Integrating Sustainability and Circularity Concepts in the Determination of End-States in Decommissioning and Environmental Remediation

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International Conference on

The Safety of Radioactive Waste Management, Decommissioning, Environmental Protection and Remediation

Ensuring Safety and Enabling Sustainability

6–10 November 2023
Vienna, Austria

Some initial words on the IAEA Conference on Safety and Sustainability

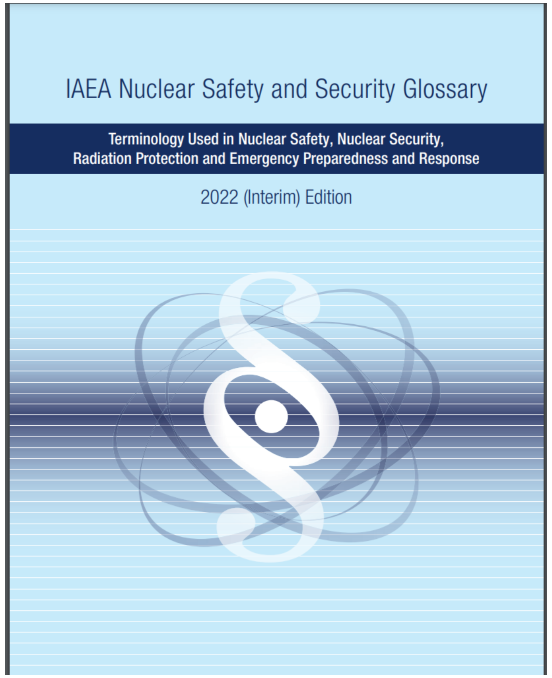
- Aimed at discussing safety and sustainability during backend management of nuclear and radiation technologies, applications, activities, facilities…
  - That is often when questions around sustainability become more visible for stakeholders;
  - Activities to be performed having operational safety mindset…

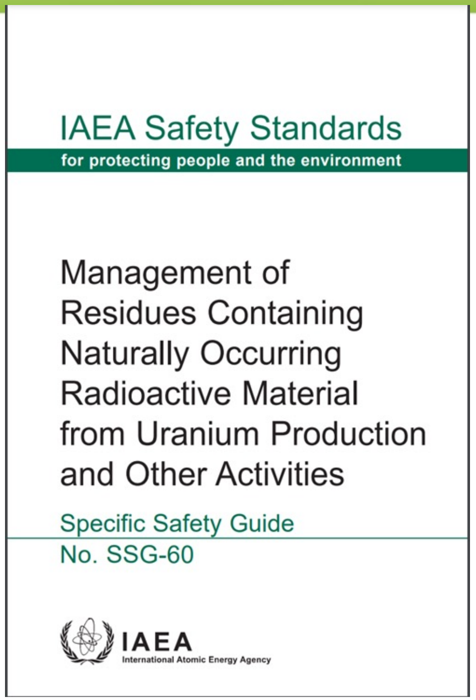
Safety as a contributor to sustainability

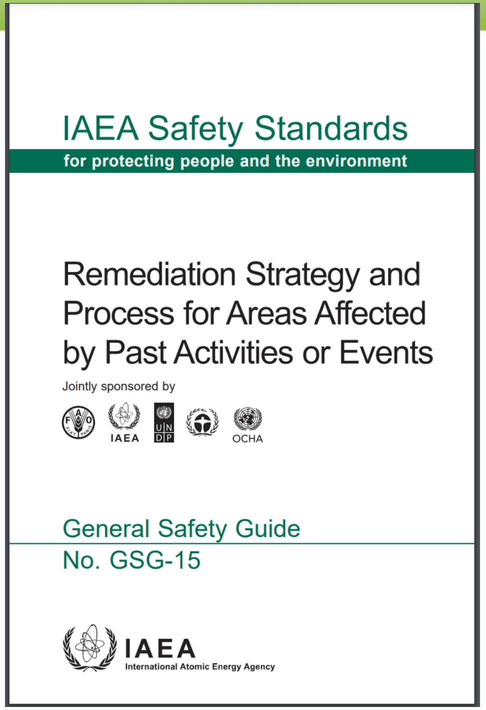
- Sustainability was seen to me somehow embodied in Safety Standards and Radiation Protection System
- However, not in explicit way and by no means indicating that sustainability has been systematically considered in decision making vis-à-vis RWM, D&ER
- Safety is integral part of Sustainability and therefore is linked with UN-SDGs but optimization of protection needs to consider safety in the context of sustainability

Some Relevant Safety Standards

Ensuring Safety and Enabling Sustainability







Sustainability is referred to in the context of nuclear security: 'Security' in a general sense encompasses related issues of global security — the sustainability of human life — in terms of energy security, environmental security, food security and water security, as well as nuclear security — to all of which the use of nuclear energy is related.

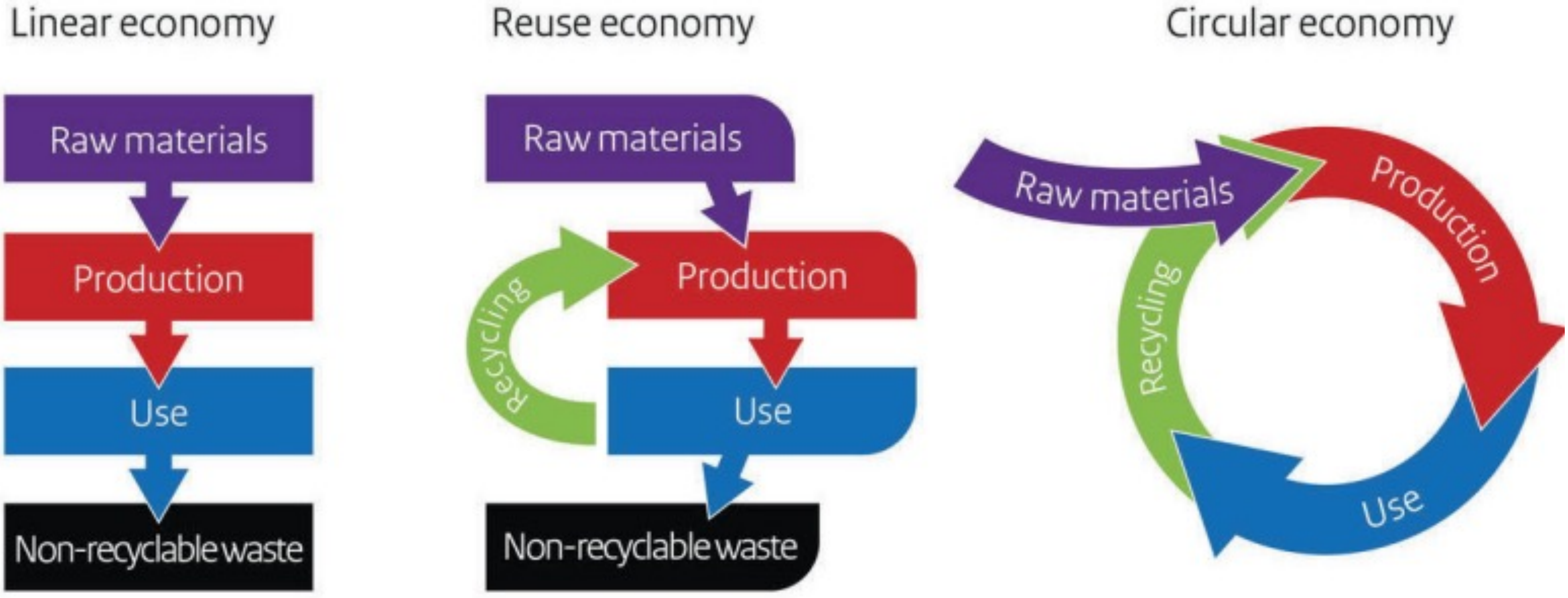
The Safety Guide is mute about sustainability and circularity though it touches on important issues such as Policy and Strategy and Inventory

When considering remedial options, it might not always be necessary to undertake significant remediation if the desired remediation objectives can be largely achieved through a **sustainable approach** involving a more moderate degree of remediation…

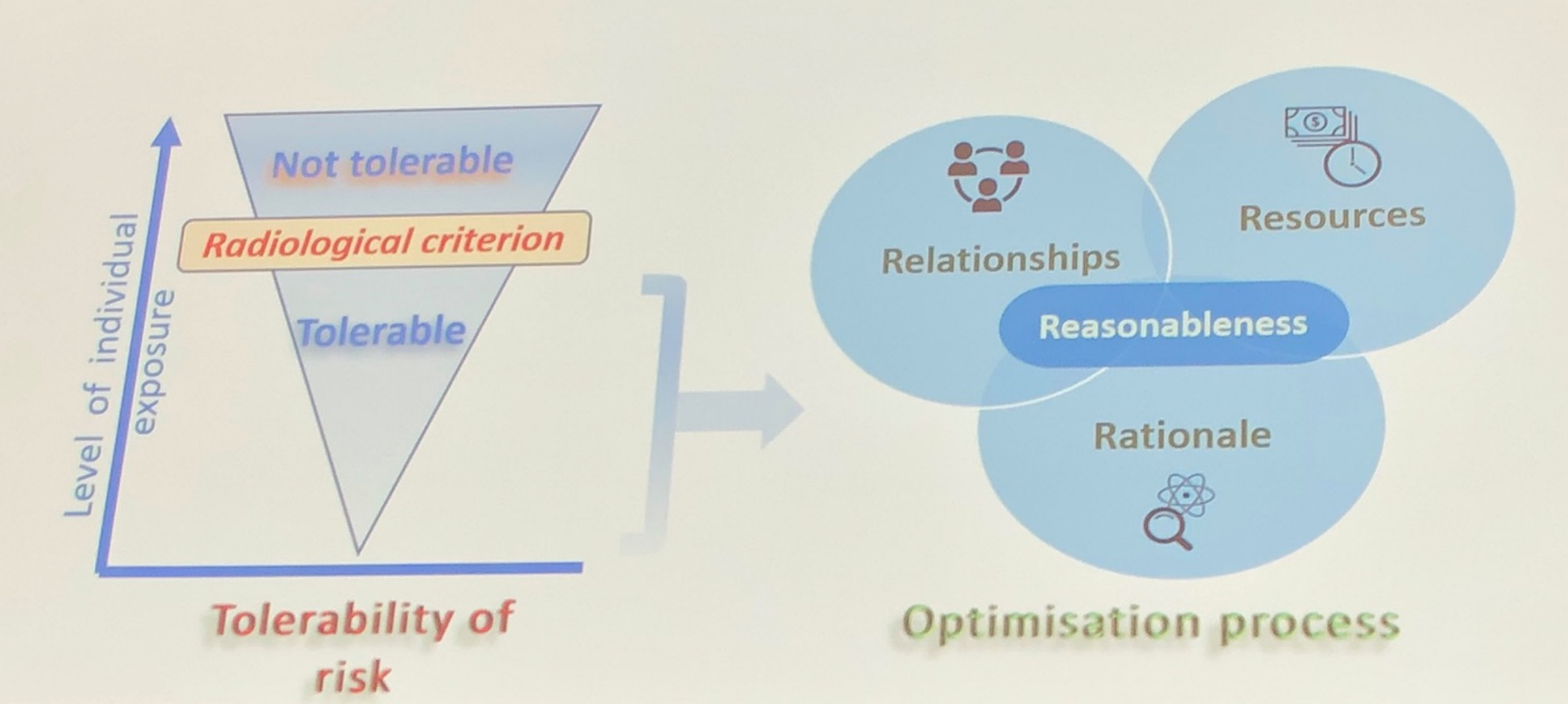
From Linear to Circular Economy

- Great acceptance of Circular Economy Principles by the Conference
- Mindset still focused on Disposal though
- Recognition that current regulatory system might not be in alignment with circular economy
- Clearance is a key aspect in this regard, but a lot of discussion is still needed.

Linear x Circular Economy



Optimization in the context of ICRP



Going beyond nuclear: 10 key pathways forward

- Recommit to the basics
- Provide a living wage
- Promote gender equality
- Innovate responsibly
- Accelerate climate action
- Improve water resilience
- Protect and restore nature
- Invest in circularity
- Commit to sustainable corporate finance
- Strengthen sustainability leadership

Steve Kenzie, UN Compact

SDG Ambition Benchmarks

- Gender balance across all levels of management (SDG 1)
- Net-positive water impact in water-stressed basins (SDG 5)
- 100% of employees across organization earn a living wage (SDG 6)
- Zero waste to landfill and incineration (SDG 12)
- Zero discharge of hazardous pollutants and chemicals (SDG 12)
- 100% sustainable material inputs that are renewable, recyclable or reusable (SDG 12)
- Science-based emissions reduction in line with a 1.5 C pathway (SDG 13)
- 100% resource recovery, with all materials and products recovered and recycled or reused at end of use (SDG 14)
- Land degradation neutrality including zero deforestation (SDG 15)
- Zero incidences of bribery (SDG 16)

Way forward

- Consider safety in the context of sustainability
- Remember – radiological hazards are not the only hazards
- Consider how to implement sustainability assessments
- Safety community is not enough – work with other experts
- Use sustainability as a common ambition to strengthen relationships
- Deliver education and capacity building on sustainability
- Language – develop clear definitions of key terms
- Reconsider existing safety principles and concetps

Way forward

Promote existing instruments and tools that ensure safety and enable sustainability

MSs to ask IAEA to develop a vision on –and make explicit commitment to sustainability

Develop a vision/position statement with ICRP

Explore solutions that have potential to be more sustainable

Communicate to all that the nuclear sector take sustainability and the SDGs as its starting point

Develop and share case studies (practical implementation of SDGs)

Challenger everyone to leave comfort zone

Disseminate conference outcomes and “do it again”!!!

How is remediation defined in the context of IAEA Standards?

- Any measures that may be carried out to reduce the radiation exposure due to existing contamination of land
- areas through actions applied to the contamination itself (the source) or to the exposure pathways to humans.
  - Complete removal of the contamination is not implied.
  - The use of the terms clean-up, rehabilitation and restoration as synonyms for remediation is discouraged.
- Remediation can entail activities that are similar to decommissioning;
- Both remediation and decommissioning activities are typically performed under an authorization.
- Abandoned and presently unauthorized industrial sites, such as former uranium mines and mills and former radium processing facilities, may have buildings and structures that are taken down by actions consistent with the decommissioning process (e.g. decontamination and dismantling); however, such activities are considered to be a part of site remediation.
- The term clean-up is used in the context of decommissioning.

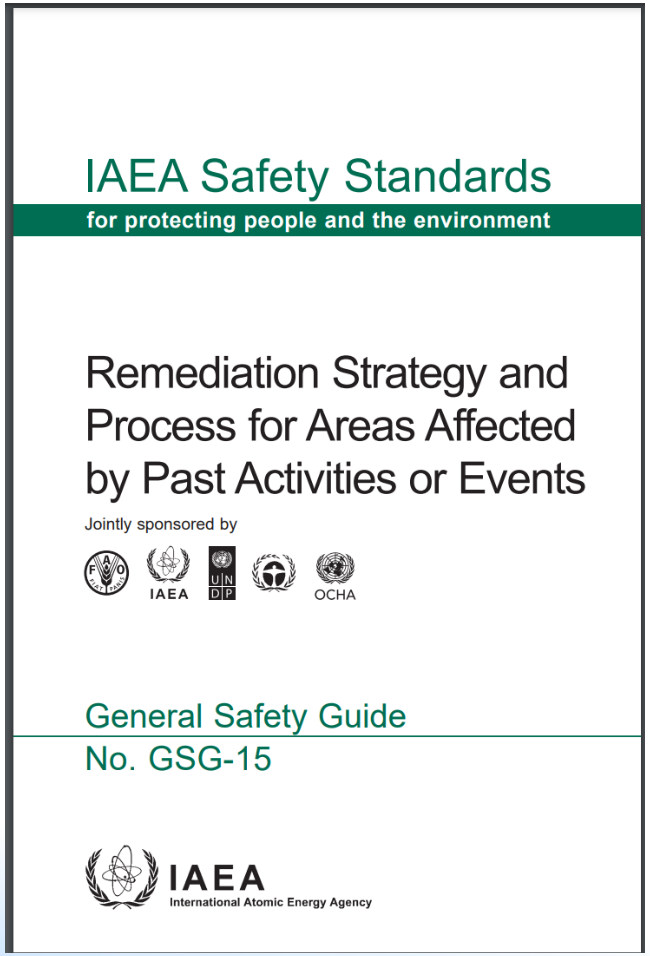
What is typically covered by remediation?

- Past activities that were not stringently regulated, where the termination of the activity and the handling of the remaining residues most probably were not adequately considered when the activity was initiated, e.g. activities involving mining and milling of ores containing natural radioactive substances;
- Long term, prolonged presence of radioactive residues from accidents and other unforeseen events that were not adequately managed;
- Radioactive residues from military activities, such as nuclear weapon production and testing

Some definitions – End-State

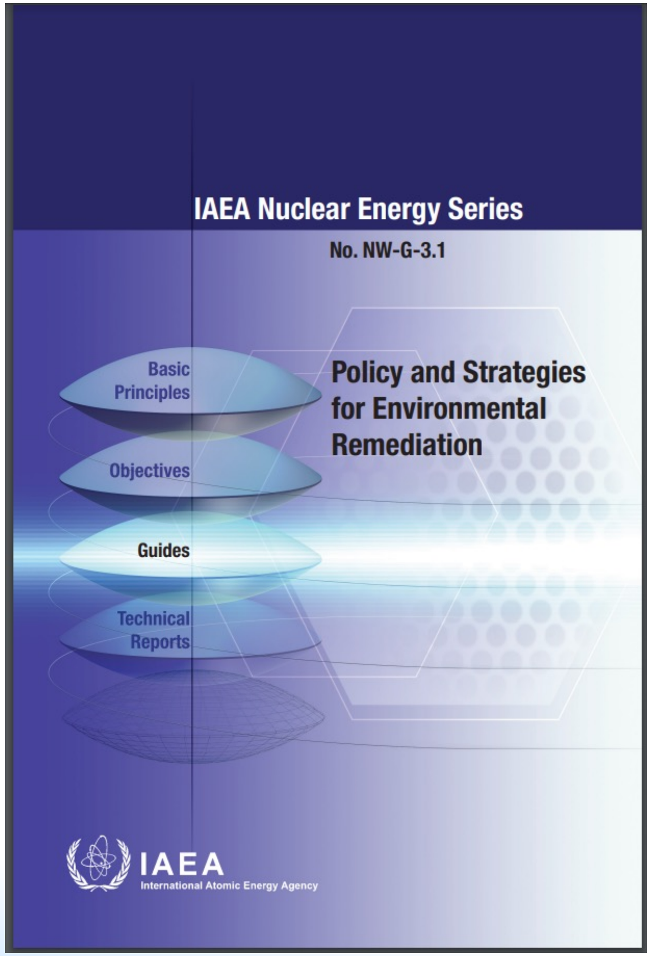
- Used in relation to Radioactive Waste Management is the state of radioactive waste in the final stage of radioactive waste management, in which the waste is passively safe and does not depend on institutional control
- Used in relation to decommissioning activities as the final state of decommissioning of a facility;
- Used in relation to remediation as the final status of a site at the end of activities for decommissioning and/or remediation, including approval of the radiological and physical conditions of the site and remaining structures.

Sustainability and Remediation



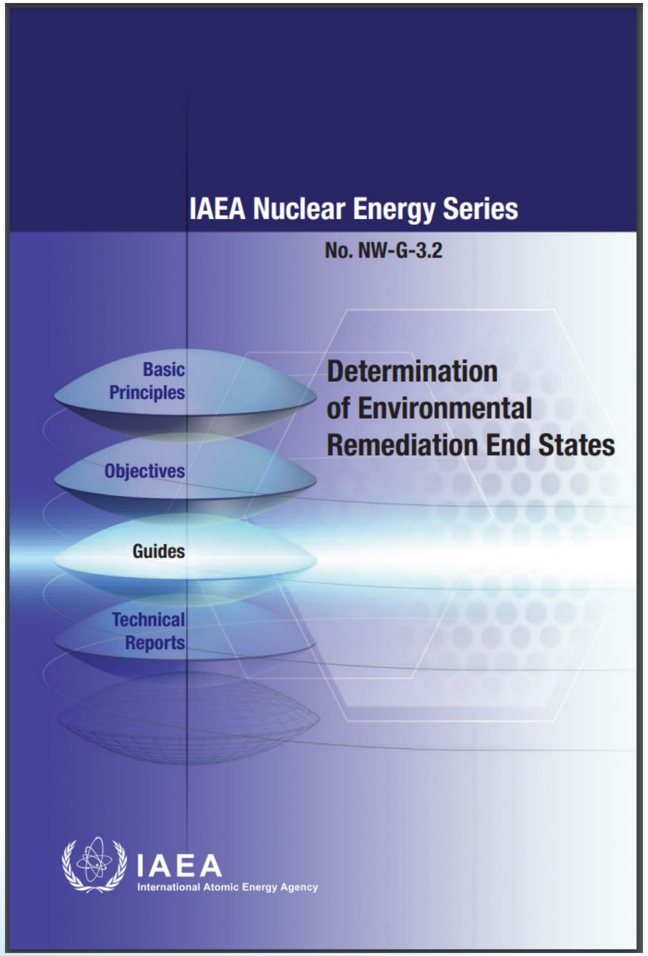
- The basis of the national framework for remediation is a national policy and corresponding strategy, and the legal and regulatory framework necessary to implement the policy and strategy
- Establishment of a preference for technologies that take account of sustainability principles, for example in evaluating active and passive remedial options to ensure that they utilize the best available technologies and consider the waste management hierarchy
- When considering remedial options, it might not always be necessary to undertake significant remediation if the desired remediation objectives can be largely achieved through a sustainable approach involving a more moderate degree of remediation.
- Selection and achievement of a remediation end state should consider sustainable long-term protection, while balancing any short-term impacts

A Starting Point

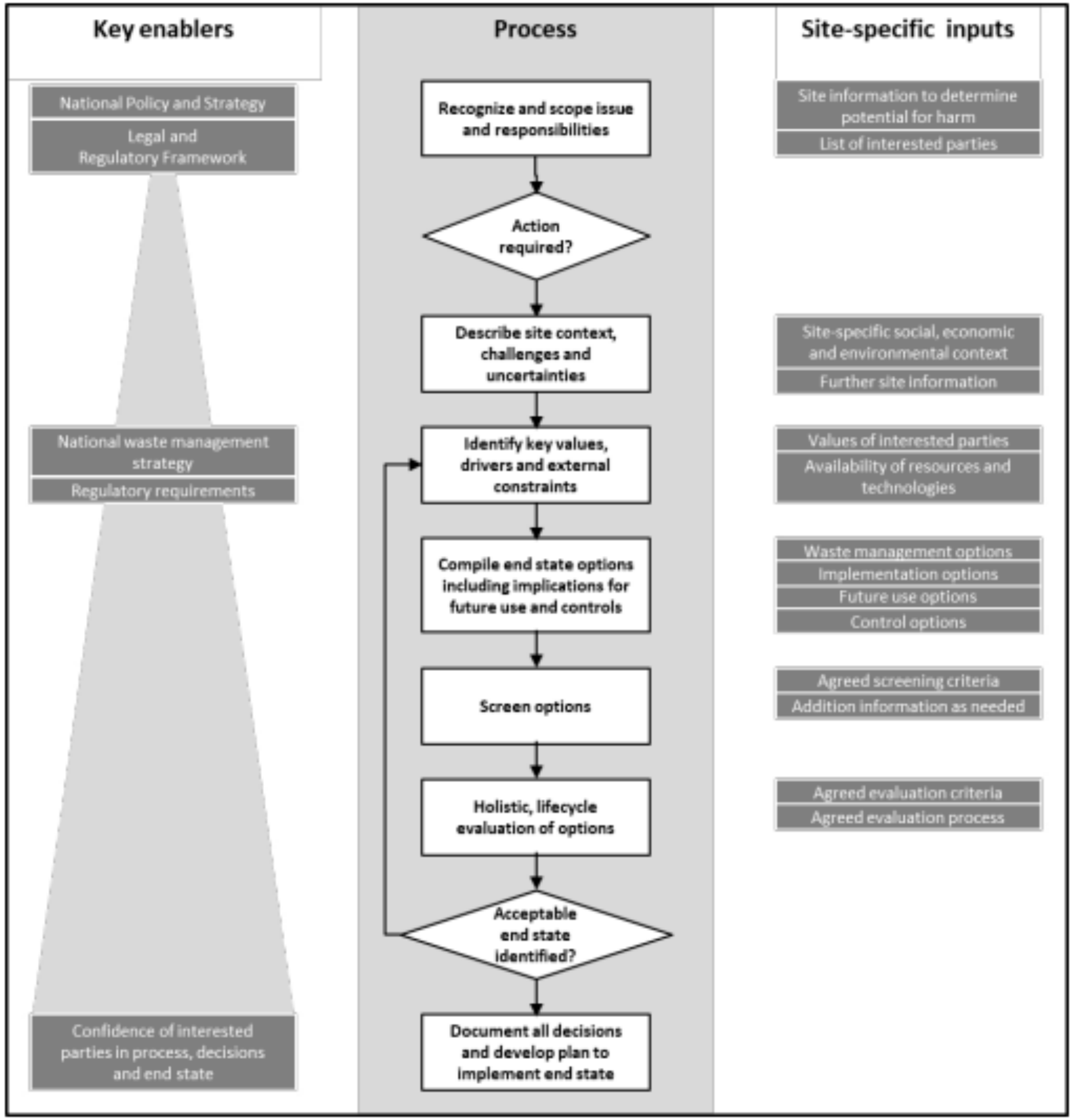


- The technical solutions proposed for the remediation of sites in the country need to be politically, technically and economically feasible.
- When selecting a set of technological procedures, an appropriate end point must be identified, usually a suitable end state
- The principles relevant for remediation are as follows:
  - Justification for undertaking remediation;
  - Optimization of the remediation;
  - Appropriate protection of future generations and the environment (this is a call for sustainability)
  - Efficiency in the use of resources;
  - Open and transparent interactions with stakeholders.

The DERES Project



- When defining the end state, there are two levels at which the principles of sustainability are considered.
  - At a strategic level, the end state could be influenced by local or regional sustainability factors, such as land use planning, economic and/or social regeneration, and waste disposal management capabilities and capacities.
  - At a tactical level, the principles of sustainability will also influence the remedial techniques selected to implement the end state.



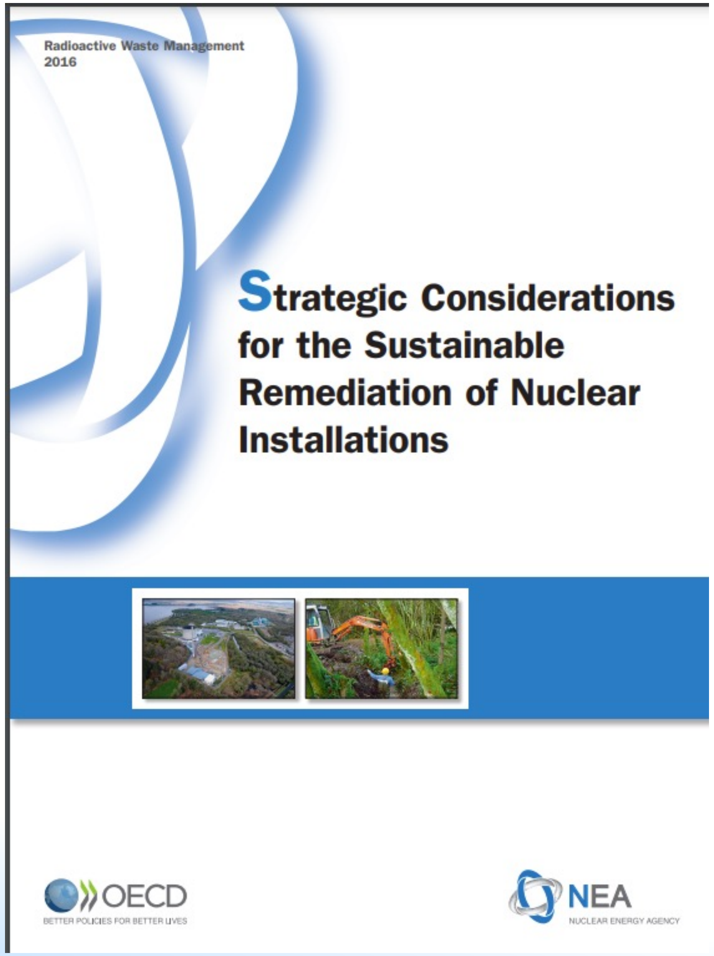
End-State Determination Process

- Key Enablers
  - National Policy and Strategy
  - Legal and Regulatory Framework
  - National Waste Management Strategy
  - Confidence of Interested Parties in process decisions and end-state

The interim state

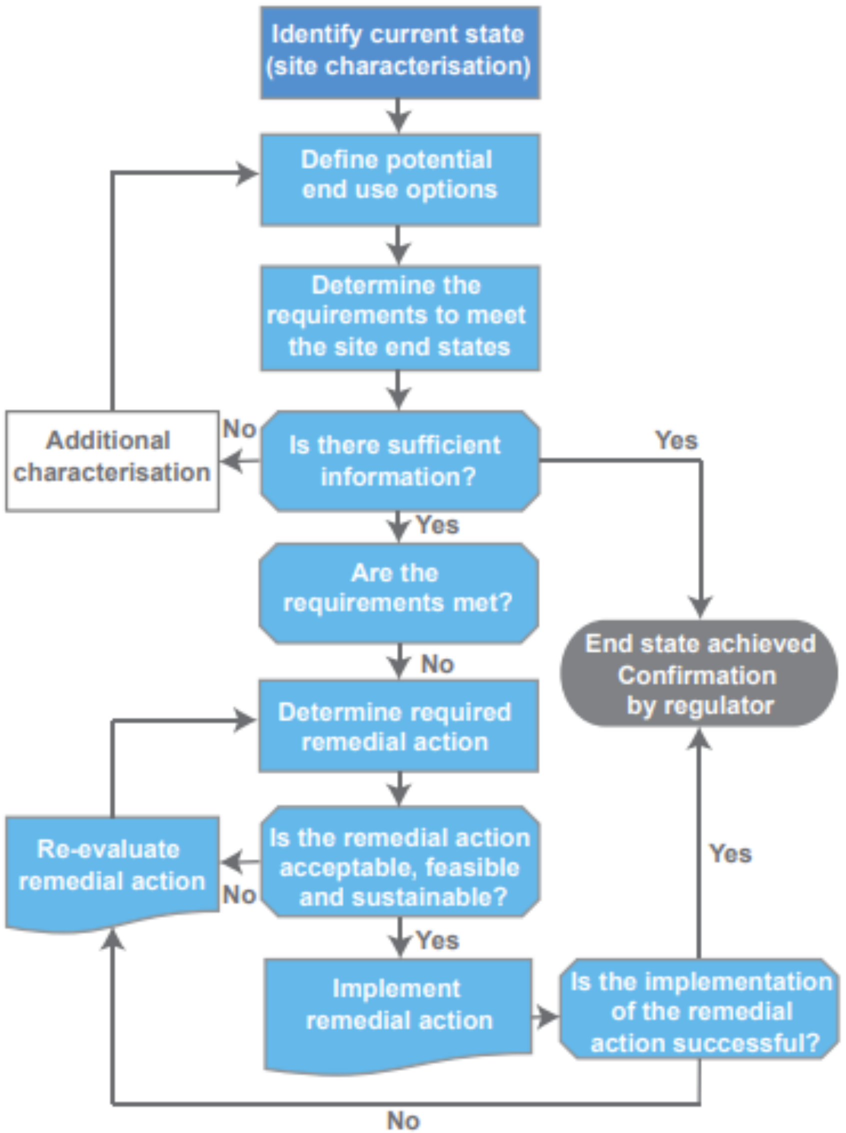
- Interim states may be necessary as steps towards reaching a final end state.
- It is used to denote that end points of progressive remediation
- Steps over time may be used in managing the overall process of reaching a 'final end state' whereby interim objectives and metrics are set to guide a stepwise series of activities at a site where a single step to the 'final end state' is difficult to obtain or manage.

Determining end states (NEA-OECD Approach)



- Adaptive remediation determination process (includes phased approach, iterative approach)
- Graded approach
- Zoning, operable or management units on physically complex sites
- Use of long-term stewardship
- Waste management constraints
- Stakeholder opinions and expectations
- Decommissioning constraints
- Environmental constraints
- Funding constraints

Generic steps for development of site end states approach



- Identify current state
- Identify potential end use options
- Implementation and verification of remediation

Completion of Decommissioning: COMDEC Project – Key issues (1/2)

IAEA

- Components of end state definition – radiological criteria, physical status, non-radiological criteria
- Factors to be considered when defining an end state, uncertainties
- End state options
- Decision making process – multi-attribute analysis vs. preferred end state
- Evolution of an end state definition
- Interim end states
- Characterization prior to clean-up
- Extent of clean-up activities

https://www-ns.iaea.org/committees/files/WASSC/1949/W5.3-Ljubenov-COMDECproject.pdf

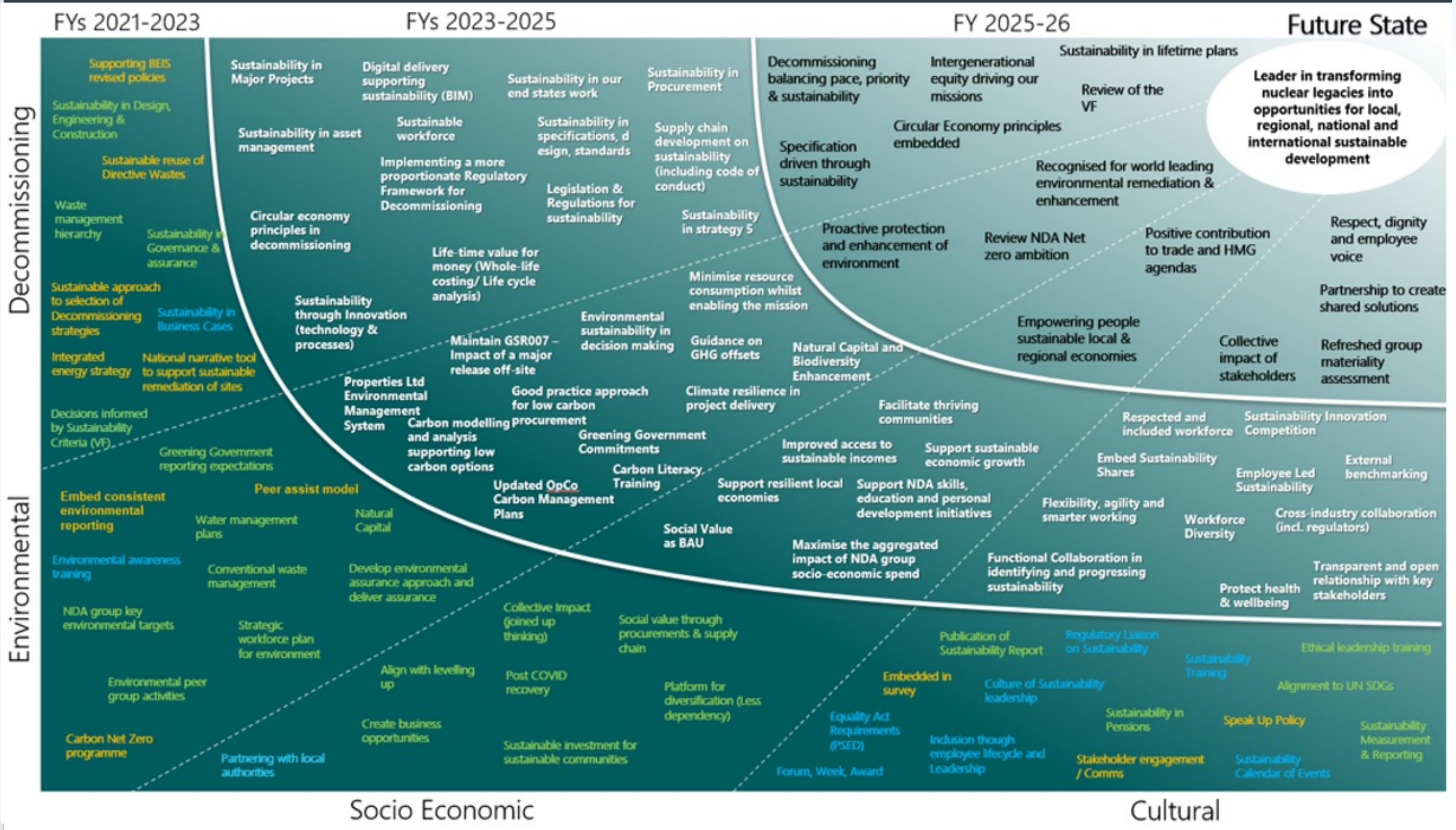
Completion of Decommissioning: COMDEC Project – Key issues (2/2)

IAEA

- Final survey
- Demonstration of compliance with end state criteria
- End state in the context of a multi-facility site
- Partial site release
- Regulatory process and decisions
- Definition of institutional controls in case of release with restrictions (type, duration, responsibilities, removal of controls)
- Introducing a new practice on the site
- Graded approach, justification, optimization
- Involvement of interested parties

https://www-ns.iaea.org/committees/files/WASSC/1949/W5.3-Ljubenov-COMDECproject.pdf

Application of Sustainability



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Timing and Pace of Dismantling

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- For facilities constructed >1990 this is planned as part of design
- For older facilities (1950-1975) little or no real consideration of dismantling strategy
- Each facility presents different decommissioning challenges in terms of their age, location and condition
- In terms of decommissioning (dismantling) definition of timing and pace:
  - When should the phases of decommissioning start?
  - How fast the work should be undertaken?
- Where the risk presented is clearly intolerable determination of preferred timing and pace of dismantling is straightforward.
- For most facilities selecting a preferred strategy is more complex and based upon multiple and competing factors
- Consideration of the benefits realised is also complex - for example, the value associated with land reuse for new build projects or the generation of skills.

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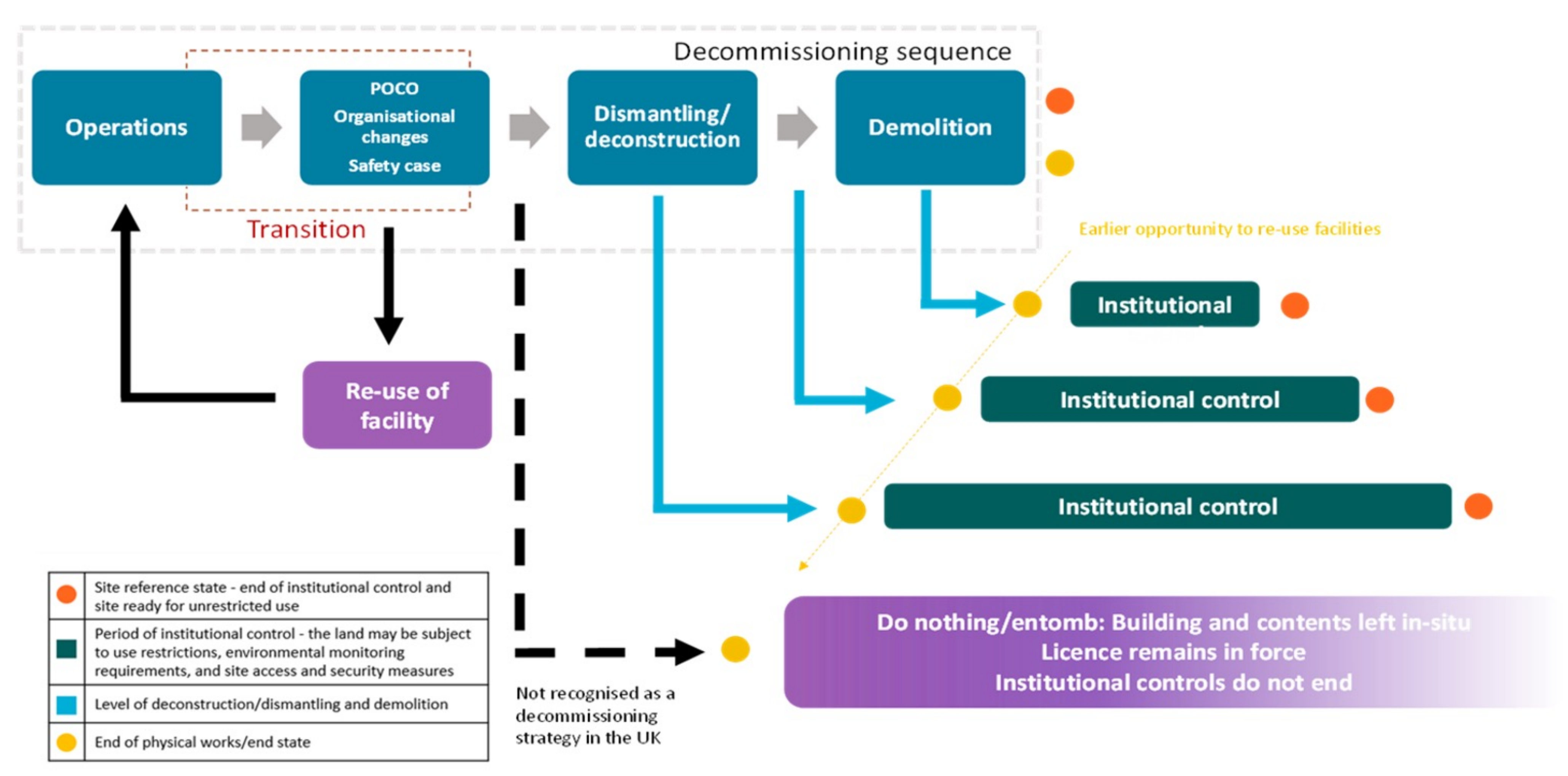
Relationship between decommissioning and end state



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Conclusions – What is Safe x What is Sustainable

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- Land remediation is framed by what is safe. An environmental safety case must be made.
- Optimisation and the consideration of controls is more than radiological protection:
  - Environmental cost
  - Worker and public safety from operations
  - Social value
  - Reuse of materials and assets (circular economy)
  - Intergenerational equity
- Good record keeping will be essential
- Proactive change control should be established early to proportionately manage uncertainty

Disclaimer: Some of the messages shared in this presentation does not necessary represent the position of the IAEA

Thank you!