

### PRESENTATION STRUCTURE

- Context of ROUTES
  - Objectives
  - List of wastes considered CHALLENGING
- **Structure** of ROUTES
  - Tasks, subtasks
  - Belgian partners involved
- Methodology followed
- Results
  - ROUTES recommendations for future R&D and collaboration
  - Applicability to the Belgian context
    - o General
    - Overview of ROUTES Deliverable Reports
    - o ROUTES recommendations for 'NO REGRET' waste management measures

### **CONTEXT OF ROUTES**

- ROUTES is one of the two strategic studies as part of EURAD
- Subject of study: waste management routes ('from cradle to grave') in Europe, with focus on 'challenging' wastes (see next slide)
- Objectives of ROUTES
  - 1. Opportunity to **share experience and knowledge** on waste management routes between interested organisations (from different countries, with programmes at different stages of development, with different amounts and types of radioactive waste)
  - 2. Identify safety-relevant issues and their **R&D needs** associated with the waste management routes, including routes of legacy and historical waste, considering interdependencies between all stages of waste management
  - 3. Describe and compare the different approaches to characterisation, treatment and conditioning and to long-term waste management, and identify opportunities for collaboration between member-states.

### **CHALLENGING WASTES**

### Wastes considered 'challenging' within ROUTES

- 1. Sludges
- 2. SIERs (spent Ion exchange resins)
- 3. Organic waste
- 4. Bituminized waste
- 5. Graphite waste
- 6. Decommissioning waste
- 7. DSRs (disused sealed radiation sources)
- 8. Particular spent fuel
- 9. Radium/thorium/uranium-bearing waste
- 10. Waste containing reactive metals
- 11. Waste containing chemotoxic substances

# **ROUTES STRUCTURE (TASKS)**

- Task 1 Coordination
- Task 2 Identification of challenging wastes
- Task 3 Characterization approaches
- Task 4 WAC (1)
- Task 5 Waste management solutions for small amounts of wastes, focusing on SIMS (2)
- Task 6 Shared solutions for characterization, treatment, storage and disposal
- Task 7 Interactions with Civil Society
- Task 8 ROUTES Extension (Evaluation of possible waste management solutions in case of small inventory and absence of WAC)

- (1) WAC = Waste Acceptance Criteria
- (2) SIMS = Small-Inventory Member States

# **ROUTES STRUCTURE (SUBTASKS)**

- Task 1 Coordination
- Task 2 Identification of challenging wastes
  - **Subtask 2.1** (Collection and analysis of existing work on categorization and classification of radioactive waste)
  - Subtask 2.2 (Understanding at EU level of the practical issues on RWM routes for challenging waste)
- Task 3 Characterization approaches
  - **Subtask 3.1** (Radioanalytical characterisation of radioactive waste and waste with complex/toxic properties)
  - **Subtask 3.2** (Characterization and segregation of legacy waste)
- Task 4 WAC
  - **Subtask 4.1** (Current use of waste acceptance criteria)
  - **Subtask 4.2** (Sharing experience on waste management with/without WAC available)
  - Subtask 4.3 (R&D needs and opportunities of collaboration)

# **ROUTES STRUCTURE (SUBTASKS)**

- Task 5 SIMS
  - **Subtask 5.1** (Collecting and analyzing actual existing knowledge about disposal options for SIMS)
  - **Subtask 5.2** (Describe the necessary predisposal routes for the disposal options of subtask 5.1)
- Task 6 Shared Solutions
  - **Subtask 6.1** (State-of-the-art on shared development and use of technologies and facilities)
  - **Subtask 6.2** (Case studies on shared development and use of technologies and facilities)
  - Subtask 6.3 (feasibility of developing further European shared solutions for cradle to grave waste management)
- Task 7- Civil Society
  - Subtask 7.1 (Scoping and development of action plan for interaction with Civil Society)
  - **Subtask 7.2** (Implementing the action plan)
  - Subtask 7.3 (Synthesis and dissemination)
- Task 8 ROUTES extension
  - **Subtask 8.1** (qualitative analysis of predisposal routes)
  - Subtask 8.2 (qualitative analysis of disposal options)

### **BELGIAN PARTNERS INVOLVED IN ROUTES**

#### Partners involved



sck cen



### Involved ROUTES Tasks

TASK 1	Coordination			ONDRAF/NIRAS
TASK 2	Identification of challenging wastes	BEL V Belgian TS0	scl: cen	ONDRAF/NIRAS
TASK 3	Characterization approaches		sck cen	ONDRAF/NIRAS
TASK 4	WAC			= Task co-leader
TASK 5	SIMS			ONDRAF/NIRAS
TASK 6	Shared solutions			
TASK 7	Civil Society			
TASK 8	ROUTES extension			ONDRAF/NIRAS

### **METHODOLOGY**

- Structured steps: initial data gathering → inclusive workshops → detailed analysis
- Alle ROUTES tasks initiated with a data gathering and analysis phase

This phase entailed surveys, workshops, and case studies

- Collecting information on national waste classification, inventory, practices regarding predisposal steps and disposal facilities, and related aspects
- Compilation of information and analysis results in milestones and deliverables

#### Inclusive workshop approach

- Facilitating collaboration among a diverse array of stakeholders
- Pivotal forums for partners with various backgrounds (SIMS and LIMS alike)
  - → Diverse perspectives are comprehensively considered
    - → Holistic and inclusive recommendations that reflect the broader societal context
- A dedicated workshop, convened in December 2022, served as a focal point for deliberating and refining recommendations generated within the project
  - → ROUTES recommendations fed into the **EURAD-2 Strategic Research Agenda**

# **R&D** needs and opportunities for collaboration (ROUTES recommendations)

Comparison of approaches regarding Common analysis on disposal strategy Impact of the EU green deal on radioactive implementation of access to resources and for waste that Do Not Meet WAC for Existing waste management inclusivity / Planned Facilities Identification of social and technical Common analysis on disposal strategy Strategic study Identification of challenges related to interrelated challenges related to long-term for particular spent fuel and depleted Long-term / rolling stewardship recommendations storage uranium Comparison and standardisation of Harmonization of procedures to facilitate SMR WASTE management radionuclides (and their speciation) to account collaborations between MS for in waste characterisation and WAC Benchmarking Exercise for WAC Development Research on Wigner Energy Threshold for Development of a mobile facility for RAW Characterisation methods to determine compliance of particular wastes with WAC WAC characterization, treatment or conditioning Research and Investigate characterization Development of methodology for Development of innovative Development methodologies and identification techniques representative sampling of challenging non destructive methods for DSRS and orphan sources waste types recommendations Investigate particular needs on treatment Development of innovative methods for Explore long-term behaviour processes for bituminized wastes coming scaling factors validation of innovative matrices from reprocessing **Development of guidance** Knowledge Development of a forum Development of guidance for the implementation of deep borehole for knowledge transfer between LIMS and Management for effective public access to information disposal, SIMS recommendations including their safety case development

### APPLICABILITY TO THE BELGIAN CONTEXT

- Recommendations for future R&D, strategic studies and KM
  - → Offer opportunity for R&D and strategic studies in a **European collaborative context** 
    - → Scale benefits, benchmarking, networking
- Descriptions and comparative summaries of the different approaches to waste management in European countries (characterisation, treatment, conditioning, long-term management)
  - → **State-of-the-art overview** of approaches to managing challenging wastes in EU
- Case analyses and treatment of specific cross-cutting topics
  - → Examples of dealing with **specific** waste management challenges
- General recommendations
  - → **Guidance/inspiration** in waste management dilemmas (e.g. early/late conditioning)
- Awareness of the importance of interaction with Civil Society

### **DELIVERABLE REPORTS**

(available on the EURAD website https://www.ejp-eurad.eu/publications)

#### Task 1 – Coordination



- D9.3 "ROUTES Recommendations for R&D, strategic study and KM activities"
- Task 2 Challenging wastes
  - D9.4 "Overview of existing work on categorization/classification of RWs in participating states"



- D9.5 "Overview of issues related to challenging wastes"
- Task 3 Characterisation
  - D9.7 "Review of radioanalytical characterisation of selected radioactive wastes and wastes with complex chemical and toxic properties"
  - D9.8 "Review of characterisation of legacy and historical wastes"

### **DELIVERABLE REPORTS**

#### Task 4 – WAC



- D9.9 "Suggestions for the management of challenging wastes"
- D9.1 "Training Materials" (on the joint ROUTES-PREDIS Summer School on WM, September 2023 in Prague)

#### Task 5 – SIMS

- D9.10 "Collection and analysis of actual existing knowledge about disposal options for SIMS"
- D9.11 "Results of the workshop dealing with possible conditioning routes for SIMS"

#### Task 6 – Shared Solutions





- D9.13 "Case studies on shared solution between Member states"
- D9.14 "Feasibility of developing further European shared solutions for waste management from cradle to grave"

### **DELIVERABLE REPORTS**

Task 7 – Civil Society



- D9.19 "Synthesis of Task 7 activities" (encompasses D9.15, D9.16, D9.17 and D9.18)
- Task 8 ROUTES extension
  - D9.21 (Report on Evaluation of existing predisposal routes for SIMS with regard to disposal options)
  - D9.22 (Summary report on analysis, assessment and evaluation of disposal options for SIMS)

### 'NO REGRET' WASTE MANAGEMENT MEASURES

- **D9.9** (Task 4) contains recommendations for 'no regret' measures in all management route phases (characterisation, treatment, conditioning, storage, disposal)
  - Figure below summarizes pros & cons of early versus delayed conditioning
  - o Repackaging without matrix conditioning can provide a flexible and reversible intermediate solution

#### Waste Conditioning Operator

Difficulties in defining an efficient management route with preliminary WAC



#### Disposal Facility Operator

Difficult to fix the WAC too early in the design of the facility before completing all safety evaluations

#### EARLY FINAL CONDITIONING

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

#### **DELAYED FINAL CONDITIONING**

- Leaves options open (to use 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 evolution / degradation of the initial conditioning solution
- May produce additional secondary waste