



ROUTES - Identified key issues and open questions about waste management routes in Europe, from cradle to grave

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OUTLINE

- ROUTES objectives and methodology
- Scope of tasks and key outcomes so far
- International collaboration
- Role of case studies and examples of their application in ROUTES
- Look-ahead for this EURAD work package



ROUTES OBJECTIVES

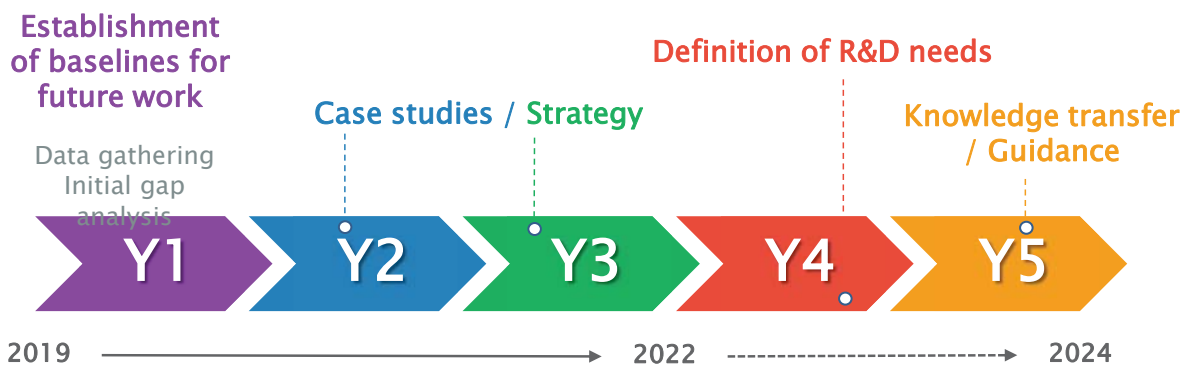
- Provide an opportunity to **share experience and knowledge** on waste management routes between interested organisations from different countries
 - different stages of development
 - different amounts and types of radioactive waste to manage



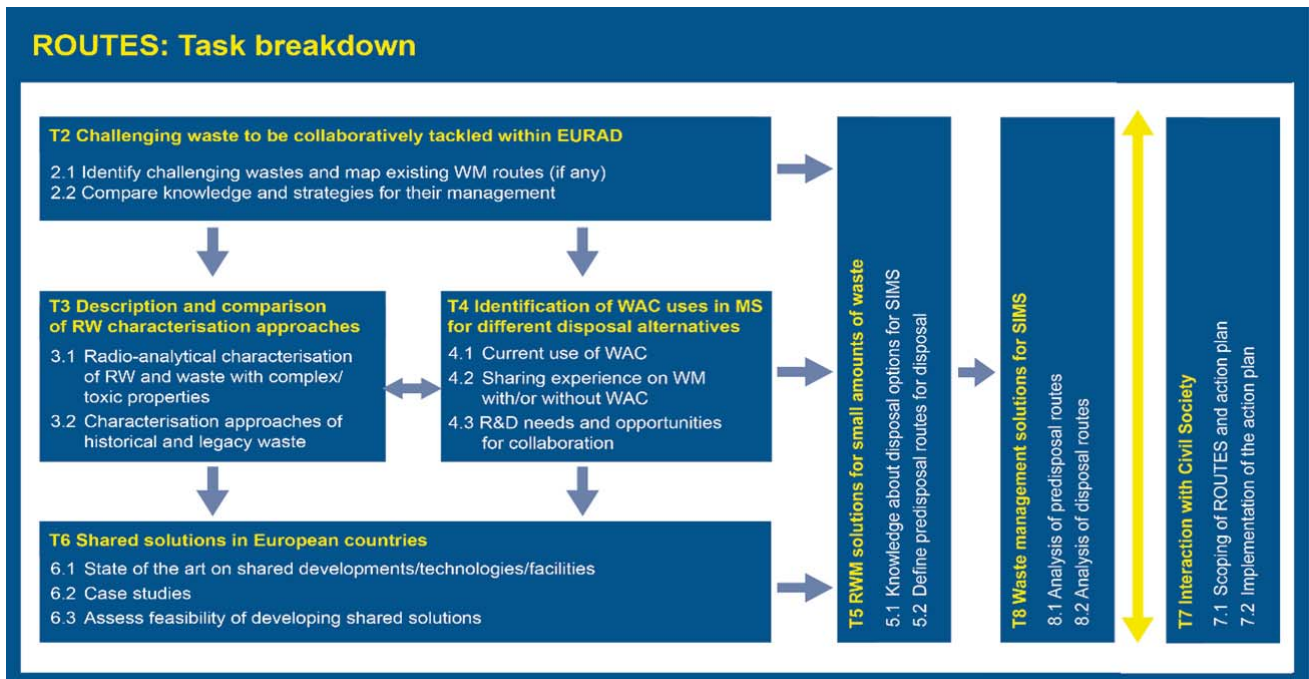
- Identify opportunities for collaboration between European Union (EU) Member-States (MS)



ROUTES METHODOLOGY



TASK BREAKDOWN



TASK 2 – CHALLENGING WASTE

UNDEFINED
MANAGEMENT
ROUTE ?

PROBLEMATIC
INTRINSIC
PROPERTIES

HOW TO DEFINE
« CHALLENGING WASTE » ?

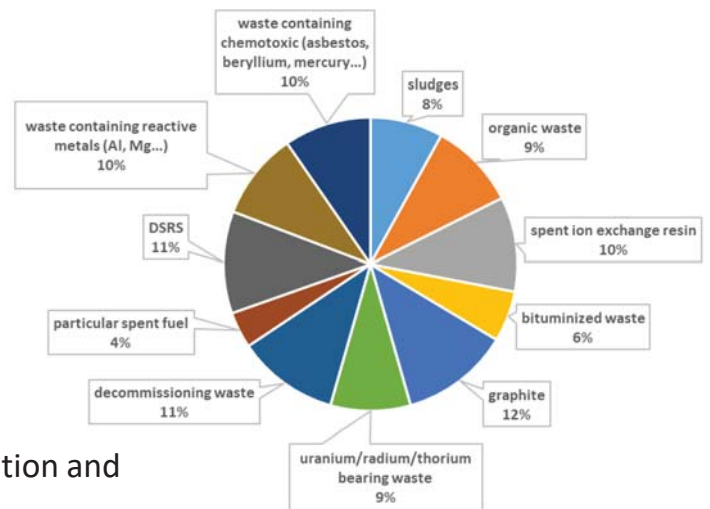
UNCERTAIN
INVENTORY

UNCERTAINTIES
RELATED TO THEIR
BEHAVIOUR



TASK 2 – CHALLENGING WASTE

11 challenging waste types
(common to multiple
Member States) identified



Outcomes

- Comparison of radioactive waste classification and categorization approaches
- Overview of challenging waste streams specific to each country
- Case studies on strategies to cope with issues related to the management of challenging waste



TASKS 3 & 4 – CHARACTERISATION AND WAC

Approaches

- Comparison of strategies, techniques and criteria for characterisation
- Case studies in order to share experience on waste management with/without WAC available

Outcomes

- Observations and recommendations of 'no regret' waste management measures through all waste lifecycle stages and during WAC development
- Approaches that impart flexibility to adapt future WM practices are of particular value when WAC are unavailable and/or the disposal route is unknown



TASKS 5 & 8 – SMALL INVENTORY MEMBER STATES

What is a “SIMS” ?

- Countries with a limited inventory (1 NPP max. or an estimated 20-25,000 m³ of conditioned radioactive waste)
 - In ROUTES: Austria, Croatia, Cyprus, Denmark, Estonia, Greece, Ireland, Latvia, Luxembourg, Malta, The Netherlands, Poland, Portugal and Slovenia

First outcomes

- Up-to-date description and comparison of approaches adopted by SIMS for the management of radioactive waste with a focus on disposal
- Work already conducted seen as highly beneficial in terms of knowledge transfer and identifying challenges. However, need to strengthen the collaboration between SIMS and LIMS

→ **Addition of Task 8** (started in 2021), focused on pre-disposal routes, disposal options including the applicability for SIMS, as well as the interdependency of pre-disposal and disposal steps, which will result in the preparation of case studies



TASK 6 – SHARED SOLUTIONS

Broad definition of “shared solutions”

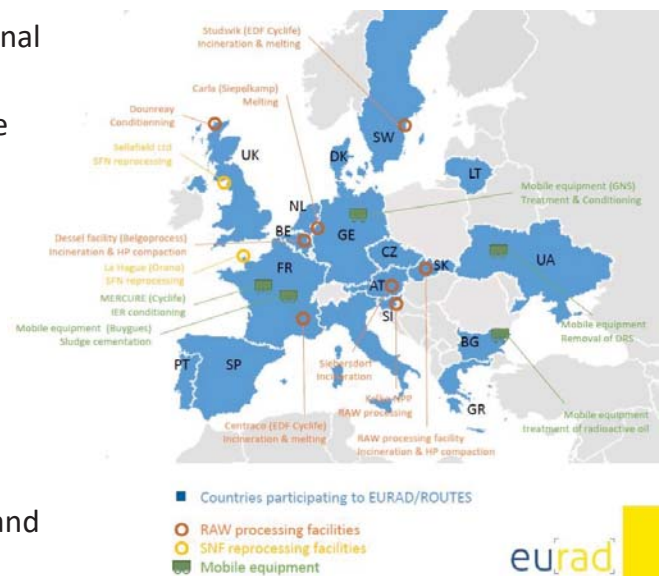
- Routes for sharing of knowledge (e.g. multinational programmes)
- Facilities treating or having treated foreign waste
- Mobile systems

First outcomes

- Achievement requires innovative developments
- Issues related to public acceptance

Perspectives

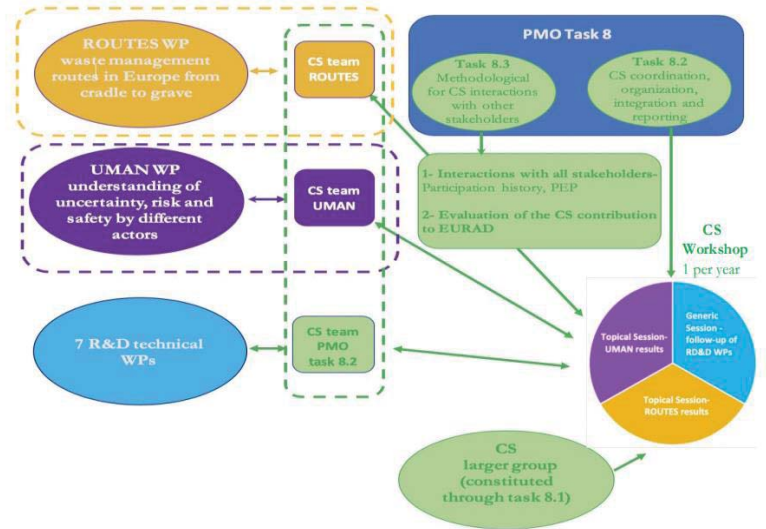
- Case study analysis on mechanisms, challenges and experiences in sharing



TASK 7 – INTERACTIONS WITH CIVIL SOCIETY

First outcomes

- Action plan including a description of further work, particularly in relation to ROUTES Task 2, Task 5 and Task 6
- **Investigations** already carried out in relation to the ROUTES Task 6 focused on transparency of shared solutions
- Two published deliverables



INTERNATIONAL COLLABORATIONS

April and May 2021 –
Two joint PREDIS/ROUTES/ERDO
webinars on WAC

Presentation of
ROUTES
to PREDIS and
SHARE Workshops



March 2021 - Joint session
CORI/FUTURE/ROUTES/KM



ICS meetings with
Civil Society larger
group

October 2021 – Session on
organic waste with CORI



Joint ROUTES – PREDIS
poster at
EURADWASTE 2022



Participation of NEA and IAEA
representatives in several workshops



ROLE OF CASE STUDIES IN ROUTES

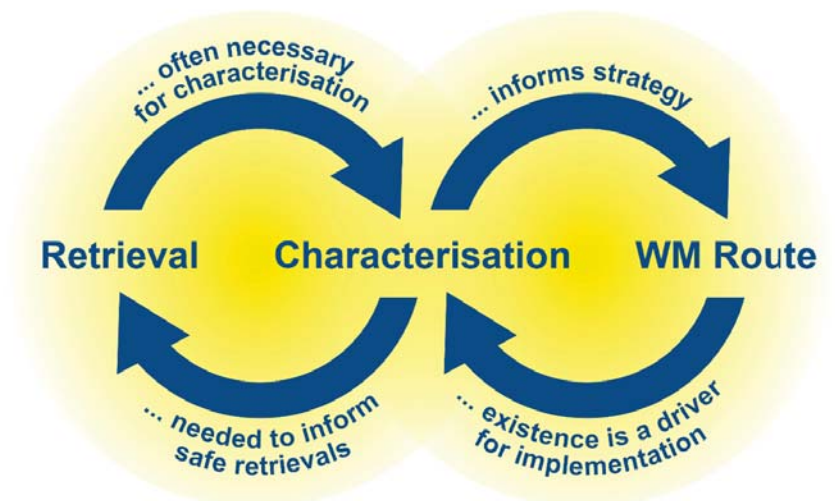
- Lessons learnt from real world experience are more relevant and representative than understanding gained by looking at collated inventories or high-level / hypothetical approaches
- Examined in all areas of ROUTES work programme
- Some examples of their application follow, illustrating:
 - Waste management challenges
 - Approaches taken to respond
 - Basis of recommendations for further R&D

BITUMINIZED WASTE OF RIVINE NPP (UKRAINE)
 WAC for ENSDF were established in 2008, and the last drum with bituminized waste was produced in 2002
 Waste acceptance criteria for ENSDF

	Met	Partially met	Not met
Radiological			
Radionuclide concentrations	Met	Partially met	Not met
Chemical			
Corrosivity and leaching agents	Met	Partially met	Not met
Leaching	Met	Partially met	Not met
Resistance of RW packages	Met	Partially met	Not met
Physical stability	Met	Partially met	Not met
Physical			
Permeability and porosity	Met	Partially met	Not met
Structural stability	Met	Partially met	Not met
Seismic	Met	Partially met	Not met
Mechanical strength of RW packages	Met	Partially met	Not met
Heat	Met	Partially met	Not met
Thermal stability	Met	Partially met	Not met

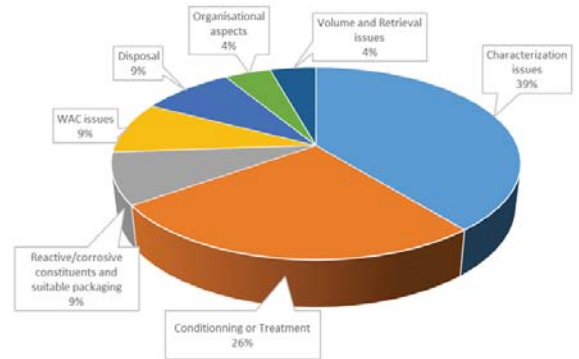


CHARACTERISATION OF LEGACY WASTES



THE EXAMPLE OF LEGACY SLUDGES

- Sludges are a common challenging waste
 - Significant variations within and across Member States
 - UK: Sludge from degradation of Magnox spent fuel during long storage
 - France: Sludges from spent fuel reprocessing and liquid effluent treatment



- Approaches to address challenges
 - Characterisation campaigns examining material sampled at different depths
 - In-depth examination of historical records (where available)
 - Requirements to recondition drums of corroded waste offer opportunities for further sampling and characterisation



WHEN TO IMPLEMENT (FINAL) WASTE CONDITIONING ?

Waste Conditioning Operator

Difficulties in defining an efficient management route with preliminary WAC

EARLY FINAL CONDITIONING

- Overall cost savings (once-through, passively safe product)
- Provides a disposable product
- Encourages standardisation
- Encourages open dialogue and trust between the Operators, the Safety Authority, the Regulator and other stakeholders
- Acceptability of 'final' packages for disposal is uncertain, especially if no existing WAC
- Early (up-front) costs

How to design the final waste conditioning ?

Disposal Facility Operator

Difficult to fix the WAC too early in the design of the disposal before completing all the safety options

DELAYED FINAL CONDITIONING

- Leaves options open (emerging technology)
- Reduces initial investments
- Final disposal acceptance less uncertain (WAC are more mature)
- Defers hazard reduction → future burden
- Requires future retrieval and re-packaging with potential evolutions / degradation of the initial conditioning solution
- May produce additional secondary waste



EXAMPLES OF APPROACHES TO RESPOND TO THIS CHALLENGE

Netherlands

- National policy for interim storage (>100 years) followed by geological disposal
- Early conditioning deployed
- Monitoring and inspection to confirm stability of packages during storage
- Safety assessment and WAC for storage are stringent and considered to be bounding of requirements for safe disposal
- Some deferred conditioning to optimise approach
- “Smart packaging and stacking”



United Kingdom

- Packaging of spent fuel in self-shielded boxes (SSBs) without matrix conditioning
- Flexible, reversible ‘middle ground’
- Facilitates emptying and decommissioning of ageing facilities
- Packages might be disposed but waste could also be reconditioned relatively easily
- Associated implications for lifecycle costs



BRINGING EXPERIENCE FROM LIMS TO SIMS

- Small Inventory Member States (SIMS) often face constraints on resources available for waste management
 - Limited pools of expertise / know-how
 - Few existing facilities / limited infrastructure
 - Funding limitations – low priority may be assigned to RAW management
- Often no, or only immature disposal strategy
 - Progressing waste treatment and conditioning is risky
- Small volumes make development of dedicated solutions disproportionately expensive
- Shared solutions of particular interest

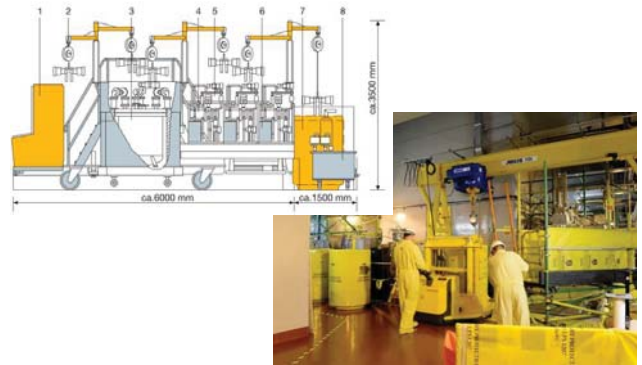
Greek case

- ~60 drums of cemented residues from research activities between 1970-1990
- Uncertainty over inventory and approach to characterise
- Evaluating options for deploying mobile characterisation facilities, drawing on experience and capabilities in other MS



DEVELOPMENT OF SHARED SOLUTIONS

- Explored for over 20 years
 - SAPIERR and SAPIERR2
 - Establishment of ERDO working group
- Continues to be much interest in the possibility of shared disposability facilities, particularly amongst SIMS
 - Only one agreement for shared disposal to-date (Luxembourg and Belgium)
- Shared solutions for characterisation, treatment and conditioning also of significant value
 - Many examples of their implementation (e.g. in Sweden, Germany, France)
 - Value of mobile facilities highlighted, particularly for SIMS → no need for dedicated facility development



SHARED SOLUTIONS – GENERAL FINDINGS

- Shared solutions provide best added value for SIMS that do not have the infrastructure for dedicated WM solutions
 - Their implementation raises critical issues
- Good transparency (public access to information, evidence-based decision-making, effective public participation and access to justice) must be established
- Specific deliberative process should be developed, with proper representation from local, national and multinational actors beside officials
- Shared solutions do not have to be purely technical
 - Opportunities for joint regulation?

LOOK AHEAD : UPCOMING ROUTES ACTIVITIES

- Years 4 & 5 → identify and prioritise common R&D needs and opportunities for collaboration
 - Particularly harmonisation of WM approaches as a precursor to more extensive shared waste management and disposal activities
- ROUTES annual meeting 21-23 June 2022
 - Workshop on feasibility of shared solutions
 - Industrial visits to La Hague and CSM Manche
- EURAD annual meeting follow-up discussions
 - KM and the role of strategic studies
- ROUTES contributions to EURAD / PREDIS KM activities
- Interactions with other EC projects



Thank you for your attention!



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