

Meeting of Nuclear Back-End Financial Aspects expert group, 8 June 2022

EURAD – European Joint Programme on Radioactive Waste Management

Overview & links to cost estimation / financing

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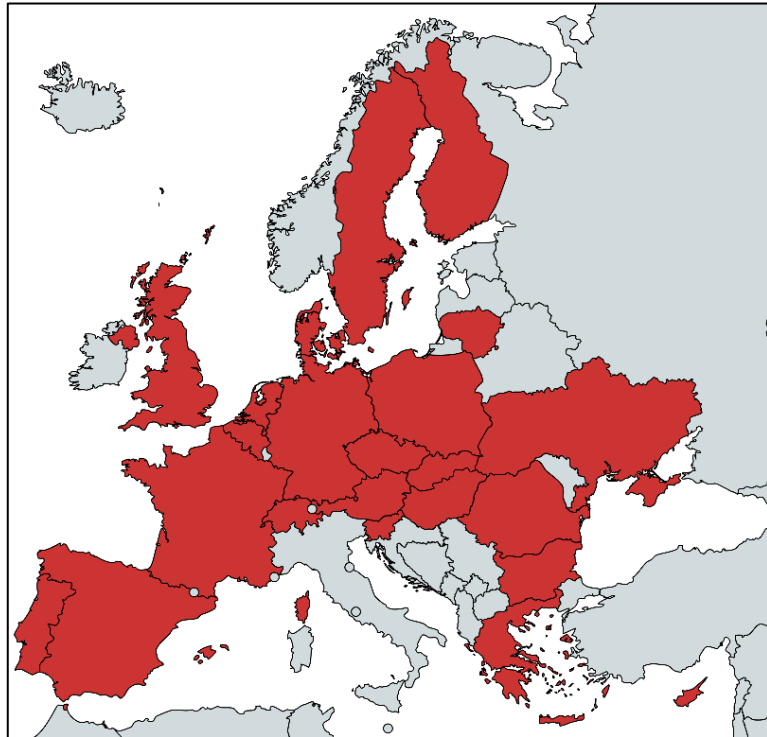
My presentation

- **Introduction of EURAD**
- **Current status**
- **Looking ahead**
- **Links of EURAD to cost estimates and financing – my personal understanding**

EURAD – Key Characteristics

- Participation of **23 countries** with rather **different boundary conditions**
 - **advanced programs** vs **early stage programs**
 - programs with **large inventories** vs programs with **small inventories** with **differences in 'complexity'** of the waste inventories of the different programs
- **Participants** of EURAD with **clearly defined roles** in their **national program** (**mandated actors**: 51), supported by **linked 3rd parties** (62) and involvement of **international partners** (3)
- **Civil society** involved – 22 members in the CS larger group
- Overall: **116 organisations** with ~ **800 individuals**
- **End-user groups** with more than 100 persons from 21 countries
- Interaction and cooperation with **international organisations** (IAEA, OECD/NEA) & **other projects/organisations**

EURAD – Countries & Mandated Actors



23 countries with ...

... and linked 3rd parties & international partners

Waste Management
Organisations: 19



Regulatory Technical
Support Organisations: 13



Nationally funded
Research Entities: 19



The Vision of the European Joint Programme EURAD

Provide added value to member states in their timely implementation of RWM activities

The vision of the European Joint Programme on Radioactive Waste Management (EURAD) is:

“A step change in European collaboration towards safe radioactive waste management (RWM), including disposal, through the development of a robust and sustained science, technology and knowledge management programme that supports timely implementation of RWM activities and serves to foster mutual understanding and trust between Joint Programme participants”.

By step-change we mean a new era of more effective and efficient use of public RD&D funding in Europe, and a deepening of research-cooperation between Member States. We aim to implement a strategic Joint Programme of research and knowledge management activities at the European level, bringing together and complementing national EU Member State programmes in order to ensure cutting edge knowledge creation and preservation in view of delivering safe, sustainable and publicly acceptable solutions for the management of radioactive waste across Europe now and in the future.

The Vision of the European Joint Programme EURAD

Provide added value to member states in their timely implementation of RWM activities

The vision of the European Joint Programme on Radioactive Waste Management (EURAD) is:

Key characteristics of EURAD (according to vision)

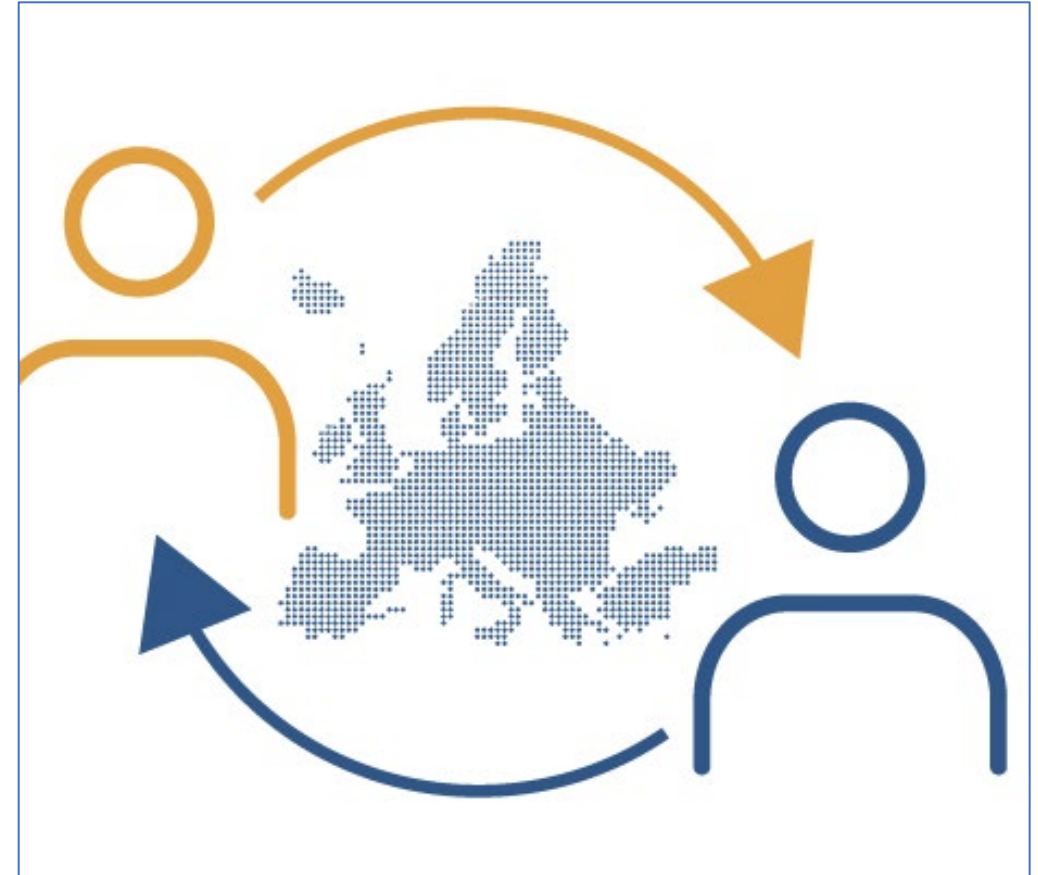
- EURAD **complements national RDD programmes** (*EURAD is at the interface of RDD and implementation*)
- Joint programming provides **added value** at the European level (more efficient, flexibility, better collaboration (& more innovation), increased learning from each other)
- Joint programming builds on **existing networks** (colleges, connections to civil society) to **drive the program**, with **coordinated activities** (with interaction)
- EURAD delivers **cutting-edge science & technology**, allows broad **networking** (strategic studies, etc) and has a strong **knowledge management programme**
- These elements are considered to be a **step change in European collaboration**

Overview EURAD – Key Characteristics

- **Joint programming**
 - **mandated actors** (mandated by *member states*), **linked 3rd parties & international partners**
 - ... representing **three colleges** (each with different functions)
 - **Waste Management Organisations** (WMO, responsible for implementation)
 - **Technical support organisations** (TSO, supporting regulatory activities)
 - **Research entities** (RE, supporting all interested bodies)
 - ... and: **interaction with other participants** (end-users, civil society, ...)
- covering ...
 - **RD+D projects**
 - **Strategic studies**
 - **Knowledge management**
 - **Information dissemination & interactions** (including end-users, civil society, etc.)
- ... with a **roadmap** and a **strategic research agenda (SRA)** as essential tools

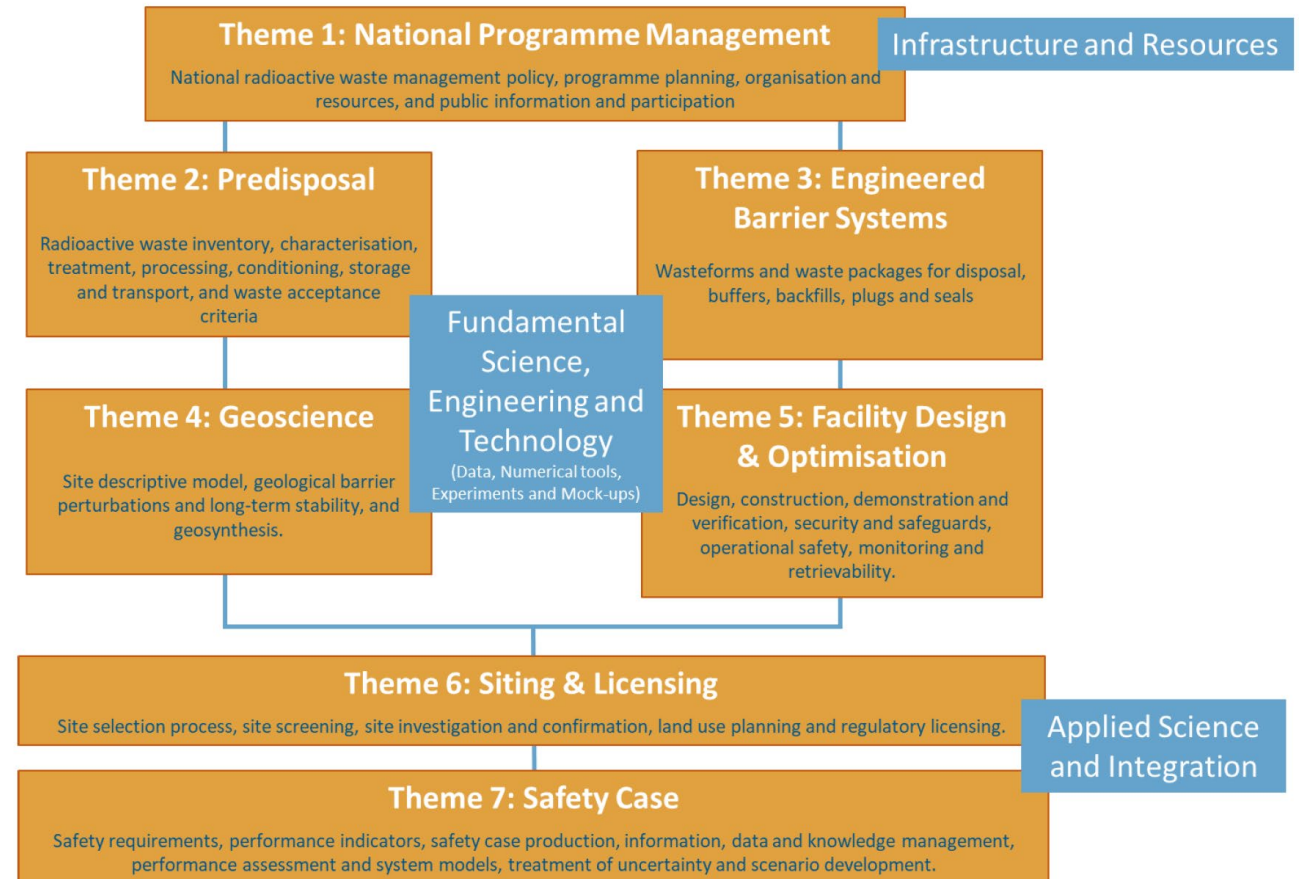
EURAD Objectives

- Based on **Strategic Research Agenda**, perform a cutting-edge **Science and Technology Projects**
- Identify and **elaborate upon complex issues** by bringing together interested actors to jointly conduct **Strategic Studies**
- Support **knowledge transfer** between Member-States and between generations with a strong **Knowledge Management Programme**
- Foster **Mutual Understanding** and **Trust** between Colleges and Civil Society participants and other stakeholders



Strategic Research Agenda (SRA) – an important element of a EJP

- structured in **7 overarching themes** covering all elements of RWM (except decommissioning)
- ... combined with **roadmap** that provides **structure and context**
- **important input** to define WPs for Joint Programming (EURAD & future EJP)
- allows to include **new findings & experience** - **update underway**
- the **update** - an **important input** for any **future waste management EJP**



Added value offered by EURAD – Science & Platform for Networking

- **EURAD provides cutting-edge science** in areas of interest to a broad range of organisations
- Based on the **concept of 'Joint Programming'**, EURAD provides a **platform for interaction**
 - Periodic update of the **strategic research agenda** (SRA): 'wish-list' for future joint RDD, strategic studies & knowledge management activities – includes structured evaluation of all relevant topics
 - Conduct spectrum of **RDD work packages** (ACED, CORI, ConCorD, DONUT; FUTuRE, GAS, HITEC, MAGIC, MODATS, SFC – see next overhead) with strong **interaction between them**
 - **Strategic Studies** on emerging issues (UMAN, ROUTES – see next overhead) with strong **interaction**
 - **Platform with the key actors** from **national programs** in waste management, with the aim to **form common views** on important issues (e.g. position papers by colleges)
 - Waste Management Organisations
 - Technical Support Organisations (regulatory view)
 - Research Entities
 - ... to get a better understanding on the **context of all scientific activities** related to disposal

EURAD: Science & Networking – covers broad spectrum of issues (12 WPs)

- **Radioactive waste characterization, processing/packaging and storage**
 - ROUTES - Waste management routes in Europe from cradle to grave (... with strong interface with PREDIS)
 - SFC - Spent Fuel Characterization and Evolution Until Disposal (SFC)
- **Engineered barrier system properties and long-term performance**
 - ACED - Assessment of Chemical Evolution of ILW and HLW Disposal cells
 - ConCorD - Container Corrosion under Disposal Conditions
 - MAGIC - Chemo-mechanical aging of cementitious materials
- **Geoscience: rock properties, radionuclide transport & long-term evolution**
 - FUTURE - Fundamental understanding of radionuclide retention
 - CORI - Cement-Organic-Radionuclide Interactions
 - GAS - Mechanistic understanding of gas transport in clay materials
 - HITEC - Influence of temperature on clay-based material behaviour
- **Geological disposal facility design and the practicalities of implementation**
 - MODATS - Monitoring equipment and data treatment for safe repository operation and staged closure
- **Performance assessment, safety case development and safety analyses**
 - UMAN - Uncertainty Management multi-Actor Network
 - DONUT - Development and improvement Of Numerical methods and Tools for modelling coupled processes

Added value offered by EURAD – Knowledge Management

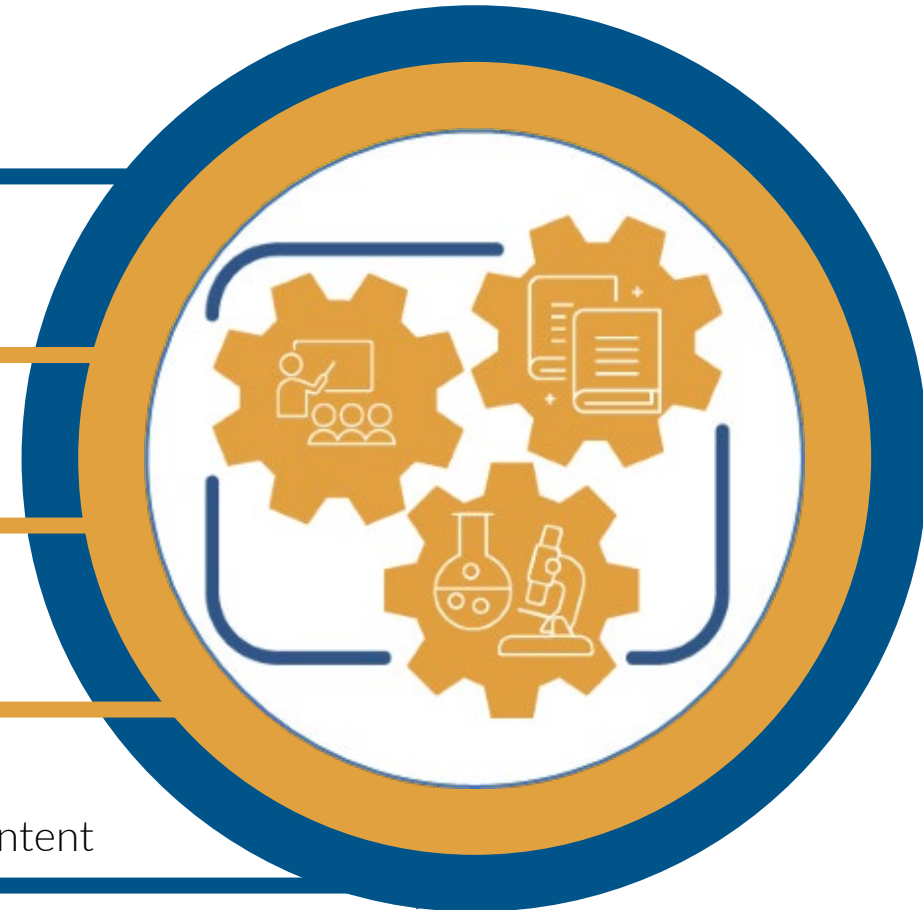
EURAD maintains a **knowledge management programme** to **support the member states** in their **timely implementation of safe disposal solutions**, and consists of ...

- 1** a **roadmap** describing the relevant **phases & themes** for implementing disposal solutions
 - ... and provides the **structure** and **context** to clearly see **which themes** are **when and why** important for **repository implementation** and to **understand the interactions** between different **themes**
 - ... and supports the **integration** of **the knowledge available** into the **national programmes**
 - ... and identifies **key capabilities** needed (**competencies & infrastructure**) for successful implementation by national programmes
- 2** capturing the current **state-of-knowledge** and **sign-posting to key references** for each of the roadmap themes (WP11 'state-of-knowledge', in progress)
- 3** **guidance** (best practice and lessons learned) **for key issues** (WP12 'guidance', in progress)
- 4** a programme for **training and mobility** (WP13 'training & mobility', on-going)
- 5** a **platform for networking** e.g. with webinars (WP 13, with all other WPs & PREDIS, on-going)

With these elements, EURAD supports **knowledge transfer** from **advanced programs to early stage programs** and **knowledge transfer between generations**

EURAD Knowledge Management & Networking Programme

- 1 Roadmap**
A common framework to structure knowledge
- 2 State of Knowledge**
What we know and why it is important
- 3 Guidance**
Best practice and lessons learned
- 4 Mobility & Training**
Transfer of experience and know-how
- 5 Networking**
Connecting people to people, and people to content



EURAD Roadmap – structure for knowledge management: phases & themes

The phases (from waste generation to closure of repository)



EURAD Roadmap – structure for knowledge management: phases & themes

... and the **themes** needed for implementation → *'what', 'when', 'why'*

1. Programme Management

2. Pre-Disposal

3. Engineered Barrier Systems

4. Geoscience

5. Design & Optimisation

6. Siting & Licensing

7. Safety Case

3. Site
Characterisation

2. Site Selection

1. Initiation

4. Construction

5. Operation and
Closure



EURAD – Status at mid-term

Significant progress has been made

- **RDD & Strategic Studies WPs 'on track'** (although with modified schedules due to pandemic)
- Strong learning-curve with **Knowledge Management** (a lot of experience with practicalities) with significant 'added value' through **connection to Roadmap**
- EURAD supports & encourages **interaction** between WPs (incl. Civil Society) & with external bodies, including **participation of end-users**
- **Joint Programming** – (i) lively interaction between colleges (WMO, TSO, RE) and with Civil Society also leading to increased mutual understanding, (ii) more efficient, (iii) flexibility to act
- Strong & successful **cooperation with PREDIS**
- **EC mid-term review** with positive response
- **Added value of EURAD** acknowledged at **EURADWASTE '22 conference** in Lyon (30 May - 2 June 2022)

EURAD – Looking Ahead

- Results of **EC mid-term review** – analysis of review results to improve EURAD
- Measures taken to **successfully complete WPs** (thoughtful use of reserve budget, timely delivery of reviewed deliverables, take advantage of feedback, ...)
- Promote **end-user feedback** (member states with their formal bodies, EURAD end-users, ...)
- **Update of SRA** (Strategic Research & Knowledge Management Agenda) underway: the value of an existing platform by Joint Programming to **scope potential future activities**
- In conjunction with EURADWASTE '22 conference, **workshop** with Member State representatives **discussed achievements** and **about future EJP**
- **EURADWASTE '22 conference** – strong participation allowed to elicit **input for scoping of future activities**
- Overall, we see strong benefits from a **follow-up of EURAD with a future EJP**
- **A follow-up EJP on Radioactive Waste Management could become reality**



Cost and financing

Key issues in cost studies (and financing) – my personal understanding

- **Key characteristics of a waste management program – some special features**
 - Large diversity of topics
 - Program of very long duration (changes expected, not all issues of later stages yet clearly defined)
 - Alternatives exist for a range of issues (e.g. 'shared solutions' vs. 'each on its own' for different RWM activities)
 - Thus, changes may and will occur
- **Each waste management program is a 'prototype' – some differences** (not complete)
 - Waste inventory
 - Legal and regulatory framework
 - Involvement of society & impact on decision-making
 - Knowledge and infrastructure available within program
 - Disposal: geological conditions
 - Different financing schemes (who, when, how, why, boundary conditions, ..., contingencies, risk appetite/'guarantees', ...)
- **What does that mean?**
 - Broad spectrum of issues influences cost estimation – but: not all factors are equally important, partially country-specific
 - Blindly copying an existing cost study is not an option
 - Case-by-case cost study needed to take program-specific issues into account
 - Importance to acknowledge bandwidth of cost estimate and consequences for financing scheme

Key issues in cost studies (and financing) – my personal understanding

- **Goal of cost study** (input to financing, comparison of options, ...)
- **Scope of cost study: what is in? what is out? why?** (partially defined by financing issues)
- **Describe programme** (goals & phases ('RQM'), boundary conditions) → elements to estimate cost: work breakdown structure (& dependencies/correlations); with plausible assumptions for poorly or non-defined WBS elements (with alternatives, where feasible)
- **Cost estimation methodology** (bottom-up, parametric, analogies → expert judgement, ...), with the most appropriate method to be used for each WBS element
- **Capturing uncertainties and risks** (threats & opportunities, 'unknowns') → contingencies (for each WBS element, general)
- **Reviewing, assessing & adjusting results** (importance of reviews & 'communities of practice')
 - comparison of program / work breakdown structure, including input / boundary conditions (*what creates the cost*) → completeness, 'optimism bias' in program, role of alternatives, ...
 - comparison of cost (overall program, individual elements): base cost (best estimate), contingencies, unit costs, ... → justified, with reasonable bandwidths → reliable input to financing, ...
 - sensitivity analyses → cost drivers (to be looked at for contingencies & economic optimisation)
 - ...

Key issues in cost studies (and financing) – my personal understanding

- **What the on-going EURAD can offer**

- **Knowledge management** (WP Guidance) - guidance document on 'cost assessment and financing schemes' (EURAD deliverable 12.4)
- **Strategic studies** (WP ROUTES) - evaluation of different routes for managing wastes – input to alternative strategies to be considered in cost estimates (esp. 'small inventory member states')
- **Roadmap** provides a hierarchically organized **generic description of waste management program** – input to work breakdown structure
- **Requirements management** (WP Guidance) - guidance document on 'requirements and their management' is planned / being set up; might be additional input to work breakdown structure
- **Strategic research agenda** (periodically updated) - indirectly: an assessment of maturity of different themes → an indicator of potential use for cost estimates / contingencies
- **Platform of informed people** (scientifically oriented) that can give input on emerging issues (see also evaluation of topics in update of SRA)
- P.S.: **PREDIS** – project on pre-disposal issues of direct relevance for cost estimation with strong interaction with EURAD; **SHARE** – with some interaction with PREDIS



Key issues in cost studies (and financing)

Options for a future European Joint Programme on RWM – to be decided



Questions? Comments?

Thank you for your attention !

<https://www.ejp-eurad.eu>



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