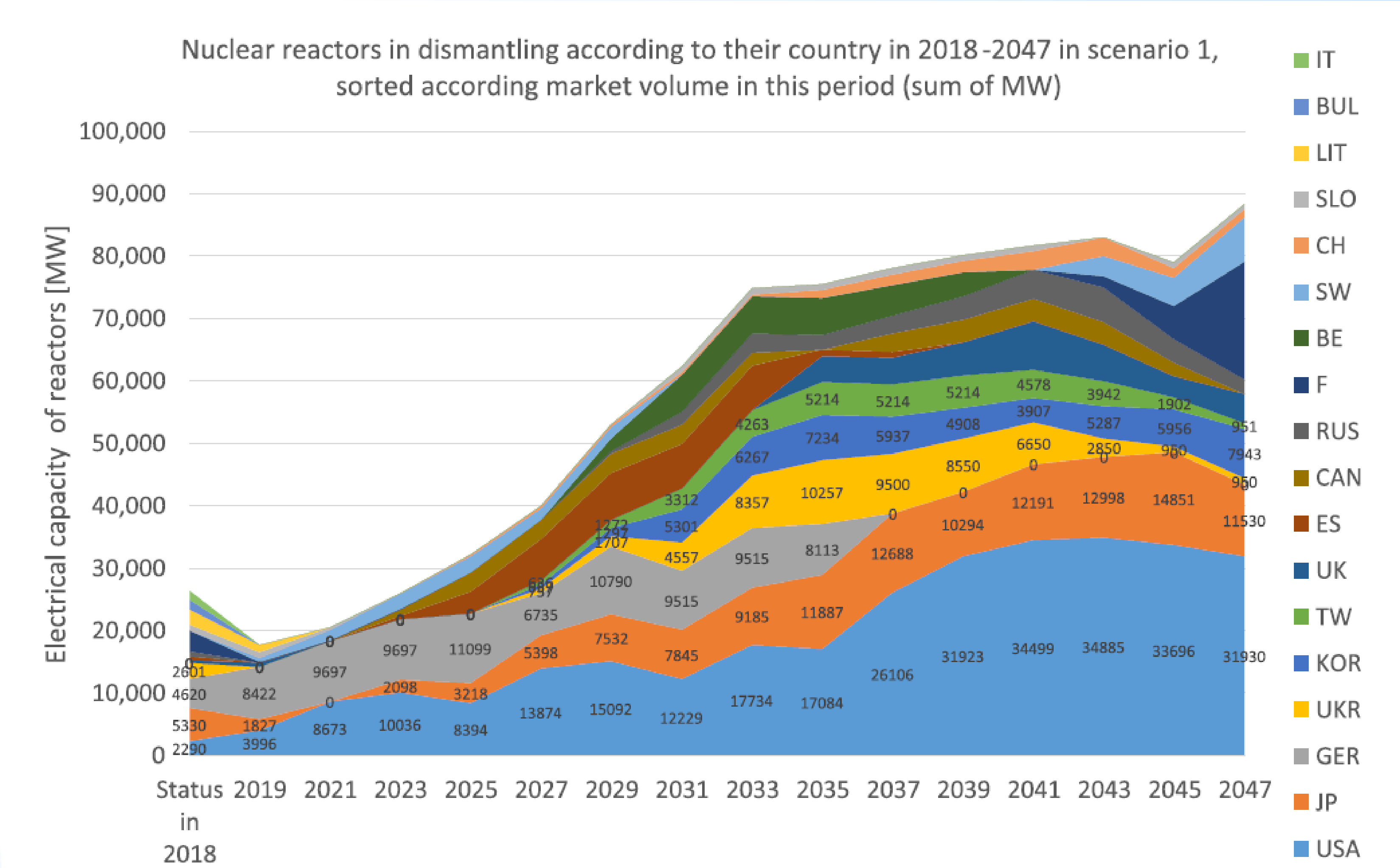

[Source: Volk et al., '*The future of nuclear decommissioning – A worldwide market potential study*', Energy Policy 124 (2019)]