EU-H2020- SHARE-Decommissioning
On-line Workshop, December 1-3, 2020

Group E
Session 8: Management of Waste

Session 8: starts at 13:50 CET

This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement nº 847626.

Group E
Session 8 : Management of Waste

Agenda

SHARE
A roadmap for research in Decommissioning

GROUP E			
⑧ Management of material and radioactive waste from Decommissioning / Legacy Waste			
Dec. 1st Link teams 1st Plenary	9:00 CET - 13:40: Plenary session (see general program) and switch to breakout sessions		
Dec. 1st Link teams Dec 1st Group E	International initiatives		
	13:50	8.A	IAEA IPN Achievements, on-going and future activities, by Rebecca Robbins, IAEA *(10min)*
	14:00	8.B	EU-H2020-ROUTE , survey on Waste with no route, by Elisa Léoni *(10min)*
	14:10	8.C	presentation of EU-H2020- PREDIS, by Erika Holt *(10 min)*
	14:20	8D	IAEA Workshop on circular economy, by Vladimir Michal *(10min)*
	14:30	8E	Presentation of NEA-CPD Task Group on Recycling and Reuse of Materials (TGRRM) by Bart Ooms, Belgoprocess N.V. *(10min)*
	14:40	8F	Methodology to Manage Material and Waste from Nuclear Decommissioning- WNA, by Michel Pieraccini, EDF *(10min)*
	14:50	8G	Presentation of first achievements from SHARE in this area + introduction to post it session, by Antony Bandford, NNL
	15:10- 16:50: Post it session by sub-thematic area		
	Link MURAL 70	70	Management routes for materials including radioactive waste streams
	Link MURAL 76	76	Treatment processes for non-aqueous liquids

Group E
Session 8 : Management of Waste

Agenda

Dec. 2nd	**9:00 – 12:00: Post it session by sub-thematic area**		
Link teams Dec 2d Group E	Link MURAL 84	84	Material clearance (methodology and procedures + instrumentation and logistics)
	Link MURAL 74	74	Treatment processes for concrete
	Link MURAL 75	75	Treatment processes for aqueous liquids
	Link MURAL 77	77	Treatment processes for organic materials
	12:00- 13-00 Lunch Break		
	13:00- 16-50: Post it session by sub- thematic area		
	Link MURAL 86	86	Management of hazardous and toxic materials (asbestos, lead in paint, etc.)
	Link MURAL 81	81	Radioactive waste conditioning
	Link MURAL 82	82	Radioactive waste packaging and logistics
	Link MURAL 80	80	Treatment processes for ILW
	Link MURAL 78	78	Treatment processes for VLLW

Group E
Session 8 : Management of Waste

Agenda

Dec 3d Link teams Dec 3d Group E	**9:00- 12-00: Post it session by sub- thematic area**		
	Link MURAL 87	87	Conventional and cleared materials recycling (circular economy)
	Link MURAL 73	73	Treatment processes for metals
	Link MURAL 85	85	Material clearance (instrumentation and logistics)
	Link MURAL 79	79	Treatment processes for LLW
	12:00- 13-00: Lunch Break		
Dec. 3d Link teams 3d Plenary	**13:00 CET - 16:00: Plenary session (see general program)**		

IAEA IPN Achievements - Current & Future Activities

Ms. Rebecca Robbins
Predisposal Team Leader
Waste Technology Section
Division of Nuclear Fuel Cycle & Waste

EU-H2020-SHARE-Decommissioning On-line Workshop, December 1-3, 2020
Management of material and radioactive waste from Decommissioning / Legacy Waste

Decommissioning & RWM Interface

Both Decommissioning and RWM benefit from thorough consideration in the **Planning & Decision-Making** phase

Facility

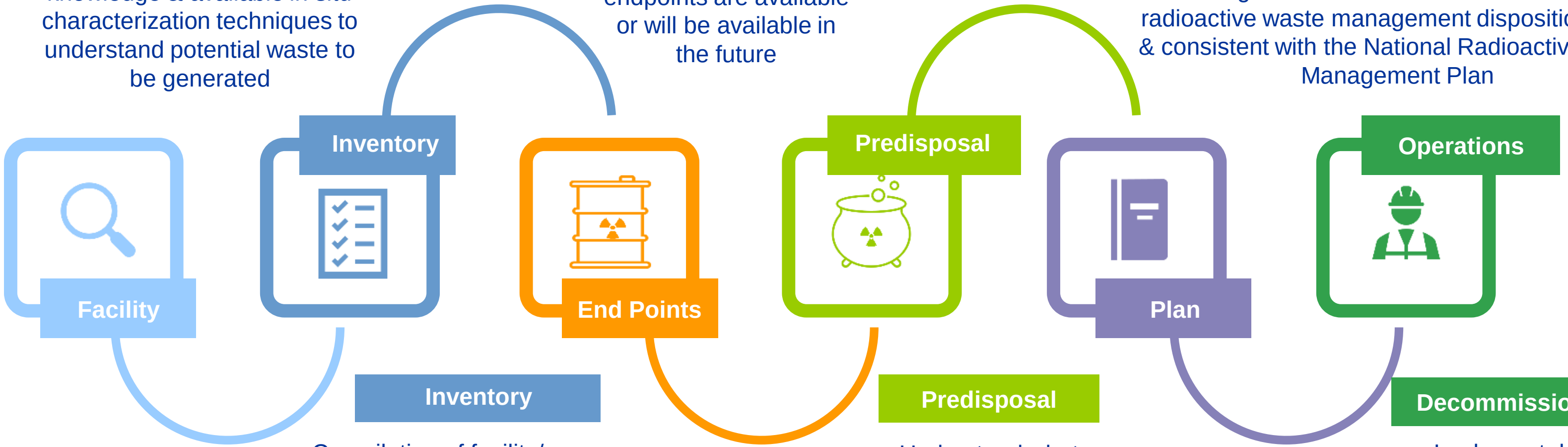
Use facility/process knowledge & available *in situ* characterization techniques to understand potential waste to be generated

End Points

Understand what endpoints are available or will be available in the future

Plan Development

Develop Decommissioning/Legacy Waste Management Plan based on the identified radioactive waste management disposition paths & consistent with the National Radioactive Waste Management Plan



Inventory

Compilation of facility/process waste characterization & categorization information to identify & quantify waste **streams** that will be generated

Predisposal

Understand what predisposal processes are needed and/or available to meet Endpoint WAC

Decommissioning Operations

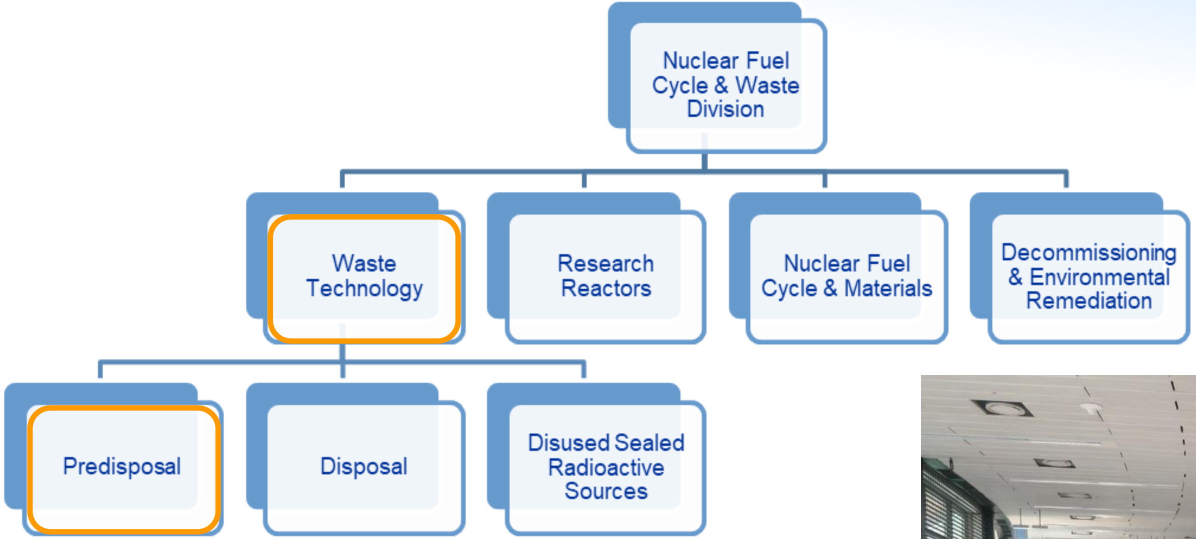
Implement decommissioning retrieval & dismantlement operations according to the Decommissioning Plan

Decommissioning & RWM Interface

Operations Phase

IAEA Waste Technology Section

The IAEA Waste Technology Section



- Promote information exchange
- Cooperative research
- Capacity building in Member States

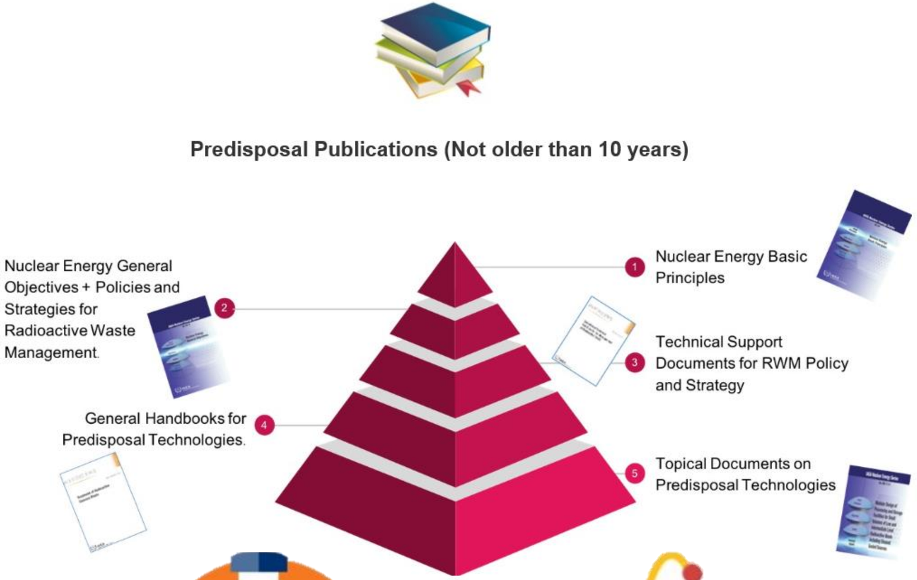
WATEC (Advisory Committee)

Waste Technology Section

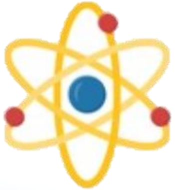
Mr Ian Gordan, WTS Section Head

Professional Networks

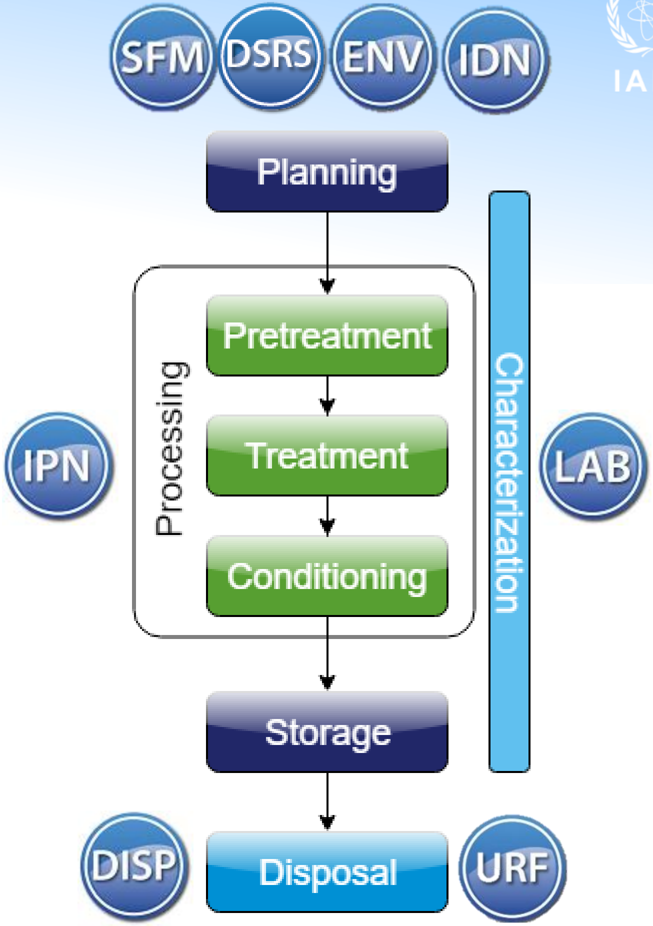
https://nucleus.iaea.org/Pages/connect.aspx



Toolkit for Predisposal



Existing Technologies and Practices



New DSRSnet network

International
Predisposal
Network

For more information visit:

http://connect.iaea.org

Or contact:
IPN.Contact-Point@iaea.org

The IAEA International Network on Predisposal - IPN

IAEA

Established 2016
>120 Members

RADIOACTIVE WASTE

- Pre-Treatment
- Treatment
- Conditioning
- Storage

Characterization

Photo credits: CEA, COVRA, NECSA, NNL,

IAEA International Atomic Energy Agency

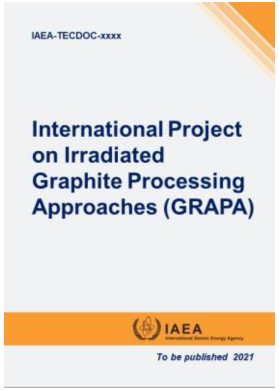
IAEA International Atomic Energy Agency

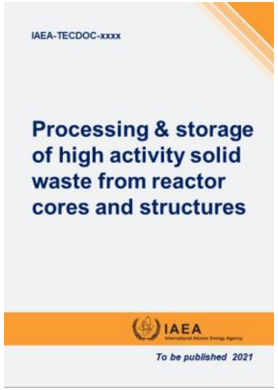
https://nucleus.iaea.org/sites/connect/IPNpublic/Pages/default.aspx

IPN Recent Activities

- 2019 Technical Meeting on Management of Radioactive Waste From Research Reactors
- NuclearWiki predisposal pages
- Joint ICTP IAEA School on Radioactive Waste Cementation
- Finalization of the Predisposal Handbook series
- GRAPA Project – graphite processing approaches

To be published in 2021





International Network of Laboratories for Nuclear Waste Characterization LABONET

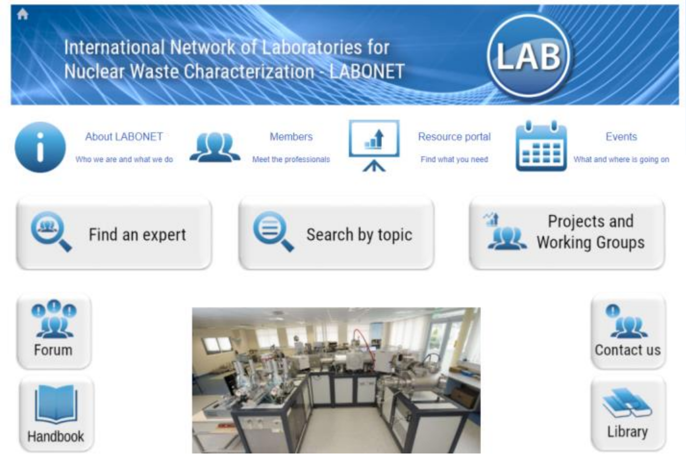
- Peer network of characterization professionals
- Forum to share knowledge and exchange information
- >150 Members world-wide

Established 2011

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

LABONET Recent Activities

- 2019 Technical Meeting on Characterisation Methods and Technologies to meet Waste Acceptance Criteria
- NuclearWiki characterization pages
- Development of catalogue of characterization methodologies
- Finalization of the Characterization Handbook



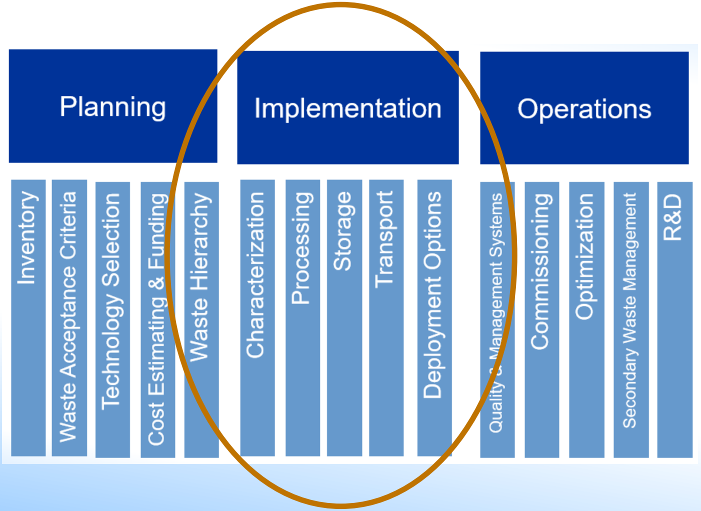
IAEA Predisposal

Current & Future programme

Pre-disposal Handbook Series

Part I: Technical Overview – provides a concise summary of technical information.

Part II: Annexes* – provide detailed information on technical options, design basis, operational requirements, best practices, lessons learned, emerging technologies



1. Characterization of radioactive waste, waste forms & waste packages

2. Treatment of low & intermediate level liquid radioactive waste

3. Treatment of low & intermediate level solid radioactive waste

4. Conditioning of low & intermediate level liquid, solidified and solid radioactive waste

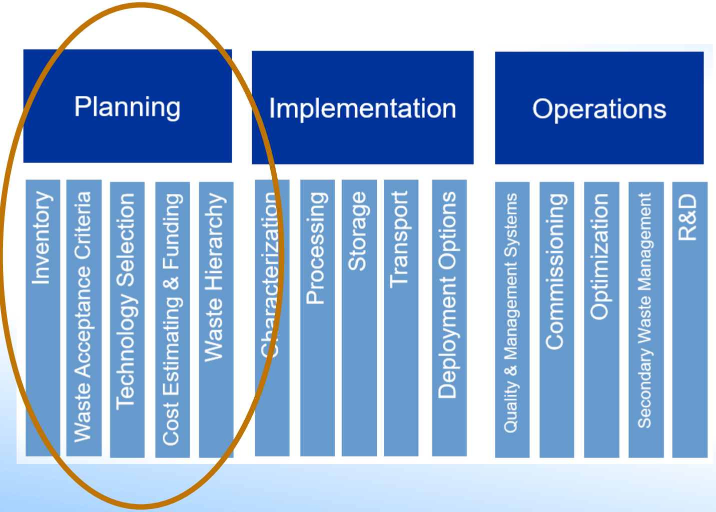
5. Processing of high level radioactive waste

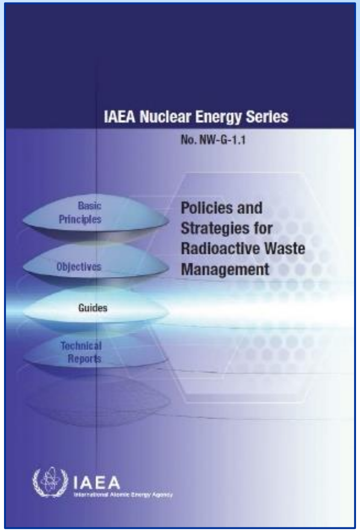
6. Storage of radioactive waste & conditioned waste packages

Drafts will be made available on the IPN network site as they become available

RWM Fundamentals

- Establishment of Waste Acceptance Criteria for L&IL – final draft
- Waste management approaches for small inventory countries

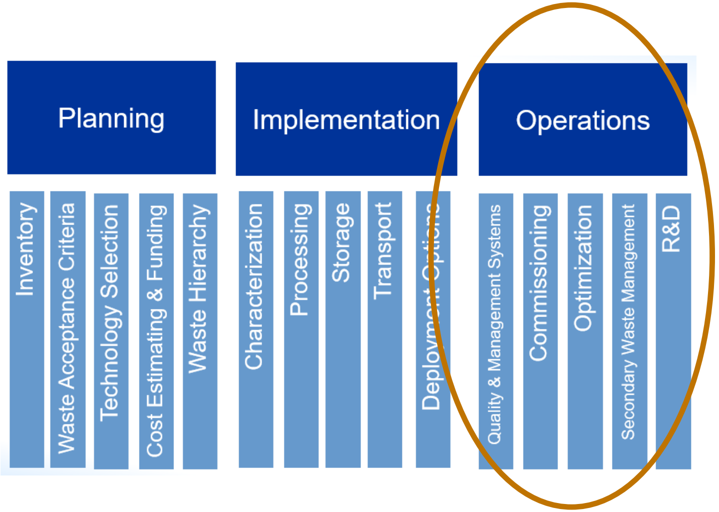




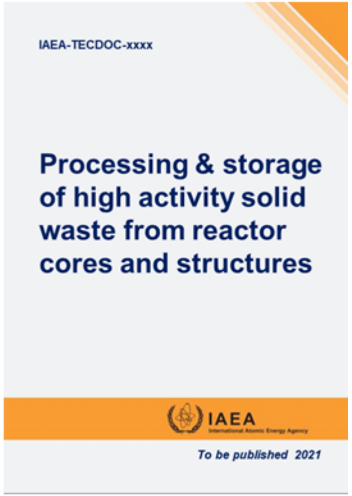
Future **new** publications:

- Establishment of a waste inventory
- Implementation of the waste hierarchy
- Revision of policy & strategies for radioactive waste management

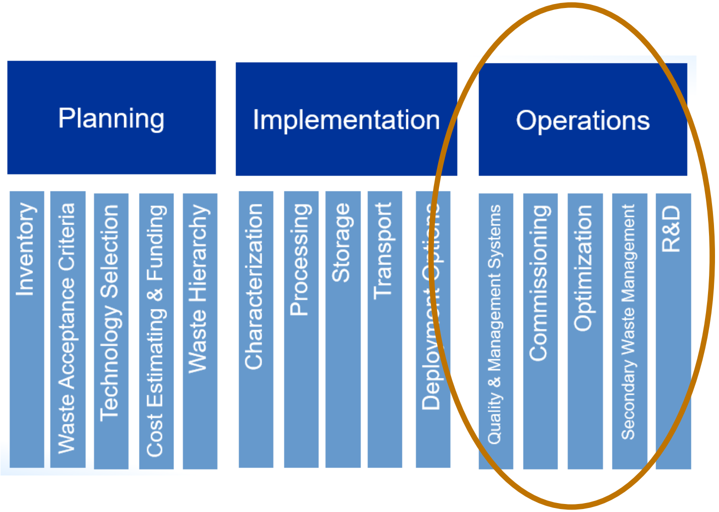
Thematic Publications



All draft documents are close to publication & drafts will be made available on the IPN network site



Thematic Publications



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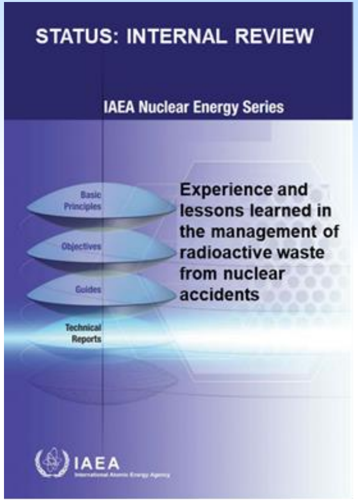
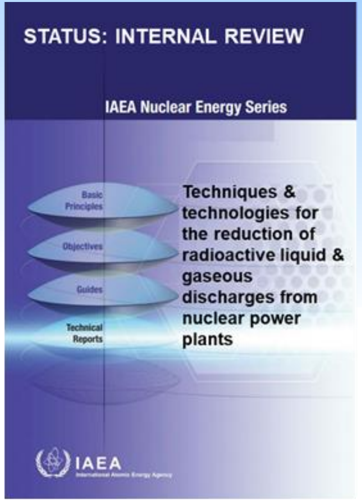




Waste Technology Section Priorities

Fix the future

Address the past

Small inventory solutions

Share good practices

Facilitate societal acceptance

Priority: Fix the future

IAEA

Address the past

Small inventory solutions

Share good practices

Facilitate societal acceptance

Fix the future

Promote the concept of:

- Integrated cradle to grave waste management before activities begin to generate RWM
- Transition to **proactive** RWM rather than **reactive**
- Plan and assure that all waste has a clear, identified pathway to disposition

Priority: Address the past

Fix the future

Small inventory solutions

Promote good practices

Facilitate societal acceptance

Address the past

- The large and complex legacy of waste from past activities leads to a negative perception nuclear energy its applications as well as presenting a significant safety hazard.
- Implementation of solutions to manage this legacy is essential to ensuring a sustainable future for nuclear technology.

Priority: Small inventory solutions

IAEA

Fix the future

Address the past

Promote good practices

Facilitate societal acceptance

Small Inventory Challenges

Small inventory solutions

- No plan to implement policy*
- No defined end-goals*
- Lack of human resources
- Insufficient financial resources
- Access to technologies*
- No disposal concept
- No waste acceptance criteria*

Share good practices

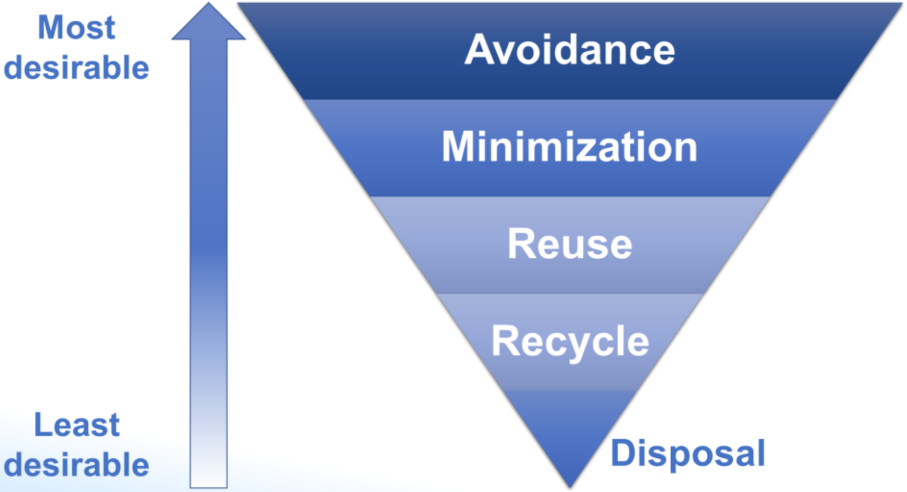
Fix the future

Address the past

Small inventory solutions

Facilitate societal acceptance

Promote good practices

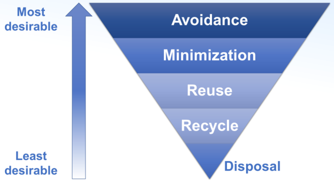


Share good practices

Fix the future

Address the past

Small inventory solutions



Facilitate societal acceptance

Promote good practices

Core Radioactive Waste Management Principles

Proven Technologies

IWM

Integrated Waste Management Concept

Supporting Tools

IAEA

Fix the future

Address the past

Small inventory solutions

Facilitate societal acceptance

Promote Good Practice

Status & Trends in Spent Fuel & Radioactive Waste Management

IAEA | SRIS

Spent Fuel & Radioactive Waste Information System

Radioactive Waste Management Registry

WWER Operational Waste Benchmarking System

Upcoming Technical Meetings

Waste optimization during NPP operations

Benchmarking of waste from NPPs

Spent fuel and radioactive waste information system (SRIS)

2021

Achievement & challenges in radioactive waste characterization (LABONET)

Status & trends in spent fuel and radioactive waste management

IPN IDN LAB DISP

Management of hazardous waste arising form the operation and decommissioning of research reactors and other nuclear installations (IPN)

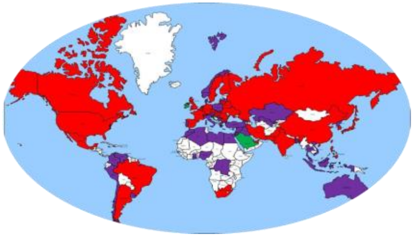
Details on dates and locations will be available on the IAEA.org and the CONNECT networks – LABONET, IPN, IDN

NuclearWiki – covering all aspects of RWM

- Decommissioning wiki fully functional on IDN Network
- Currently expanding wiki content to cover all of radioactive waste management
  - Predisposal
  - Disposal
  - Decommissioning
  - Environmental Remediation
- Type of content:
  - Facilities
  - Technologies
  - Lessons Learned
  - Good practices
  - ……

Toolkit for Predisposal

Existing Technologies and Practices



Disposal Facilities World-wide

IAEA
International Atomic Energy Agency

International Conference on Radioactive Waste Management: Solutions for a sustainable Future
01 to 05 November 2021
Vienna, Austria

Conference Website: https://www.iaea.org/events/international-conference-on-radioactive-waste-management-2021

Abstract submission deadline: 5th March 2021

Professional Networks – link

eLearning – link

Videos:

- Two minute - link
- Ten minute – link

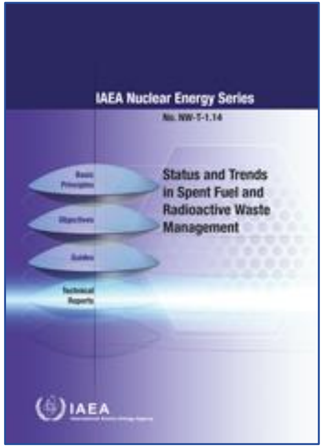
Nuclear Communicators' Toolbox - link

Thank you! And Stay Connected !

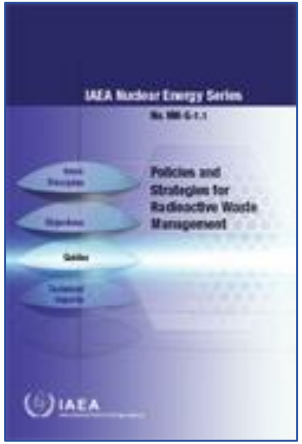
Bonus slides . . .

Outputs of IAEA (summary)

- **IAEA publications - link**



Status & Trends - Link



Policies and Strategies - Link

- Professional networks - Link

eTools:

- Spent Fuel and Radioactive Waste Information System (SRIS) – Link
- E-learning - Link

- Technical Cooperation Projects
- Workshops, technical meetings and conferences.

UN SDGs


1 NO POVERTY
2 ZERO HUNGER
3 GOOD HEALTH AND WELL-BEING
4 QUALITY EDUCATION
5 GENDER EQUALITY
6 CLEAN WATER AND SANITATION
7 AFFORDABLE AND CLEAN ENERGY
8 DECENT WORK AND ECONOMIC GROWTH
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE
10 REDUCED INEQUALITIES
11 SUSTAINABLE CITIES AND COMMUNITIES
12 RESPONSIBLE CONSUMPTION AND PRODUCTION
13 CLIMATE ACTION
14 LIFE BELOW WATER
15 LIFE ON LAND
16 PEACE, JUSTICE AND STRONG INSTITUTIONS
17 PARTNERSHIPS FOR THE GOALS
SUSTAINABLE DEVELOPMENT GOALS

PRESENTATION OF ROUTES

December 1st 2020 • SHARE Workshop • Elisa Leoni (IRSN)

The project leading to this application has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement n° 847593.

EURAD - ROUTES KEY FIGURES

ROUTES is one of the 13 WP of the EURAD Joint PROJECT

ROUTES IS A STRATEGIC STUDY (no R&D carried out)

2019 → 2024

35 Organisations

21 Countries

Total budget: 1.7 M€

EC contribution: 1.2 M€

ROUTES GENERAL OBJECTIVES

- **ROUTES OBJECTIVES**
  - To enable Partners to share their experience and lessons learned on the management of radioactive waste considered as problematic or challenging.
  - To identify the gaps in research, knowledge and facilities.
  - To describe and compare the different approaches in the different steps of the waste management life-cycle and to identify opportunities for further collaboration between Member-States (MS)

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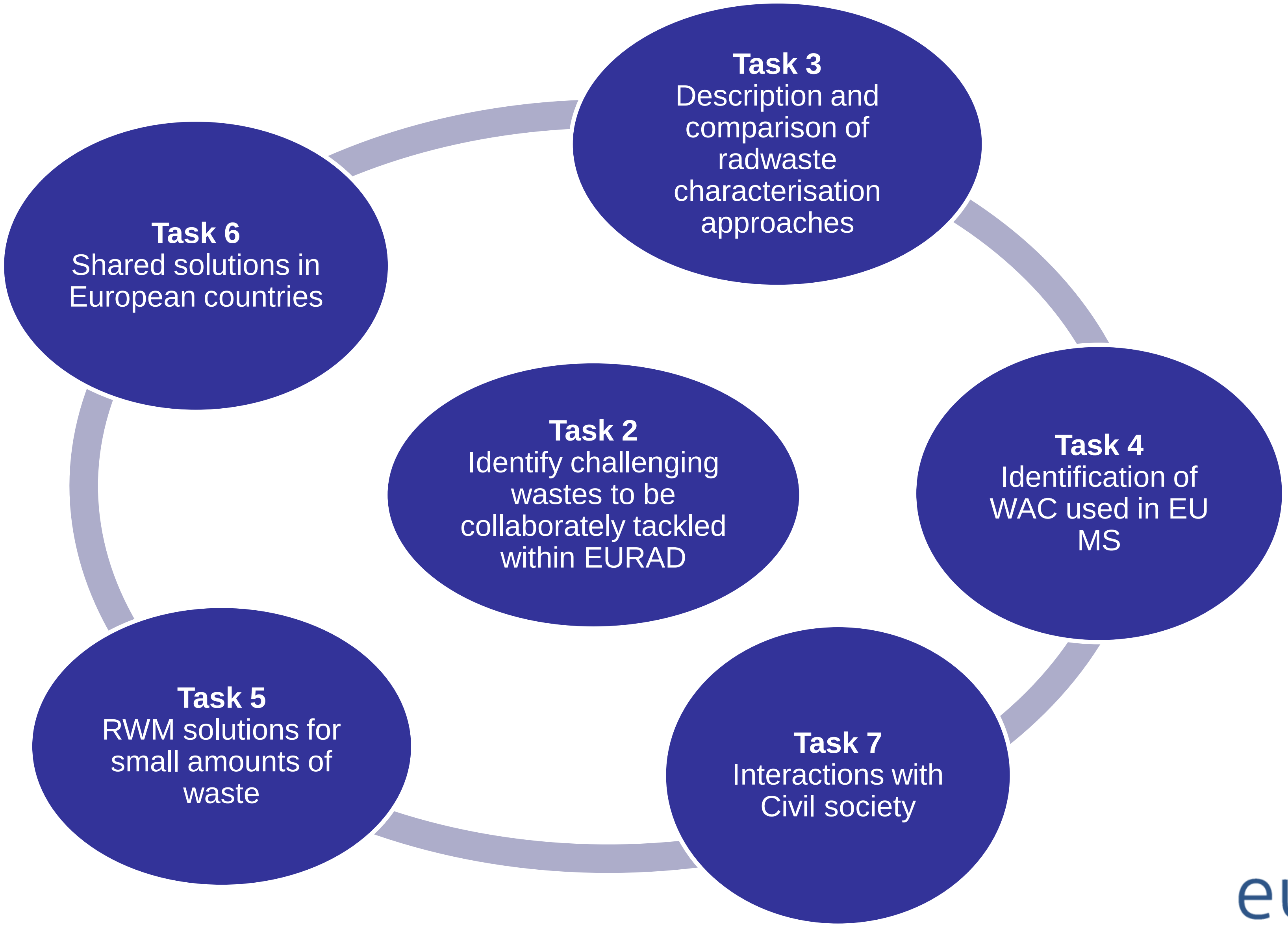
TASK BREAK DOWN



METHODOLOGY

- **ROUTES Survey**
  - ➢ 25 questions with the aim to gather relevant and up-to-date information needed for ROUTES
  - ➢ Questionnaire is organized in six topics covering the activities addressed in the different tasks:
    - General information
    - Inventory of challenging waste and management routes
    - Waste acceptance criteria
    - Characterization
    - Management strategy and R&D programmes
    - Shared solutions for waste management
- **ROUTES Workshops and Meetings**
  - ➢ Case studies and lessons learnt
- **Publicly available information (from EU, IAEA, NEA)**
  - ➢ National Reports & Programmes (EU, IAEA), National Summaries (NEA), reports on THERAMIN and CHANCE, IAEA TECDOCs…

ROUTES SURVEY - INVENTORY OF CHALLENGING WASTE

- Up-to-date inventory of challenging waste in MS
- Only a few countries have established a clear and publicly available inventory of challenging wastes, and the strategy implemented or foreseen to manage them is not generally described
- Information gathered for each country
  - Description of the origin
  - Detailed description of the properties (Volume, activity, physico-chemical description…)
  - Details about the reasons why there are considered as challenging

ROUTES SURVEY - INVENTORY OF CHALLENGING WASTE

- Example of Ion Exchange Resins

spent ion exchange resins	Characterization issues (radiological, physical, chemical), inventory	re-conditioned to conform our interim storage WAC (and state-of-the art waste management techniques)	Wait and see strategy because disposal facility is not available	WAC do not exsist	The resins are considered not suitable for long term storage. Potential processes to condition the radionuclides in the resins are plasma	Technologies available in other MS but not accessible	Conditionning/treatment	disposal	Lack of human and financial resources in waste management	Sampling techniques are under development	Too small volumes to develop a dedicated facility/technology	Treatment (incinerator) is uncertain due to incompatibility with available facility	Other available treatment/conditioning methods do not lead to a waste form that is compatible with surface or geological disposal	No or poor public acceptance of the foreseen solution	Lack of, or poor knowledge in waste management
1		x													
2	x											x	x		
3	x						x								
4															
5	x						x	x							
6	x														x
7												x	x		
8	*		*			*	'	*	'	'	*				
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15	x						x	x							
16															
17															
18							x								
19															
20							x			x					
21							x	x							

➔ Example of waste stream that is considered as challenging in a Country while a solution for its management has already be found in some others

ROUTE SURVEY – INVENTORY OF CHALLENGING WASTE

- **Some notable observations:**
    - ➢ Similar inventories of challenging waste and technical issues related to their management (including SIMS),
    - ➢ But different boundaries conditions (amount, available facilities…)
    - ➢ One of the predisposal steps technology or disposal is not available (THERAMIN, PREDIS)
    - ➢ Lack of characterization
    - ➢ Toxic vs radioactive
    - ➢ Challenging waste are considered as challenging because no WAC are available
    - ➢ Waste conditioned when WAC for disposal were not yet available
- **These preliminary results reinforce the idea that solutions can be found jointly**
- **Steps forward :**
    - exchange on specific waste streams have been initiated taking into account both predisposal and disposal issues
        - To identify possible R&D new activities
        - To establish technical basis for Knowledge and technology transfer

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ROUTES TASK 4 - WASTE ACCEPTANCE CRITERIA

- **WASTE ACCEPTANCE CRITERIA – TASK 4**
  - Topics addressed in Y1
    - Status and nature of WAC in different countries (linked to national waste management activities)
    - Approaches to develop and update WAC and WAC-related responsibilities of different parties
    - Use of generic WAC
    - Detailed requirements set out in WAC (some parameters, range and methods for their determination)
    - Approaches to determine compliance with WAC
    - Approaches to respond when a non-compliance with one or more WAC is detected

  - **WAC as a tool** to establish a Waste management strategy

ROUTES SURVEY - WASTE ACCEPTANCE CRITERIA

- Some notable observations:
    - Up-to-date information on WAC in MS
    - Different interpretations of the term 'WAC' in different countries
    - Application of WAC (and analogous requirements / procedures / policies / decrees / criteria / regulations / specifications) during different lifecycle stages varies considerably
    - Limited use of generic WAC
        - Variable interpretation of what 'generic WAC' constitute
    - Widely varying roles of different parties in applying WAC and determining compliance
    - Range of technical approaches to determine compliance
- Steps forward :
    - **Gap analysis** will compare situations in which final **WAC for disposal are available** with cases of experience with conditioning or management of waste **without WAC**, facilities or technical solutions
        - i.e. How the development of generic WAC can help in defining a management route for challenging waste?

CONCLUSIONS

- The work done within ROUTES can provide :
  - ➢ Up-to date information about the Inventory of challenging waste in participating MS
  - ➢ Up-to date information on WAC in MS
    - ➢ Covering both pre-disposal and disposal steps

- Interactions and common work with other EC Projects highly beneficial

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Thank You for your attention!

PREDIS

PREDIS Overview SHARE workshop

Session 8 - Management of material and radioactive waste from Decommissioning / Legacy Waste

1.12.2020 @ 14.10

ERIKA HOLT & MARIA OKSA,
COORDINATORS, VTT TECHNICAL
RESEARCH CENTRE OF FINLAND

This project has received funding from the European Union's Horizon 2020
research and innovation programme under grant agreement No 945098.

PROJECT SHORT OVERVIEW

- Title: “PREDIS: Pre-disposal Management of Radioactive Waste”
- Participants: Consortium of 47 partners from 17 countries
- Duration: 4 years, planned September 2020 through August 2024. Proposal was submitted 25.9.2019. Positive decision February 2020, agreements signed June.
- Budget: 23.7 M€ total, of which EC contribution of 14 M€
- Reply to: Euratom call NFRP-10, Research and Innovation Action (RI)
- Support/endorsement from Nugenia, IGD-TP, IAEA, NEA, EURAD project – all are listed for cooperation during the project duration (establishing i.e. MoU for information sharing)
- Project web page: https://predis-h2020.eu/

This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 945098.

PROJECT OBJECTIVES

PREDIS high-level, overall objectives are to:

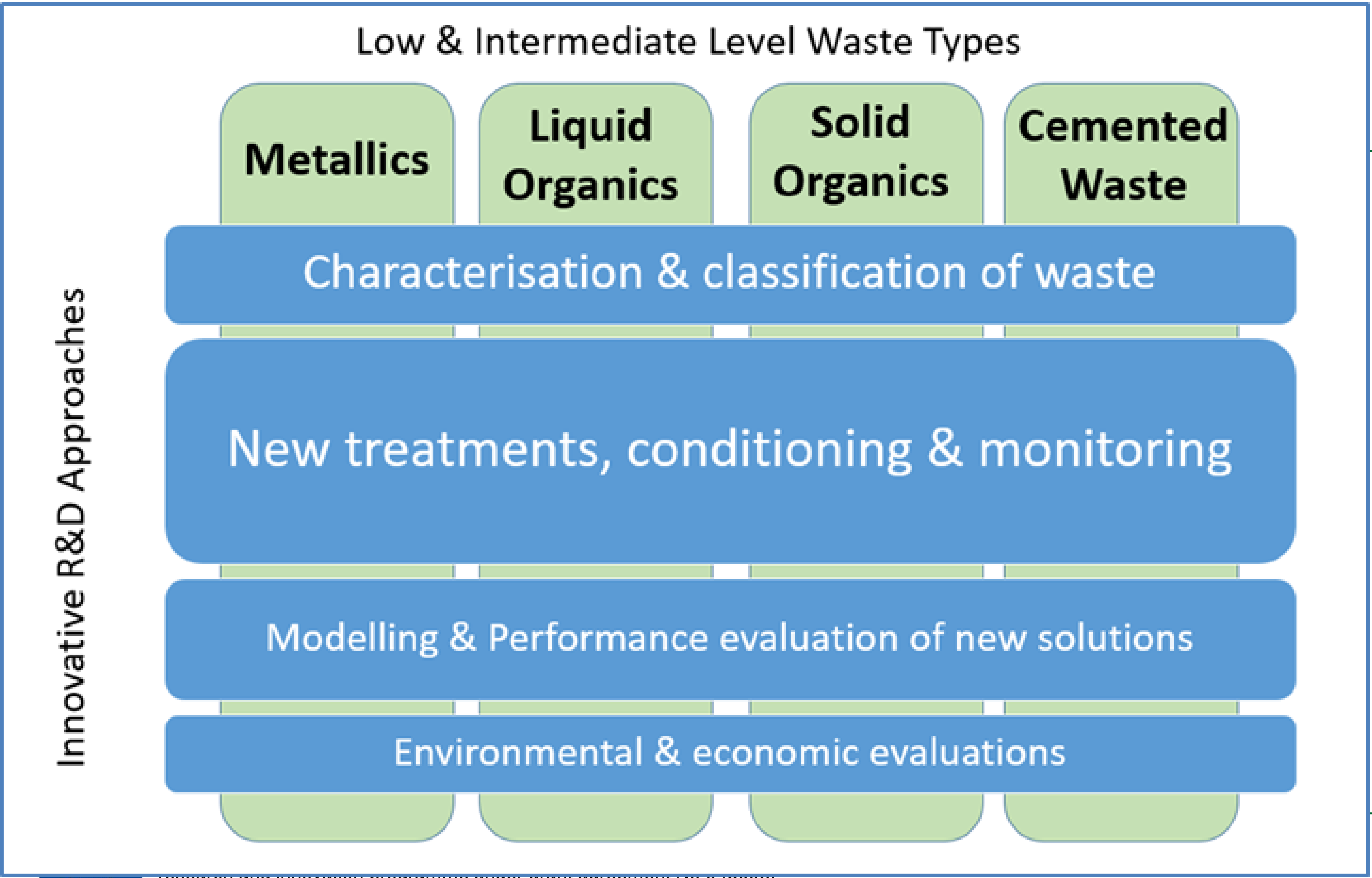
- **Develop solutions (*methods, processes, technologies and demonstrators*) for future treatment and conditioning of waste across a number of MSs for which no industrially mature or inadequate solutions are currently available, improving safety during next waste management steps;**
- **or improve existing solutions with safer, cheaper or more effective alternative processes where they bring measurable benefits to several MSs (Member States).**
- **Analyse criteria, parameters and specifications for materials and packages with associated Waste Acceptance Criteria (WAC) for pre-disposal and disposal activities, supporting homogenisation of waste management processes across Europe.**

These high-level objectives will be met by PREDIS having specific objectives:

1) Applying multi-disciplinary and multi-scale scientific approaches to demonstrate technical, economic and environmental feasibility of the new solutions;
2) Addressing project drivers from the end users' points-of-view;
3) Fostering deeper cooperation between experts from many EU Member-states and across generations;
4) Training new experts in the field of pre-disposal waste management technologies;
5) Updating and revising pre-disposal guiding documents (vision, SRA, roadmap, governance and deployment mechanisms), together with the EURAD EJP executive bodies.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 945098.

TECHNICAL SCOPE



Scope was developed in spring 2019 based on iterative feedback from end user community, regarding priorities on R&D topics.

Selection of topics and tasks based on areas having highest potential for technical and innovation impact.

Description of Action (Project Plan) gives exact techniques and their current, project and future technology readiness level (TRL) targets

CONSORTIUM MEMBERS

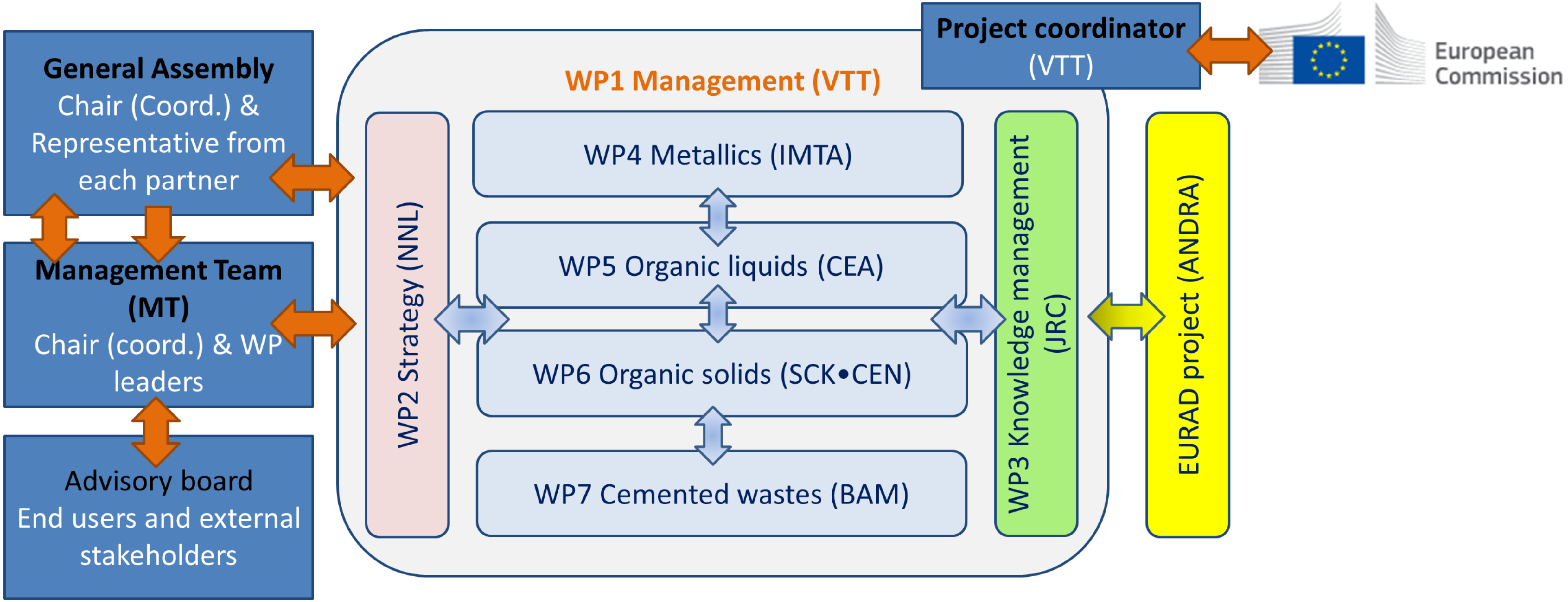
Bold indicated WP leaders, = Project Management team

29 of 47 partners are also participating in EURAD

- **VTT Technical Research Centre of Finland, Finland**
- **National Nuclear Laboratory (NNL), UK**
- **Joint Research Centre (JRC), Belgium**
- **Institut Mines Télécom Nantes Atlantique (IMTA), France**
- **Commissariat à l'énergie atomique et aux énergies alternatives (CEA), France**
- **Studiecentrum voor Kernenergie / Centre d'Etude de l'Energie Nucléaire (SCK•CEN), Belgium**
- **Bundesanstalt Fuer Materialforschung und Pruefung (BAM) Germany**
- Magics Instruments, Belgium
- Technical University Sofia, Bulgaria
- Ceske Vysoke Uceni Technicke V Praze (CTU), Czech Republic
- Centrum Vizkumu Rez (CVRez), Czech Republic
- Statni Ustav Radiacni Ochrany (SÚRO), Czech Republic
- ÚJV Rez, Czech Republic
- University of Helsinki, Finland
- Centre National de la Recherche Scientifique, France
- Ecole Centrale de Lille, France
- Institut de radioprotection et de Sûreté Nucléaire (IRSN), France
- ORANO CYCLE, France
- DMT GmbH & Co., Germany
- Forshungszentrum Julich GMBH, Germany
- Karlsruher Institut Fuer Technologie (KIT) Germany
- National Center for Scientific Research "Demokritos" (NCSRD), Greece
- Isotoptech Nuklearis Technoloiai Esszolgaltato Reszvenytarsasag, Hungary
- Radiookologiai Tisztasagert Tarsadalmi Szervezet (SORC), Hungary
- TS Enercon Mernokiroda KFT, Hungary
- Ansaldo Nucleare SPA, Italy
- Agenzia nazionale per le nuove tecnologie, l'energia e lo sviluppo economico sostenibile (ENEA), Italy
- Istituto Nazionale di Fisica Nucleare (INFN), Italy
- Nucleco Societa Per L'Ecoingegneria, Italy
- Politecnico di Milano, Italy
- Società Gestione Impianti Nucleari (SOGIN), Italy
- University of Pisa, Italy
- Valstybinis Moksliniu Tyrimu Institutas (FTMC), Lithuania
- Nuclear Research and Consultancy Group, Netherlands
- Institutt for Energiteknikk (IFE), Norway
- Regiei Autonome Tehnologii pentru Energia Nucleara - Institutul de Cercetari Nucleare Pitesti (RATEN), Romania
- Amphos 21 Consulting SL, Spain
- Centro de Investigaciones Energeticas, Medioambientales y Tecnologicas (CIEMAT), Spain
- Agencia Estatal Consejo Superior Deinvestigaciones Cientificas (CSIC), Spain
- Empresa Nacional de Residuos Radioactivos SA (ENRESA), Spain
- Universidad Autónoma de Madrid, Spain
- Paul Scherrer Institut, Switzerland
- Galson Sciences Limited, United Kingdom
- University of Manchester, United Kingdom
- University of Sheffield, United Kingdom
- National Science Centre Kharkov Institute of Physics and Technology (KIPT), Ukraine
- Institute of Environmental Geochemistry, National Academy of Science, Ukraine

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 945098.

PROJECT STRUCTURE



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 945098.

PREDIS

Total effort = 223 PM, among 16 partners.

WP2 Strategic Studies - TASKS

- Task 2.1 Establish a pre-disposal stakeholder community (SCK•CEN)
  - Mapping who has interest in this topical area, who gives feedback on project issues
- **T2.2 Development of a pre-disposal strategic research agenda (NNL)**
  - Priorities for future R&D, Deliverable draft due August 2021, revised 2023-24. **SHARE Inputs?**
- Task 2.3 Waste acceptance systems (CVRez)
  - Including assessments from WP4-7 cases
  - Close interaction with EURAD (WP9 Routes), IAEA, NEA etc
- Task 2.4 Governance (VTT)
  - How to integrate waste producers to future joint program decision making body?
- Task 2.5 Cross work package strategic assessment (CEA)
  - Including Life Cycle Assessment (LCA) and Life Cycle Costing (LCC) from WP4-7 case studies
- **Task 2.6 Gap Analysis pre-disposal needs (VTT)**
  - Justification for how this project was chosen. Deliverable draft due May 2021. **SHARE Inputs?**

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 945098.

PREDIS

Total effort = 77 PM, among 8 partners.

WP3 Knowledge Management - TASKS

- Task 3.1 Development of Knowledge Management Programme (Amphos 21)
  - Develop a pre-disposal programme **aligned with EURAD project,** KM platform and tools
  - Require at different stages feedback from end-users
- Task 3.2 State of Knowledge (SoK) (UJV)
  - Evaluate what knowledge is needed and how to ensure transfer to future generations
  - Executed in close collaboration with PREDIS WP3-7
- Task 3.3 Developing and Implementing Training Programme (Amphos21)
  - Target internal and external training modules and events
  - **Close cooperation is** planned with EURAD, SNE-TP, IAEA, NEA, PREDIS beneficiaries, …
- Task 3.4 Implementing Mobility Programme (UJV)
  - Target internal partner mobility, but external could be an option

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 945098.

Total effort = 534 PM, among 23 partners.

WP4 – Innovations in metallic material treatment and conditioning

- Develop innovative conditioning matrices for reactive metallic wastes.
- Develop innovative and optimised characterisation techniques for metallic wastes.
- Demonstrate innovative techniques to decontaminate metallic wastes to quantify the efficiency of decontamination processes and allow more effective application of the waste hierarchy.
- Develop treatment techniques for secondary waste streams after decontamination.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 945098.

Total effort = 618 PM, among 21 partners.

WP5 – Innovations in liquid organic waste treatment and conditioning

- Study of innovative materials (geopolymers) and their interactions with ROLW
- Development of direct conditioning solutions for RLOW based on geopolymer from TRL3 to TRL6 including validation tests with real waste and feasibility scale-up tests.
- Optimisation of geopolymers options and formulations to optimise ROLW encapsulation, especially incorporation rates and matrix performance.
- Process robustness regarding waste, raw materials and process variability including study definition and execution of non-standard tests to verify the stability and durability of the final waste form.
- Disposability assessment from the study of matrix performances and long-term behavior including “technical standard tests” related to WAC when available and scientific approaches for deeper physico-chemical understanding including the development of methodologies to evaluate parameters important for disposability assessment.

This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 945098.

PREDIS

Total effort = 509 PM, among 14 partners.

WP6 – Innovations in solid organic waste treatment and conditioning

- Closing the cycle for treatment of RSOW by proposing, developing, testing and verifying suitable matrices for conditioning of residues and secondary wastes stemming from (thermal) treatment options (like those investigated within THERAMIN).
- Development of geopolymers as alternative binder material to ordinary cement-based systems for conditioning of residues and secondary wastes.
- Demonstrate robustness of full treatment cycle for selected RSOW waste streams.
- Assessment of full treatment cycle in terms of technology and economical assessment, achieved volume reduction factor, final conditioned matrix performance and related WAC for different primary waste stream physico-chemical characteristics.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 945098.

PREDIS

Total effort = 408 PM, among 17 partners.

WP7 – Innovations in cemented waste handling and pre-disposal storage

- Innovative NDE tools for evaluation of package integrity, including, but not limited to visual methods, muon tomography and ultrasonic techniques
- Innovative sensor technologies for instrumented packages, including, but not limited to fiber optical techniques and methods for wireless power supply and data transmission
- An approach for developing and maintaining digital twins of packages, including a package evolution model based on inventory data, chemical and mineralogical characterisation data, data from chemical modelling, and monitoring data
- Application of machine-learning algorithms, trained on digital datasets, to produce a fast and accurate description of the geochemical evolution and the geo- and thermo-mechanical integrity of radioactive waste packages during pre-disposal
- A digital twin of a radioactive waste package based on machine-learning algorithms that can offer advanced information for waste package inspection protocols and, thus, contribute to safety of storage facilities
- Large digital database to train the machine-learning algorithms
- A decision framework model that is based on existing knowledge, data from measurements and predictions from digital twins
- Advancement of the overall TRL for data handling, processing and fusion in the context of intermediate radioactive waste storage from 4 to 6
- Reports on treatment options for existing packages, potential improvements in package design and recommendations for store automation concepts.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 945098.

GETTING INVOLVED TO THE PROJECT

- Project expects high level of cooperation with Stakeholders Group (wider community) and End User Group (focused group).
- NPPs and WMOs are direct users of results = End User Group (EUG)
- Both are volunteer groups, without financing or obligations (or voting rights)
- EUG: Need to send Application form (contact name, areas of interests) and signed Commitment letter (non-disclosure agreement). Available from VTT/Coordinator upon request
- Approval of EUG members done by General Assembly vote (EU/Euratom member countries assumed automatic approval). Every 3-6 months.
- Can also register via project web page https://predis-h2020.eu/
- Next public events include free online webinars and gap analysis survey (Jan-March 2021)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 945098.

Thanks!
Questions?

WE LOOK FORWARD TO INTEGRATING **SHARE** OUTCOMES & CONTINUING COOPERATION

Comments & questions not answered today – please be in touch erika.holt@vtt.fi

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 945098.

EXTRA SLIDES – TECHNICAL WP SPECIFICS

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 945098.

WORK PACKAGES & LEAD CONTACTS

- WP N°1: **Project Management & Dissemination.** VTT (erika.holt@vtt.fi & maria.oksa@vtt.fi)
- WP N°2: **Strategic Implementation.** NNL (anthony.w.banford@uknnl.com).

  Networking issues including issues on stakeholder engagement, SRA updates, waste acceptance/classification, LCA/LCC.
- WP N°3: **Knowledge Management**. JRC (Paul.CARBOL@ec.europa.eu)

  with assistance from Amphos21 (lara.duro@amphos21.com) and UJV (Vaclava.Havlova@ujv.cz). Addressing state of knowledge, training/mobility.
- WP N°4: **Innovations in metallic material treatment and conditioning**. IMT-Atlantique

  (Bernd GRAMBOW - grambow@subatech.in2p3.fr)
- WP N°5: **Innovations in liquid organic waste treatment and conditioning**. CEA (Maxime.FOURNIER@cea.fr)
- WP N°6: **Innovations in solid organic waste treatment and conditioning**: SCK•CEN (thierry.mennecart@sckcen.be)
- WP N° 7: **Innovations in cemented waste handling and pre-disposal storage**: BAM (ernst.niederleithinger@bam.de)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 945098.

Total effort = 534 PM, among 23 partners.

WP4 Metallic material treatment and conditioning - TASKS

- T4.1 WP management (IMTA)
- T4.2 Defining Europe-wide Needs and Opportunities for Management of Metallic Waste Streams (GSL)
- T4.3 Development and optimisation of decontamination processes (IMTA)
- T4.4 Optimisation of metallic waste characterisation and procedures for waste minimisation and recycling (NCSRD)
- T4.5 Encapsulation of reactive metals in magnesium phosphate cement-based matrices (CNRS)
- T4.6 Dissemination (IMTA)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 945098.

Total effort = 618 PM, among 21 partners.

WP5 Liquid Organic waste treatment and conditioning - TASKS

- Task 5.1 WP5 Management (CEA)
- Task 5.2 Collection & review of waste, regulatory, scientific & technical data (GSL)
- Task 5.3 Study of direct conditioning process (RATEN & SOGIN)
- Task 5.4 Study of conditioning matrix performances (ECL & USFD)
- Task 5.5 Preliminary technical, economic and environmental analysis (GSL)
- Task 5.6 Implementation & dissemination (UNIPI)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 945098.

Total effort = 509 PM, among 14 partners.

WP6 Solid Organic waste treatment and conditioning - TASKS

- Task 6.1 Work package management (SCK•CEN)
- Task 6.2 Database on solid organic waste forms and their final state and value assessment analysis (GSL)
- Task 6.3 Thermal treatment of the radioactive waste forms and characterisation of the treated / reconditioned wastes (CEA)
- Task 6.4 Immobilisation of the treat wastes by geopolymer or cement-based materials encapsulation or by molten glass coating (CVRez)
- Task 6.5 Densification (USFD)
- Task 6.6 Physico-chemical characterisation of reconditioned waste form and stability testing (VTT)
- Task 6.7 Economic and Environment impact - Implementation (GSL)
- Task 6.8 Dissemination and Reporting (SCK•CEN)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 945098.

PREDIS

Total effort = 408 PM, among 17 partners.

WP7 Cemented waste handling and pre-disposal storage - TASKS

- Task 7.1 WP management (BAM)
- Task 7.2 State of the art in packaging, storage, and monitoring of cemented wastes (GSL)
- Task 7.3 Innovative integrity testing and monitoring techniques (BAM)
- Task 7.4 Digital Twin (PSI)
- Task 7.5 Data handling, processing and fusion (VTT)
- Task 7.6 Demonstration and implementation of monitoring, maintenance, and automation/digitalisation techniques (Orano)
- Task 7.7 Dissemination and Reporting (GSL)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 945098.

IAEA
International Atomic Energy Agency

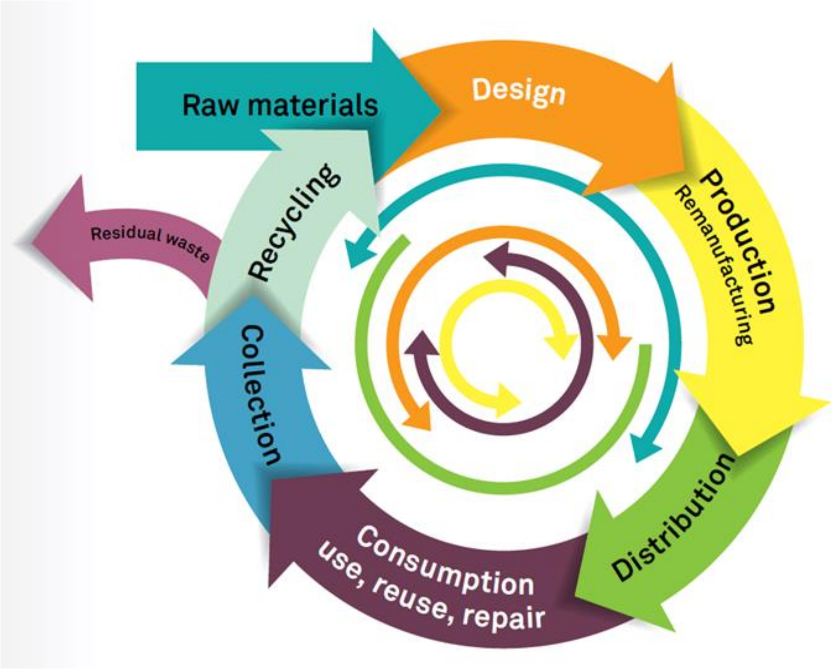
IAEA Workshop on Circular Economy

Vladimir Michal
Division of Nuclear Fuel Cycle and Waste Technology
Department of Nuclear Energy, IAEA

SHARE Workshop (virtual), 1-3 December 2020

Circular Economy

- Aims at minimizing waste and making the most out of resources;
- Recovers and regenerates products at the end of each life cycle;
- Delivers positive society wide benefits.



Application of the Circular Economy concept in decommissioning

- Moving towards Circular Economy principles in decommissioning offers a possibility to transform the engagement on decommissioning within a range of stakeholders, including decision-makers and the general public;
- Sustainable decommissioning lessons might be learned from non-nuclear industries ("we are <u>not</u> so special" view):
  - Availability of technologies and approaches,
  - Reduction of costs, uncertainties and risks.
- An extensive amount of knowledge and experience is available in the non-nuclear sectors, both in deconstruction operations, waste / material management and circular economy;
- Especially, the demolition industry has significant expertise in the processes, means and methods.

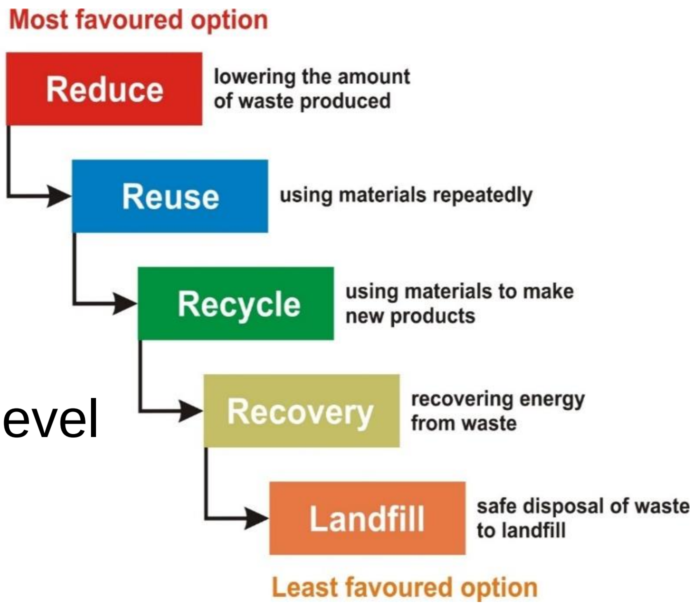
Application of the Circular Economy concept in decommissioning

- Dialogue can be centred on the development of progressive and sustainable solutions while creating value to society, rather than on dealing with old facilities and radioactive waste management;
- Enhanced focus on nuclear or non-nuclear reuse & redevelopment in line with the waste management hierarchy (well established concept within the nuclear industry);
- Material can be released from regulatory control and can be reintroduced into the conventional material cycle (by application of concepts of exclusion, exemption and clearance);
- This can be linked to the ‘end-of-waste’ criteria.

Waste Management Hierarchy

Few examples from nuclear industry:

- Systematic reduction of material / waste to be managed during decommissioning operations;
- Free release and recycling of metals and other materials after dismantling and removal from the site;
- Reuse of contaminated components in new equipment on a different nuclear site;
- Reuse / recycling of demolished concrete structures as fill materials in pits (to enable leaving a levelled site);
- Manufacturing of nuclear fuel using spent fuel resources (reprocessing);
- Alternative disposal options for very low-level waste.



Sustainable Decommissioning Mindset

- **Strategic view**: decommissioning as a <u>sustainable process</u> to support <u>further development</u> of the site:
  - ➔ Long-term thinking: post-decommissioning future of the site to be considered as the integral part of decommissioning planning

- **Corporate social responsibility view**: best use of the (most often taxpayer) money
  - ➔ Viewing all parts of decommissioning process as potential assets

Social and Economical Dimension: Decommissioning is the start of a new life

- **Redevelopment**

Energy and Material Research Centre

  - To be considered before decommissioning action, in consultation with local communities,
  - Impact on what to keep, how to prepare the site for a new life.

- **Local employment**
  - During decommissioning,
  - Attracting businesses for the new life of the site.



Stakeholder Engagement – Another Key Aspect

- **Generic: Mechanisms to enable decisions and approach**
  - Stakeholders include authorities, local and national governments, NGOs,
  - Building trust over years is a long road and maintaining is a must.

- **Specific to Decommissioning**
  - Impact of the end of life of a facility on local economy,
  - Different / new types of risks to be managed.

- **Specific to Recycling and Circular Economy**
  - Addressing the “zero risk society”,
  - Economic value for the community.

IAEA activities

IAEA

- International workshop on Application of Sustainability Principles and Circular Economy to Nuclear Decommissioning, 18-21 June 2019, Rome, Italy;
- Promotion of topic through the IAEA communication channels (e.g. IDN Network, webinars);
- A new event planned for 2021 – to be confirmed;
- Integration of the Circular Economy topic into variety of aspects of our programme of work.

Circular Economy Workshop in Rome

IAEA

- Hosted by Sogin in Rome + site visit of Latina NPP;
- Experts from the IAEA, France, Germany, Italy, Japan, Slovakia, Spain, Sweden and the United Kingdom discussed ways of effectively addressing CE principles in decommissioning and waste management;
- Sogin approaches and international case studies were presented;
- One day with wider audience of Sogin counterparts was organized in Palazzo delle Esposizioni (about 90 registered participants);
- Report by experts has been prepared for Sogin:
    - An overview of the European and national regulatory frameworks, taking into account green engineering and Green Public Procurement rules regarding circular economy,

Circular Economy Workshop in Rome

- Analysis of the flow and management of the reusable or recyclable materials arising from decommissioning activities,
- Assessment of the actual practice of recycling and reuse,
- Identification of the obstacles to recovering scrap materials arising from decommissioning, and waste avoidance approaches.

IAEA news

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International Atomic Energy Agency

Press centre Employment Contact

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IAEA Workshop Highlights Novel Trends in Decommissioning

Vladimir Michal, IAEA Department of Nuclear Energy
Irena Chatzis, IAEA Department of Nuclear Energy

JUN
28
2019

The site of the former Yankee Rowe Nuclear Power Station, in Massachusetts, USA, which operated from 1960 to 1992. It is one of the 17 nuclear power reactors that have been fully decommissioned. As of 31 December 2018, 173 power reactors have been permanently shut down across the world. (Photo: Yankee Rowe)

Decommissioning of nuclear power plants and other nuclear facilities based on sustainability and circular economy principles can bring great benefits, including less waste, lower costs and reduced risk of delays. It is also a great

Related Stories

- IAEA Strengthens its ARTEMIS Review Service
- Meeting the Challenge of Future Nuclear Decommissioning through Education and Training
- IAEA Helps Member States Do More Cost Effective Management of Decommissioning Waste
- IAEA, Norway's Institute for Energy Technology to Work Together on Digital Technologies in Decommissioning, Nuclear Knowledge Management
- IAEA Workshop Highlights ARTEMIS Peer Review Service

Related Resources

Sogin news

SOGIN

Sogin and IAEA. First international discussion on circular economy in decommissioning

01 July 2019

Sogin hosted, from 18 to 21 June, the **first international workshop** on the **circular economy** in nuclear decommissioning, organized by the International Atomic Energy Agency (IAEA).

Entitled "Application of Sustainability Principles and Circular Economy to Nuclear Decommissioning", the event was a moment of discussion with the experts of the Agency and the operators of the industry – from France, Germany, Japan, Slovakia, Spain, Sweden, United Kingdom and Italy - on **best practices** and **innovation** in circular economy. At the same time, Sogin presented a document with an analysis of its circular economy strategy, on which it received observations by the experts.

The workshop consisted in **technical sessions**, including a site visit to the Latina nuclear power plant, and a **plenary session**. The latter took place on June 20 in Rome at the Palazzo delle Esposizioni and was attended, among others, by the Director of the Nuclear Fuel Cycle and Waste Technology Division, Christophe Xerri, the President of the Superior Institute for Protection and Environmental Research, Stefano Laporta, the Director of the National Inspectorate for Nuclear Safety and Radiation Protection, Maurizio Pernice, and Sogin top management, President Marco

IAEA
International Atomic Energy Agency

Thank you for your attention !

Report on Recycling and Reuse of Materials arising from decommissioning of Nuclear Facilities

Mr Bart Ooms
Belgoprocess
Chair, NEA Task Group on Recycling and Reuse of Materials

EU-H2020-SHARE-Decommissioning
December 1-3, 2020

Motivation of the mandate

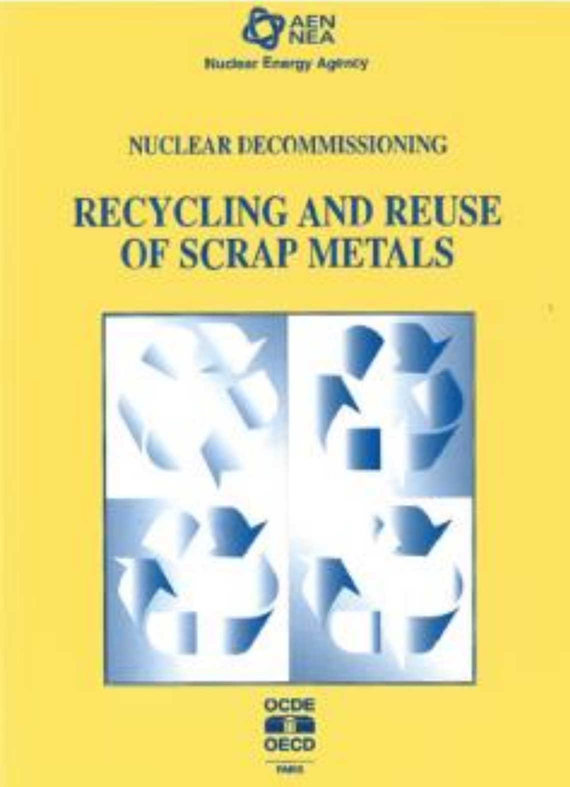
- Significant volumes of materials will be generated from decommissioning of nuclear facilities throughout the world
    - Concrete and steel are the main materials

- In Europe, more than 1/3 of currently operating reactors are due to be shut down by 2025
    - The importance of the management of slightly contaminated material will grow
    - The inherent value of these materials and the need to reduce radioactive waste to be disposed require attention

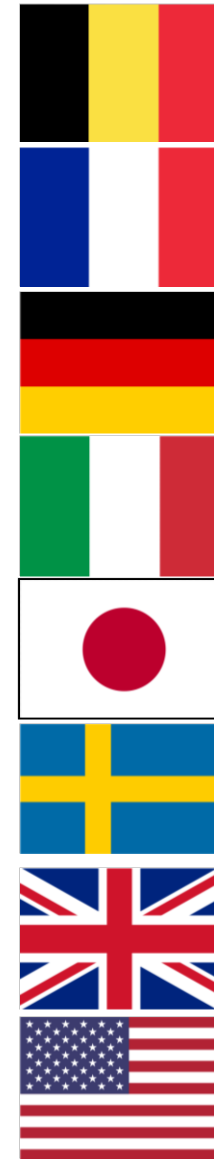
- International community is far from a complete harmonization of the strategies and regulations on this issue

Objectives and Scope

- ✓ Objective of the work was to :
  - ✓ Review the work done by CPD and the resulting report published in 1996
  - ✓ Analyze the experience of the nuclear industry over the past 20 years on the subject
- ✓ Scope NOT limited to metals (as in 1996 report) but expanded to include all materials (i.e.concrete)



Task Group members



Contributors to drafting and review

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Current Policies and Regulations

- ✓ The 1996 report concluded that the absence of consistent, internationally accepted release criteria is a significant impediment to the recovery of materials arising from decommissioning

- ✓ Task Group examined existing and proposed standards and regulations and compared these with those from 1996

- ✓ Since 1996, there are 4 international reference documents that provide high level guidance
  - ✓ IAEA RS-G1.7 (RP 157, comparative study between IAEA RS-G1.7 and RP122, **2010**)
  - ✓ RP89 – Radiological protection criteria for the **recycling of metals** (**1998**)
  - ✓ RP113 - Radiological protection criteria for **clearance of buildings and rubble** (**2000**)
  - ✓ RP122 – part 1, **guidance on general clearance levels** for practices (**2000**)

Current Policies and Regulations

- ✓ The Task Group prepared a survey questionnaire to gather information from participants. General results from questionnaire analysis show that :

  - ✓ Recycling is most commonly achieved through **unconditional clearance** and conventional materials recycling
  - ✓ Recycling after **conditional clearance** or recycling within the nuclear industry are mainly attempted **when unconditional clearance** is **not achievable**

Routes	**Number of responses**
Conditional clearance and conventional recycling	2
Conditional clearance and recycling within the nuclear industry	4
Recycling within the nuclear industry without clearance	3
Unconditional clearance and conventional recycling	15
Was any other route to recycling used?	2
Total	**26**

Current Policies and Regulations

- ✓ Unconditional clearance practices:
  - ✓ Generally well-regulated practice. Since 1996, a legal framework exists in most countries.
  - ✓ Unfortunately differences remain between countries, i.e.:
    - ✓ Mass specific limits for a radionuclide may vary from country to country, but always within RP89-limits (i.e. Cs-137 for **metals**: 0,1-1Bq/g)
    - ✓ Unconditional clearance of **building rubble and concrete blocks** from nuclear areas is a challenge : release limits are either mass specific (blocks and rubble, Germany), surface area specific (whole buildings prior to demolition, Germany) or in some cases, a combination of both (Belgium)

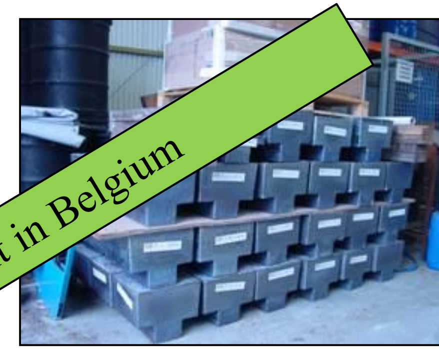
Current Policies and Regulations

- ✓ Conditional clearance practices
  - ✓ Legal framework exists in many countries despite absence of international guidance
    - ✓ Some countries have developed specific national regulations and release limits that are based on this international guidance (**Germany, Spain and Belgium**)
    - ✓ Other countries use these international guidelines to regulate on a site specific, case by case basis (**USA, Italy and Sweden**)
  - ✓ The **UK** currently does not have regulations for conditional clearance but there is an additional waste classification (VLLW) which allows certain wastes to be disposed at landfill sites
  - ✓ **France** is an exeption, having no regulation for clearance

Experience since 1996

- ✓ Case studies metal
  - ✓ Clearance and recycling of large components
  - ✓ Recycling of lead

Ringhals NPP in Sweden



BR3 Nuclear Power Plant in Belgium

  - ✓ Recycling of copper (WAK)

Experience since 1996

- ✓ Case studies metal
  - ✓ Clearance and recycling of aluminium
    - ✓ Ningyo-Toge U-enrichment plants, from pipes from gas centrifuges
    - ✓ Total amount : 602 tonnes
    - ✓ 11 tonnes reused for flower beds
    - ✓ Lack of public acceptance, no conventional recycler would accept the material

Conclusions (1)

- ✓ Several international guidelines exist for how clearance and R&R of materials should be regulated and many countries that have developed specific criteria have achieved high levels of success.
  Nevertheless, harmonisation of regulations amongst countries has not evolved significantly in the past 20 years.

- ✓ The IAEA and European Commission have developed high-level guidance and criteria that provide a framework for national-level policies and procedures.
  - ✓ For unconditional clearance, most countries use the general limits introduced in these documents with minimal to no further restrictions.
  - ✓ For conditional clearance, national legislation and site specific regulations are routinely imposed by authorities for all materials.

- ✓ Many case studies illustrate that it is not only feasible to safely release materials, but also cost beneficial.

Conclusions (2)

- ✓ Instrumentation may not be capable of meeting the requirements of risk-based very stringent clearance standards.
- ✓ Key drivers for recycling are generally the lack of disposal facilities and the comparison of costs between recycling options and disposal.
- ✓ Stakeholder acceptance of R&R remains a barrier. Greater involvement of regulators in communicating directly with recyclers and the public can lead to enhanced trust and alignment of objectives.
- ✓ Numerous challenges to recycling and reuse of materials persist internationally.
- ✓ The TGRRM feels that success stories, such as those included in this report, need to be shared internationally to help build consensus for the safe R&R of valuable materials.

Thank you for your Attention!

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Report content

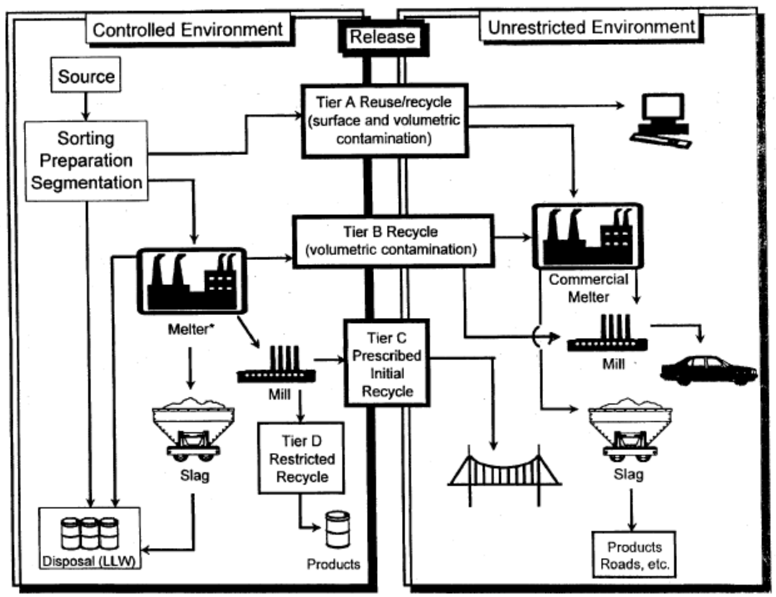
- The report considers the following :
  - ✓ Executive Summary (Ch3)
  - ✓ Review of the 1996 report and its conclusions (Ch4)
  - ✓ Policies, regulations and regulatory control (Ch5)
  - ✓ Case Studies (Ch6)
  - ✓ Drivers to adopt a R&R strategy and Stakeholder issues (Ch7)
  - ✓ Barriers, Constraints, Restrictive Factors and Keys to Succeed (Ch8)
  - ✓ Conclusions (Ch9)
  - ✓ Bibliography : review of accessible data from IAEA, EC and government websites related to Recycling and Reuse legislation and guidance (Ch10)
- Report does NOT contain :
  - ✓ details of Decontamination Techniques for metal or concrete
  - ✓ Techniques for undertaking release measurements …as these have been studied previously

Case studies

Project	Site	Country	Material	Amount/tonnes	Physical form/processing	Tier	Endpoint
BWR turbine rotors Ringhals NPP	Ringhals NPP	Sweden	Steel	360	Large/whole component	A	Conventional recycler
Berkeley boilers	Berkeley NPP	UK	Steel	3200	Segmented component/melting	A, B	Conventional recycler
Lead from removable shielding	BR3 NPP	Belgium	Lead	34	Encapsulated lead/melting	A, D	New hot cells
Fuel reprocessing plant	Eurochemic	Belgium	Concrete/ Steel	25,166/2,439	Building structures and rubble	A	Conventional recycler
Concrete from PWR Containment	Ringhals NPP	Sweden	Concrete	200	1 tonne concrete blocks	A	On-site construction
Sorting plant decommissioning	Ranstad uranium processing facility	Sweden	Concrete	15,000	Building structures and rubble	B	Site remediation
Release of cable	WAK	Germany	Copper	4.15	Off-site cable shredder	A	Conventional recycler
Concrete debris recycling	JRR-3 research reactor	Japan	Concrete	1,800	Concrete rubble	A	Site remediation

Case studies

Project	Site	Country	Material	Amount/ tonnes	Physical form/processing	Tier	Endpoint
Gas centrifuges	Ningyo-Toge centre	Japan	Aluminium	11	Pipes	A	On-site construction
Off-gas building decommissioning	Caorso NPP	Italy	Concrete/Steel	7,200/908	Crushed concrete/Scrap metal	A	On-site construction
Turbine building	Caorso NPP	Italy	Concrete/Steel	-/8,272	Whole building/ Scrap metal	A	Reuse
Calder Hall cooling towers	Calder Hall NPP, Sellafield	UK	Concrete	5,200	Crushed concrete	A	Conventional recycler/Site remediation
Windscale pile chimney	Windscale, Sellafield	UK	Concrete	3,000	Crushed concrete	A	On-site construction
Waste management building	MZFR, WAK, Karlsruhe	Germany	Concrete	3,530	Whole building	A	Conventional recycler
Plant decommissioning	NPP Vandellos-1	Spain	Concrete	78,962	Concrete structures Scrap metal	A, D	Recycler/Site remediation


Controlled Environment
Release
Unrestricted Environment
Source
Sorting
Preparation
Segmentation
Tier A Reuse/recycle
(surface and volumetric
contamination)
Tier B Recycle
(volumetric contamination)
Commercial
Melter
Melter*
Mill
Tier C
Prescribed
Initial
Recycle
Mill
Slag
Tier D
Restricted
Recycle
Slag
Disposal (LLW)
Products
Products
Roads, etc.

World Nuclear Association Presentation & Activities

Dr. M. Pieraccini
Chairman of WNA Waste Management & Decommissioning activities

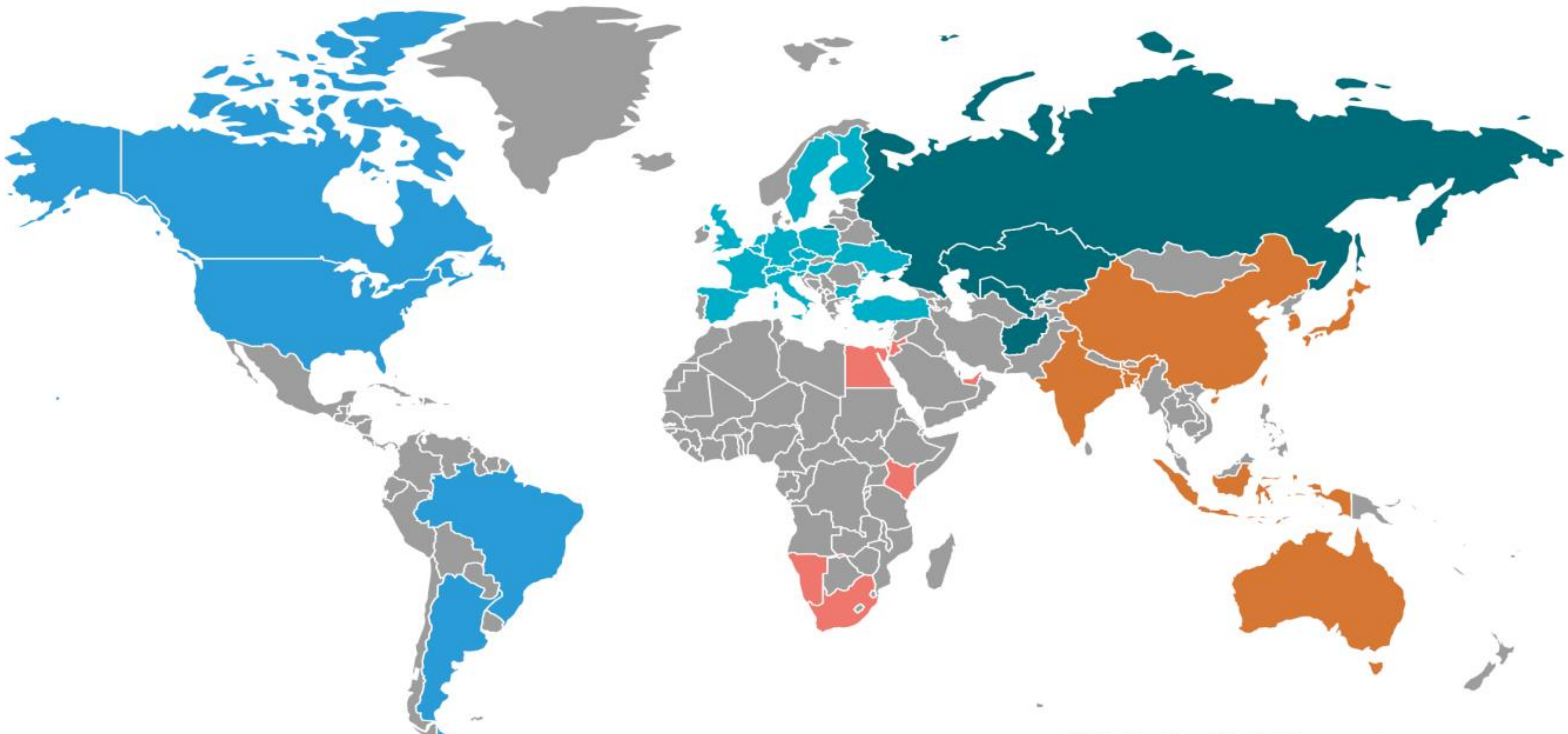
European Commission - Euratom - Share Project - 1st December 2020

WNA is the industry international organisation that represents the global nuclear industry

A strong network of 182 member companies from across the world (43 countries)

Europe | 57 members
Austria, Belgium, Bulgaria, Czech Republic, Finland, France, Germany, Hungary, Italy, Luxembourg, Netherlands, Poland, Slovenia, Spain, Sweden, Switzerland, Turkey, Ukraine, United Kingdom

Russia and Central Asia | 14 members
Afghanistan, Kazakhstan, Russia, Uzbekistan



Americas | 49 members
Argentina, Brazil, Canada, USA

Africa and Middle East | 11 members
Egypt, Israel, Jordan, Kenya, Namibia, South Africa, United Arab Emirates

Asia-Pacific | 51 members
Australia, Bangladesh, China mainland and Taiwan, India, Indonesia, Japan, Singapore, South Korea

Introduction

WNA's goal is to develop industry positions on relevant issues through our various groups

Fuel Cycle Working Groups	Fuel Report • Sustainable Used Fuel Management • Security of the International Fuel Cycle • Transport
Plant Performance Working Groups	Cooperation in Reactor Design Evaluation & Licensing • Supply Chain • Capacity Optimization • Waste Management & Decommissioning
Cross-Cutting Working Groups	Economics • Law • Radiological Protection • Nuclear Innovation Roadmap - NI2050
Advisory Groups	Advisory Panel • Communication Group

WORLD NUCLEAR ASSOCIATION

Introduction to WNA WM&D

Waste Management & Decommissioning Activities

✓ The **WNA WM&D WG monitors** developments **and shapes industry positions** with a view to improving the system of waste management and decommissioning

✓ The **WM&D WG is** the industry's interface **with official international institutions** such as the :

IAEA International Atomic Energy Agency

✓IAEA, (Waste Safety Standards Committee (WASSC), WATEC, IDN, …),

NEA NUCLEAR ENERGY AGENCY OECD

✓OECD/NEA (RWMC, CDLM, RF, FSC, …),

✓European Commission and its Institutions (Euratom, Foratom, …).

✓ The WG cooperates with other WNA WGs on topics such as Radiological Protection of workers during decommissioning, multinational repositories,
spent fuel, but also laws & economics.

WNA organises and fosters Important events

World Nuclear Association Strategic eForum 2020

High-level panels:

- Building a stronger and cleaner tomorrow with nuclear energy
  578 participants from 60 countries (9-11/09/2020)

- Driving investment towards nuclear projects
  435 participants from 49 countries

- Maximising nuclear energy's socio-economic & environmental benefits
  339 participants from 41 countries

- Launching The World Nuclear Supply Chain: Outlook 2040 Report
  23 September

- Working Group meetings
  1-25 September

WNA WM&D Contributions & New publications

UNITED NATIONS ECONOMIC COMMISSION FOR EUROPE

- ✓ Contribution to **UNECE 2020 Report** in cooperation with the IAEA
- ✓ 24 September - UNECE session on the role of nuclear energy resources in sustainable development (UNECE Energy Week 2020)

IAEA International Atomic Energy Agency

SETA 2020

- ✓ 12-15 October - Smart Energy Technology Asia 2020 virtual conference (SETA)

NEA OECD

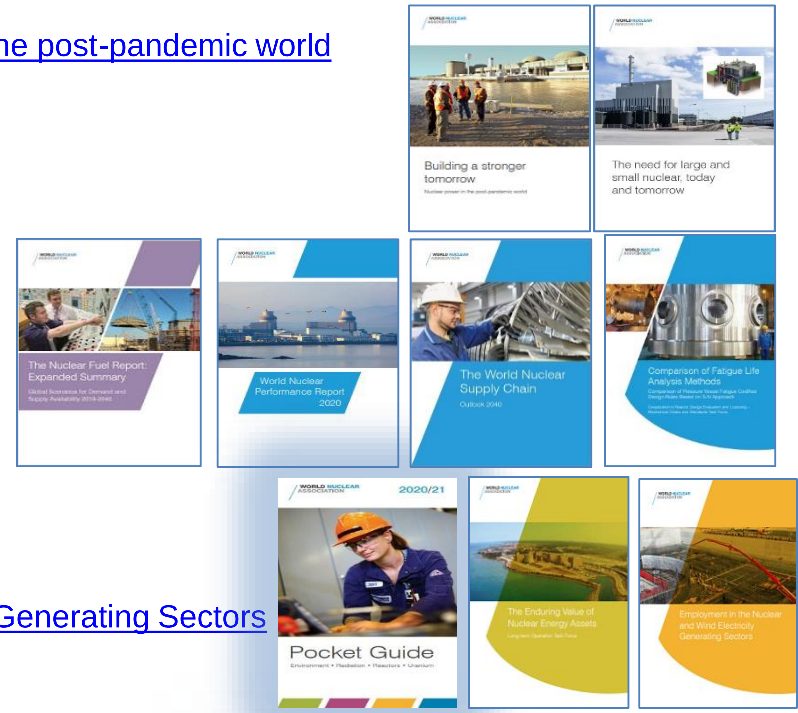
- ✓ First of a kind, in-depth, collaboration between OECD-NEA and the Association, co-developing policy briefs and a webinar series **on key themes devoted to low carbon energy development.**

WORLD NUCLEAR ASSOCIATION

Extract of some recent WNA Outcomes

White Paper / Policy Paper / Information papers / Reports / Technical Position Papers:

- **White paper:** Building a stronger tomorrow: Nuclear power in the post-pandemic world
- **Policy paper:** Policy Paper
- **Information papers / Press Statements :**
  - COVID-19 Coronavirus and nuclear energy
  - Security of Nuclear Facilities and Material
- **Reports:**
  - The Nuclear Fuel Report Expanded Summary
  - World Nuclear Performance Report 2020
  - The World Nuclear Supply Chain: Outlook 2040
  - Comparison of Fatigue Life Analysis Methods
  - Pocket Guide 2020/2021
- **Technical Position Papers :**
  - Employment in the Nuclear and Wind Electricity Generating Sectors
  - The Enduring Value of Nuclear Energy Assets
- **Harmony Bimonthly :** HARMONY What will power our electric future?



Radioactive Waste - Myths and Realities

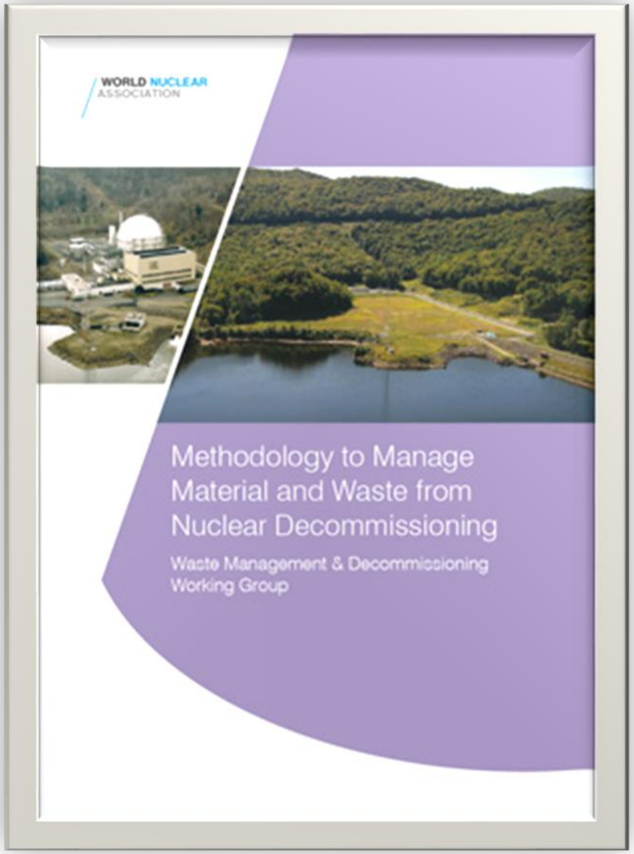
- **There are a number of pervasive myths regarding both radiation and radioactive waste.**
- **Some lead to regulation and actions which are counterproductive to human health and safety.**

Over the years, many views and concerns have been expressed in the media, by the public and other interested groups in relation to the nuclear industry and in particular its waste. Questions have been raised about whether nuclear power should continue when the issue of how to deal with its waste has apparently not yet been satisfactorily resolved.

Some of the more commonly expressed views and concerns include:

1. The nuclear industry still has no solution to the 'waste problem'.
2. The transport of this waste poses an unacceptable risk to people and the environment.
3. Plutonium is the most dangerous material in the world.
4. Nuclear waste is hazardous for tens of thousands of years. This clearly is unprecedented and poses a huge threat to our future generations.
5. Even if put into a geological repository, the waste might emerge and threaten future generations.
6. Nobody knows the true costs of waste management. The costs are so high that nuclear power can never be economic.
7. The waste should be disposed of into space.
8. Nuclear waste should be transmuted into harmless materials.
9. There is a potential terrorist threat to the large volumes of radioactive waste currently being stored and the risk that this waste could leak or be dispersed as a result of terrorist action.
10. Man-made radiation differs from natural radiation.

WNA WM&D Activities
Methodology to Manage Material and Waste from Nuclear Decommissioning



Available to download from the [Association website]

WNA WM&D Methodological Guide to manage Materials & Waste from Nuclear Decommissioning

- **As a consequence, in decommissioning, Material and Waste management strategy is induced by the following methodological sequence :**
  - End States and Decommissioning Strategies definition (in accordance with funds availability)
    - Dedicated Organisation based on Material & Waste Management lead decommissioning principle

  - Materials Inventories
    - to be made as early as possible than regularly updated
    - Nature and types of materials to be accurately selected during design and conception (in compliance with available waste routes (**Do not generate waste without outlet**)
  - Waste Routing to be identified following available means, treatment facilities
    - **Waste volume reduction, recycling, reuse are to be given the priority**

  - Management in Practice of Radioactive Waste
    - Any kind of available process that mitigate risks and volumes (decontamination, remediation, incineration, melting, …)
    - Keeping in mind that disposal have to be considered as rare resources only devoted to real radioactive materials
  - Provide Funds mechanisms and Skilled Resources, to be Available, ON TIME, when needed
  - Taking into account lessons learnt : Continuous improvement , taking into account international feedback and technical innovation to reduce ultimate waste volume and consequently decommissioning durations

Key Driver : Anticipate, Improve, be opened

As a Summary, the Guide reminds that a well mastered decommissioning process :

- **relies on :**
  - An **earliest as possible involvement** of all counterparts (owners, operators, regulators, local/national authorities, …) to agree on suitable means & funds **to build credibility towards public acceptance**,
  - A **clear definition** of aimed **end state** mainly based on the implementation of waste hierarchy,
  - Application of a **sequence of steps** to be followed as **Key principles** being reminded by the **structure of the** Methodological **Guide** itself,

- **will result in:**
  - The smallest possible volume of waste packages for final disposal,
  - Preserved storage capacity as **repositories are considered as rare resources**,
  - Reduction of Waste liabilities & **risk mitigation approach**, especially when repository unavailability.
  - The opportunity to optimize the overall waste management cost,
  - The opportunity to **enhance** a constructive **regulator/operator partnership** to improve safety, preserving environmental impacts as well as non-renewable raw materials,
  - the opportunity to develop solutions for some "exotic" challenging material, such as Irradiated graphite, to maintain nuclear industry credibility and stakeholders' confidence. Common Regulators/operators Solutions need to be found to foster **circular economy** !!
  - encouraging the **recycling and reuse** and thus the minimization of waste to be disposed of,
  - a better shared knowledge and application of worldwide existing BAT if it is coupled with a kind of regulation alignment/Harmonisation between countries.

Events

- ✓ **1-25 September 2020** – Working Group meetings, Online
- ✓ **2 September 2020** – Strategic eForum pre-event on *Industry Gamechangers*, Online
- ✓ **9-11 September 2020** – World Nuclear Association Strategic eForum 2020, Online
- ✓ **23 September 2020** - Launching The World Nuclear Supply Chain: Outlook 2040 Report, Online

- ❑ **12-13 January 2021** – Working Group meetings, Online
- ❑ **12-13 April 2021** – Working Group meetings, Stockholm, Sweden
- ❑ **13-15 April 2021**– World Nuclear Fuel Cycle 2021, Stockholm, Sweden
- ❑ **8-10 September 2021** – World Nuclear Association Symposium 2021, London, UK

Thank you for your Attention

www.world-nuclear.org

WNA WM&D Methodological Guide to manage Materials & Waste from Nuclear Decommissioning

3 Decommissioning Strategy options are available
(Refering to International Guidelines and Safety Standards)

International Standard ecommissioning Strategy

Decom strategy impacts on edules / Waste volumes / Costs

➔ "The Earlier , the better"

WNA METHODOLOGICAL GUIDE ON the MANAGEMENT OF MATERIALS & WASTE COMING FROM DECOMMISSIONING

Example of Decommissioning Strategy Principle and Waste Management Optimisation driven by early/reactive relationship between operators and regulators, defining clear WAC and mastered concerted regulation process