

Development of guidance documents in the EURAD and PREDIS projects

Peter Ormai¹, Bálint Nös¹, Jiří Faltejsek^{2,*}, Jitka Mikšová³, Nadja Železnik⁴, Irena Mele⁴, Kateryna Fuzik⁵, Paul Carbol⁶, Anthony Banford⁷, and Erika Holt⁸

¹ PURAM, Puskás T. u. 11., 2040 Budaörs, Hungary

² SÚRAO, Dlážděná 6, 110 00 Praha 1, Czech Republic

³ SÚRO, Bartoškova 28, 140 00 Praha 4, Czech Republic

⁴ EIMV, Hajdrihova 2, 1000 Ljubljana, Slovenia

⁵ SSTC NRS, V.Stusa Street, 35-37, 03142 Kyiv, Ukraine

⁶ JRC, European Commission, DG Joint Research Centre, Unit G.I.6 Research on decommissioning and Waste Management, PO Box 2340, 76125 Karlsruhe, Germany

⁷ NNL, National Nuclear Laboratory Limited, 5th Floor, Chadwick House, Birchwood Park, Warrington WA3 6AE, UK

⁸ VTT, VTT Technical Research Centre of Finland, Box 1000, 02044 Espoo, Finland

Received: 15 April 2022 / Received in final form: 9 September 2022 / Accepted: 5 October 2022

Abstract. Particular emphasis is dedicated to Knowledge Management activities within the EURAD (European Joint Programme on Radioactive Waste Management) and PREDIS (Pre-disposal management of radioactive waste) projects to ensure the capture of existing knowledge, transfer of knowledge between Members States and management of the knowledge for future generations. The EURAD project has three work packages dedicated to knowledge management. One of them, the EURAD Guidance work package (WP12) is developing a comprehensive suite of specific guidance documents that can be used by Members States with radioactive waste management (RWM) programmes that are at an early stage of development but can be beneficial also to more advanced programmes. The PREDIS project does not have a specifically allocated work package for guidance development. Rather, such activities are integrated within deliverables produced as part of the Strategic Implementation and State of Knowledge actions of the Roadmap contributions on predisposal waste management. The EURAD guidance work is based on the existing PLANDIS guide on RD&D planning, developed by the Implementing Geological Disposal of Radioactive Waste Technology Platform (IGD-TP). The guidance documents complement other documents prepared in parallel knowledge management activities inside EURAD project: the State of Knowledge documents. The differentiation is that guidance documents explain in more detail how the process can be established and performed, including illustrative examples. The guides are self-standing documents and integrated with the EURAD Roadmap. The target end users of the guidance are primarily programme owners and managers (i.e., governments/administrations, Waste Management Organisations, Research Entities and Technical Support Organisations) responsible for planning and implementing the RWM programme and the supporting RD&D activities at a national level, even though they might also be of use and interest to other interested stakeholders, such as representatives of civil society. To produce a first list of prioritised topics for guidance documents with the aim to select a topic for a pilot guide, the Guidance WP has developed a screening process that includes review by experts and end users. Based on the priority list, the first pilot guide was developed with the title “Cost Assessment and Financing Schemes of Radioactive Waste Management Programmes”. Experience gained during the selection of topics for the pilot guide and during its production are being incorporated into the procedure for identification of new topics for which guides will be developed. First, the degree of coverage of the EURAD Roadmap themes by suitable guide documents will be analysed by the WP 12 team. The analysis will be combined with feedback from experts verifying the needs for missing guides. Finally, the potential end user community representatives will be given the opportunity to comment on the prioritisation of selected guidance documents and make additional suggestions. The potential end users stay involved also during the production of the guides. This procedure aims to optimise the scarce expert resources in relation to the identified needs of guidance documents. This article explains the approach for selecting topics for guidance documents and the results obtained both in EURAD and PREDIS.

* e-mail: faltejsek@surao.cz

1 Introduction

Radioactive waste management (RWM) consists of a large multidisciplinary set of different tasks covering all administrative and operational activities involved in the handling, pre-treatment, treatment, conditioning, transport, storage and disposal of radioactive waste. Typically, RWM has a large time span overarching many decades. These characteristics of the RWM promote the importance of a systematic approach to identify, manage, share knowledge, and enable groups of people to create new knowledge collectively to help achieve safe management of radioactive waste. Activities ensuring this systematic approach are known as knowledge management.

Knowledge management (KM) – including knowledge consolidation – is recognized as a key part of the RWM implementation process and has gained increasing interest in the past 10 years.

The main reasons for the importance of KM are the RW disposal implementation time, spanning several decades, and the complexity and variety of disciplines involved. Each individual phase of a RWM programme from waste generation through processing, disposal, and repository closure, requires continuous RD&D development with improved process understanding.

EURAD supports the implementation of the Waste Directive in EU Member-States, considering the various stages of advancement of national programmes. National RWM programmes across Europe cover a broad spectrum of stages of development, inventories, and level of advancement, particularly with respect to their plans and national policy towards implementing geological disposal.

The PREDIS project targets the development and implementation of activities for pre-disposal treatment of radioactive waste streams other than nuclear fuel and high-level radioactive waste. It is possible to identify several roles which the KM could cover, but within the scope of the project they are closest linked to the technical work package development for characterisation and processing waste streams, as well as waste acceptance criteria (WAC) issues. The long-time span addressed by WM programmes is bringing the need for trans-generation knowledge transfer in all phases of implementation, from pre-disposal through disposal. Another role is to manage effective knowledge transfer inside the multi-disciplinary programmes. The KM is applied to knowledge transfer between different actors within a program or transfer between national RWM programmes themselves. Both EURAD and PREDIS are reactive and responsive while developing ideas for the KM and networking needs of their partner and stakeholder communities.

The KM activities are integrated with technical and strategic activities. This allows KM to benefit from the huge pool of expertise existing within the EURAD programme.

An example of an important programme output which is used not only inside the EURAD project is the EURAD Roadmap [1]. The EURAD Roadmap was prepared as a representation of a generic RWM programme that shall enable users and programmes to orient themselves in

the whole area of RWM. The content is focused on what knowledge, and competencies (including infrastructure) is considered most critical for implementation of RWM, aligned to the EURAD Vision and to the EURAD Strategic Research Agenda. The EURAD Roadmap provides detailed information about themes, subthemes and domains and is an efficient tool to map different activities inside a RWM programme.

The Roadmap enables different activities to be linked to the overall RWM process. This addressing provides easier orientation for potential users when they are searching for information on how to start or manage particular activities, taking into account the current best practices.

In the PREDIS project all these items are covered by one work package (WP3), whilst inside the EURAD project there are three different work packages. In EURAD, one team collects existing information (WP11), the second one (WP12) prepares information on how to carry out RWM activities and the third one (WP13) deals with training and networking. The detailed description of the organizational arrangement of knowledge management inside EURAD is given in parallel articles [2–4].

The subject of this article is experience of preparation of guidance documents that are useful for national RWM programs.

In that sense, it is important to identify potential end-users' groups:

- the first group consist of end-users who need to start (or substantially change) a disposal programme implementation. This end-user group is characterized by low experience in a particular area. For this group it is important to get basic orientation. The exchange and sharing of knowledge between advanced programmes and newcomers to the topics is typical. Positive and even negative (if available) examples may be effective but should not be used without taking into account national circumstances. Guides targeted to this end-user are more general, usually covering broad subjects.
- End-users who need to manage knowledge in a relatively narrow area, usually within an established framework, are typical for the second group. Guides for this group are more detailed in a narrow topic. The level of detail and variance in national circumstances often make it difficult to provide guidance that is valid for multiple programmes.

With respect to the nature of the Joint European Programme end-users in organizations at an early stage of the RWM programme were approached to facilitate sharing and transfer of knowledge on “how-to do” different activities in RWM.

Needs are identified from a combination of identification of gaps using the Roadmap and Experts (top-down), and specific needs raised directly by the wider community of stakeholders (bottom-up). This has been done either via surveying the KM needs and gaps among organisations or by listing prioritised topics where gaps exist, or information is not sufficient.

2 Method

2.1 Selection of pilot guide

Within the EURAD Guidance Work Package (WP12), activities aim to develop a comprehensive suite of instructional guidance documents that can be used by various stakeholders in any country with RWM programmes, regardless of their status in geological disposal implementation.

The goals of the guidance documents are (a) to share existing experience and lessons learned and to assist transfer of knowledge towards Member States with early-stage RWM programmes, as well as (b) transfer of knowledge between generations. Both goals are objectives of EURAD's Vision [5].

Guidance documents can facilitate orientation in the field itself (existing knowledge resources and existing international cooperation and networking) as well as to foster understanding different solutions in different cases and countries.

The main priority of the Guidance WP has been to identify a list of the most needed and prioritised topics of guidance documents from which a topic for a pilot guide could be selected. This included considering topics where there is access (within EURAD) to suitable experts from Member States with an Advanced Programme (AP) who could contribute to the Guidance development.

A pilot guide was compiled to test the guidance development process (and the quality management procedure). The EURAD Roadmap Advisory Committee consisting of experts from AP, proposed areas where expert knowledge of programme history would provide useful strategic guidance to new or early stages programmes. The short list consisted of the following topics:

- funding and financing aspects of radioactive waste disposal.
- Optimization of disposal of radioactive waste.
- Derivation of requirements for the disposal system.
- Waste Acceptance Criteria (reserve).

The Guidance WP team finally proposed the topic of 'Funding and Financing Aspects of Radioactive Waste Disposal' (Domain 1.3.1 [1]) to be developed as a pilot guide as the time and the readiness of resources for its timely development was assessed as reasonable.

2.2 Developing further guidance

For future guides to be developed in EURAD the simplified approach – implemented for selecting the topic of the pilot guide – will be complemented by following two strategies, the top-down and bottom-up approach. The bottom-up approach at EURAD level means that the selection process is carried out based on the EURAD Roadmap and the needs for further guidance are identified by the systematic evaluation of the themes, sub-themes and domains. This is implemented using input from the available literature, from experts who have experience from the implementation process and feedback from the potential end-users.

The top-down approach means that experts (selected based on their experience and knowledge accumulated in their respective fields of activities) identify where guidance is needed but not available.

Based on the result of this activity and the ongoing evaluation of end user needs and feedback, the approved list of prioritised topics will be regularly updated as a 'living document'.

Analysis of existing guidance literature

The mapping started by establishing a starting reference point related to the mapping of the available guidance and guide-like technical documents, through a detailed literature search of:

- international regulation documents (ICRP and WENRA);
- international guides (IAEA);
- international guide-like technical documents (IAEA, OECD NEA, EC Projects);
- national guides;
- national guide-like technical documents.

Other main sources for the mapping have been EURAD partners' courses and international nuclear entities.

Open web was searched to complete the "big picture" of geological disposal materials.

Based on the survey it was concluded that although the available technical documents and guidance are numerous, early-stage programmes or small inventory programmes often face a challenge of information overload and deciphering which sources of information are most accurate and most recent, thus the guidelines aim at providing concise references to orient the reader.

Selection criteria

For selecting guidance topics some basic criteria were defined, clearly linked to and coherent with the EURAD founding documents (Vision document [5], EURAD Roadmap [1] and Strategic Research Agenda [6]):

- interaction with EURAD WPs: are there any outputs from EURAD already available to be used for guidance development? How and to what extent are they used?
- clearly demonstrate European-added value (improved information and knowledge transfer between national programmes and across generations);
- be meaningful, focused and manageable;
- is that any identified guidance gap;
- each contribution should bring complementarity (avoid duplication, keep clear of disconnected, spread or repeated contributions);
- responsive to the end-users needs and expectations (effectively assists the targeted end-users in their programme implementation, i.e. be need-driven);
- importance (it should be evaluated how big an area of the Roadmap is covered by the topic, which more or less correlates with the aspect of how significant a role the given topic has in RWM programme implementation);

- urgency in terms of programme implementation stage (in what stage of RWM programme development should the guidance be implemented, when should the guidance on the given topic be ready for the target end-users);
- expertise (how much expertise is necessary for the development of the given topic outside from Guidance WP, or outside from EURAD);
- length of development (based on the preliminary assumptions how lengthy could the process of development of the guide be).

There are multiple options of materials available for selection that potentially meet the selection criteria and the guidance will be used to identify the strengths and weaknesses of the options. One may want to create early buy-in amongst a wider range of end-users by engaging them in the selection and development process. There is a longer time frame for the decision-making process that allows for a more thorough selection process.

Topic selection

On the basis of this long list the Guidance WP team members prepared some topic proposals. The short list consists of the following topics:

1. using the safety assessment as a tool to derive requirements for the disposal system elements;
2. role of implementer in planning and managing repository development programme;
3. developing strategy for data management and preservation of records and knowledge in the context of radioactive disposal programme;
4. using the safety case (and safety functions) to prioritize geological disposal RD&D plans;
5. developer/implementer and regulator interactions during the planning, siting, engineering design, RD&D and construction of disposal facilities;
6. managing interactions in multidisciplinary teams (engineers, geoscientists, sociologists; physicists; modellers, lawyers etc.);
7. establishing and managing programme requirements and how these need to be linked to the findings of the RD&D programme;
8. developing the design basis for a geological repository;
9. assessing the acceptability of site conditions for the location of a geological repository;
10. characterization of high-level waste at different management stages.

The list was evaluated against predefined selection criteria based on the expert judgement of the Guidance team members in a qualitative and semi-quantitative way.

Each team member could score the topic proposals and the results were discussed at the WP web-meeting. It was emphasised that for any guidance document it shall be ensured that it provides an added value to the target end-users (needs driven) in an area, which is not covered by existing guidance (avoid duplication). Feedback from

the potential end-users will also be sought for prioritization suggested topics. Final list of selected topics will be approved by EURAD General Assembly.

After having the topic for the guides approved, experts with relevant experience in the given area will be selected to assist the Guidance WP team in the elaboration of the guidance.

Further guides will be elaborated in current EURAD project in collaboration with experts with experience on the given topic (who ‘have done it before’). Experts from countries with different status of geological disposal implementation are going to work together, which will create a network of experts (effectively contributing to knowledge transfer at EURAD level).

In the case of the PREDIS project, guidance development so far has been especially focussed in one specific topical area for Waste Acceptance Criteria (WAC). This has been dealt with using the goal of developing a suite of guidance documents for (i) the selection of optimal methods for the determination of WAC parameters, (ii) principles and procedures regarding the qualification of waste forms for storage/disposal, and (iii) formulation of generic WAC whenever a disposal system has been missing. Information about national experience collected from a number of countries worldwide [7] is being converted into a set of practical advice on establishing the mentioned aspects of a national waste acceptance system. There are also additional guidance documentations that will be part of other technical deliverables within the work packages addressing treatment and processing of waste. However, these are not stand-alone documents within the Knowledge Management part of the PREDIS structure. The format of guidance for PREDIS is more incorporated into the overall knowledge management that is provided through training tools, such as Domain Insights, case studies of best practices and lecture materials that target specific issues in predisposal waste management that are not already covered by other sources, such as the IAEA e-learning modules and Wiki.

3 EURAD guideline production

The EURAD Guidance team adopted the Quality Management Procedure for Guidance Development [8] where the quality principles and procedures to be taken into consideration while producing and updating guidance documents for RD&D activities in RWM are outlined. The aim of such a procedure is to set the requirements for a quality management system targeted at production of any guide document to ensure quality, inclusiveness and transparency during its elaboration, further improvement, and implementation. Among others this includes:

- quality assurance (QA) criteria for elaboration of RD&D Guides to be developed in the framework of WP 12,
- quality requirements how RD&D Guides should be developed, maintained and used according to the QA criteria,
- consultation and review process during the development of the RD&D Guides.

3.1 QA criteria for production/update of guidance documents

Few norms specify how quality, inclusiveness and transparency is assured in a guidance document. Especially, the criteria for selection of authors and guidance production are considered to be relevant for the development of any RD&D guide within EURAD.

3.1.1 The competencies of authors

The authors should have experience and competence for the development of particular guidance document, in line with the scientific area the given guide covers. It is an important quality criterion that the authors of any RD&D guides should have wide experiences and highly qualified competencies to the covered topic.

The authors can be experts having wide experience in RD&D planning, individuals, representing WMO responsible for the development of RD&D plans and Technical Support Organisations (TSO), involved in the reviewing process of these plans and Research Entities (RE), involved in the execution of RD&D activities. End-users of RD&D Guides from early-stage programmes and small inventory programmes participating in disposal should be involved in the drafting process of the RD&D Guides as well.

3.1.2 Procedure for selection of authors

The procedure of selection of authors for a given RD&D guide should be compatible with the general EURAD rules and it would apply within the Guidance work package.

3.1.3 Guidance production criteria

The guidance production criteria have been developed from a list of the scope of criteria for evaluating the overall EURAD Programme and are given in EURAD Quality Management Plan (QMP) [8]. Most important are:

- to support the overall EURAD Roadmap [1], EURAD Vision document [5] (and also Strategic Research Agenda [6]),
- to be ambitious, creative, innovative, and address key needs of End Users with Programmes in Early Stage and with Small Inventories,
- to reach a major impact of the RD&D area of the procedures at relevant phases,
- to systematically outline the set of activities to be implemented,
- to demonstrate procedures intended to be used to attain the stated objectives,
- to describe clearly how appropriate they are for the planned activity and their feasibility,
- to identify the most significant steps to achieving the stated objectives and explain how these will be addressed,
- to show clearly how meaningful and independent peer review can be integrated within the overall implementation plan on a timely basis.

3.1.4 Lessons learned on QA from pilot guide development

As there is an expectation of the highest quality of guidance, the process of its development shall comply with all quality assurance requested in the “EURAD Quality Management Plan” [8] and the “Quality Management Procedure for Guidance Development” [4]. The guidance selection process also must comply with the “Approved list of prioritized topics for further guidance documents and selection process of one topic for the development of a pilot guide” [9].

The quality management procedure consists of the requirements for a quality management system on guides production with special emphasis on the quality assurance criteria, quality requirements on guides development and utilisation. The high importance is given to the reviewing process during the guide production.

The whole process must be performed in a close cooperation with the EURAD Chief Scientific Officer, Bureau/PMO and the Editorial Board, ensuring a thorough review process, transparency in guides topics selection and a requested quality of guidance content. All selected topics must be approved by these EURAD governance bodies and EURAD General Assembly members.

3.2 Guidance production procedure

Development and approval of a guide is performed in several steps. These steps include initiation, drafting, peer review, finalization, approval and “socialization”.

At the “Initiation” step the Terms of Reference (ToR) is developed by WP12 team and approved by Bureau/PMO. The ToR defines the whole process of development of the guide, including topic justification and selection based on the performed gap analyses and the interest from the target end users. In the ToR there is clear definition of the scope of the guide, the timeline, responsibilities (and their distribution between authors, reviewers, other experts and end-users), requirements in volume and contents, etc. In this step special attention is devoted to the clarification of tasks for the individual authors, confirmation of the guide development schedule and organization of a kick-off meeting(s) between the authors.

At the “Drafting” step, detailed development of structure and contents of the guide is completed with identification of reliable and trusted sources of information (e.g. IAEA, EC and international projects, IGD-TP, SITEX Network, EURADSCIENCE). The writing of the guide is performed based on the collection of information from the identified sources according to the established structure and contents of the guide. In the ToR the supporting experts’ team and end-users are identified and consulted to incorporate their feedback. Finally, draft guide is submitted to Bureau/PMO for peer review.

The “Peer review” step includes independent review of the draft guide organized by Bureau/PMO (including selection of reviewers) and submission of Bureau/PMO feedback to the development team.

The “Finalization” step comprises of revision of the guide according to comments and recommendations received from the peer review, agreement of finalized guide

by Guidance WP and submission of finalized guide to Bureau/PMO for approval. At the “Approval” step the final checking the management of reviewer comments or statements by Bureau/PMO and approval of the guide by Bureau/PMO is done. During the “Socialization” step distribution of the guide among Communities of Practice (CoP) is performed including the collection of feedback to be used for future revision.

3.3 Consultation, incorporation of feedbacks and final reviews

Consultation with experts and target end-users during the development of a guidance document can bring significant inputs to the deliverable and as a result, can increase its quality. Consultations with PMO representatives/coordinators on the objectives and scope of the given Guide is important to be in line with the general expectations of EURAD. Consultation can be organized especially with Bureau (College representatives), end-users representatives or other EURAD WPs including KM WPs.

When a guidance document is developed in such details that the usability and applicability (whether the document meets the pre-defined goals) can be tested, the feedback from some potential end-users can be asked. Potential end-users of guidance documents can be representative of mandated actors (WMO, TSO, RE) from Advanced Stage Programme (AP), from Early-stage Programme (ESP), from Small Inventory Programme (SIMP) Member States in line with the scope and topic of the given guide. The potential ways of obtaining feedback concerning a draft guide could include asking independent views about the applicability of the given guide, organizing events for the end-users to identify collective viewpoints, compiling questionnaires for dedicated topics.

4 Pilot guide and lessons learned

4.1 Objectives of the pilot guide

The first guide produced (pilot guide) was on “Costing and Funding” for implementation of a radioactive waste disposal [10].

Cost estimations are needed for all projects, programmes and operations. Information on this topic is abundant, and guidance on various approaches and methods is widely available. However, the estimation of the costs of disposal programmes remains challenging due to their complex and societally sensitive nature and long implementation periods, and practical guidance on this issue remains insufficient.

Countries that are just starting to develop their disposal programmes and which have little or no experience in this area may have difficulties in finding the relevant advice on how to perform cost estimations. This guide aims to describe the cost estimation process specifically focusing on radioactive waste disposal programmes, and to provide practical advice on how to conduct this process to result in a consistent, reliable and well-documented cost estimation.

The guide suggests a stepwise approach to costing to make the whole process more transparent and easier to manage. The steps are interdependent and logically cover all the important phases in the cost estimation from defining the purpose and scope of the estimate, selecting the method and obtaining the input data, to performing the cost estimation and the consideration of, including suitable approach to, addressing cost uncertainties and risks management.

The guide also addresses possible mechanisms for financing disposal of radioactive waste. Since details on various financial mechanisms can be found in a number of documents this guide describes only the financing of RWM activities from a pre-collected fund, which is the most commonly applied method.

The intended end-users of this guide include primarily waste management organisations (WMO) or designated organisations if no WMO has yet been established in small inventory programme and early-stage programme countries (including countries that are initiating a new-build nuclear programme), which are, in most cases, responsible for conducting the cost calculations for their respective national programmes. The guide may also be beneficial for those entities (ministries, regulatory bodies and/or their technical support organisations) responsible for reviewing the cost calculations or those obliged to implement the “polluter pays” principle (e.g., waste generators).

The target audience may also include project managers and costing experts (who establish, revise and justify estimations) and those entities which are responsible for financing the national RWM programme.

4.2 Scope of the pilot guide

The guide focuses primarily on the cost assessment methodology for geological disposal, but with certain adaptations it can also be applied to near-surface or borehole disposal programmes since the principles are the same and, from this perspective, the guide may also be beneficial for small inventory disposal programmes.

The report provides general guidance on developing a cost estimation for radioactive waste disposal programmes, including more detailed advice on using a structured approach.

Initially, the guide explains the necessary prerequisites and boundary conditions for the disposal programme and its cost estimation, and emphasises the importance of a national RWM policy and national RWM programme, the existence of a national legislative framework and waste inventory, stakeholder engagement, etc.

The guide provides a brief description of each of these steps including information on additional literature that contains more detailed information.

In the guide the cost assessment of the disposal programme is described as a process consisting of several steps, starting with defining the purpose of the cost estimation, the scope of the work and the timing of activities included in the estimation, selecting the appropriate method for cost estimation, and preparing the Work Breakdown Structure (WBS) as a framework for a detailed

cost estimation. After performing the cost estimation, the process also includes the analysis of uncertainties and risks in cost assessment and provisions for addressing them as well as thorough documenting of the whole process to provide traceability and performing an independent review of cost estimate to establish confidence in the estimate.

In the guide each of these steps is briefly described and wherever possible additional guidance referring to geological disposal provided. Specific attention is given to the development of the WBS as an essential and practical tool for performing the detailed cost assessment. Based on several disposal programmes and their respective WBSs an attempt was made to summarize the approaches and develop a more generic WBS for geological disposal that would be useful for countries and organisations that have just embarked upon or plan to launch the cost estimation process in the near future.

Similarly, when considering the uncertainties and risks in cost estimation of the disposal programme, the guide provides information on the most common uncertainties and risks in geological disposal (GD) programmes and suggests how they might be addressed.

The guide emphasises that the cost estimation is an iterative process that requires regular updates and improvements in the input data, as well as transparency and quality assurance in the cost assessment process and the data and information management systems.

4.3 Benefits for users of the pilot guide

Potential users of the guide may find beneficial the presentation of a practical example of how the work scope of the geological disposal programme could be broken down into smaller, meaningful elements and hierarchically organised in the form of a WBS, and a discussion on the possible cost uncertainties and risks related to the various WBS elements of geological disposal programmes.

The presentation of selected lessons learnt and experience obtained from the cost estimation processes in a number of national programmes may also be helpful for gaining a better understanding of the process.

The potential users may also find very useful several examples of cost estimations for various aspects of the disposal programme from different countries (e.g., Hungary, Slovenia, Czech Republic) that are included in Appendices as illustrations of how cost estimations are performed in practice.

4.4 Lessons learned

The crucial aspect of the guide production process is a mutual interaction with potential end users which can ensure a complementarity of selected topics and end users needs on guides development. With respect to this, the first short priority list of selected topics developed by WP12 has been communicated with a group of potential end users what provided a valuable contribution to the WP12 team when selecting topic for pilot guide.

Within the process of guidance development, an interaction with international entities is recommended (e.g.,

the IAEA and NEA) with special emphasis on already published or planned guides. Also, other relevant documents (technical, strategical, methodological, etc.) from publicly accessible sources has been considered and evaluated during a gap analysis leading to the topics selection.

This approach has been consistently applied within pilot guide topics selection and its subsequent development. The feasibility of the guide production process from a technical point of view and the expected timescale has been demonstrated, thus the process can be applied for the next guide production. In addition to the urgency criterion, the accessibility of the experts contributing to the guides must be seriously taken into account when selecting the next topics for guide production. With respect to the demanded experts limited availability, the EURAD cooperation with PREDIS can be highly recommended for planning further RD&D programmes as both projects have available large spectrum of experts.

5 Conclusions

EURAD as a European Joint Programme in the field of RWM research is managing three Knowledge Management WPs (WP11, WP12 and WP13) contributing to the expected KM goals. Within PREDIS, there is one KM WP (WP3) for all KM, closely working with other PREDIS WPs. During implementation of both projects, we begin to coordinate our activities to avoid potential duplication (e.g. EURAD WP12 excluded guide on waste acceptance criteria from its list as it is foreseen in PREDIS activities). The initial informal coordination was developed to more formalized form as EURAD and PREDIS representatives signed Joint Statement on knowledge management in 2021 [11].

EURAD WP12 is contributing to the KM through developing a comprehensive suite of instructional guidance documents that can be used by every interested end user involved in the RWM programmes, preferably those in early stage of its implementation and/or dealing with small inventory, but guidance documents developed within WP12 could be beneficial for advanced programmes as well.

KM should represent an integral part of all RWM programmes in order to support their efficient establishment and successful implementation during all programme phases. The main goal is dedicated to the knowledge enhancement and transfer between involved stakeholders/institutions, possibly between national RWM programmes and, in particular over generation to contribute to the RWM programme sustainability. KM should be considered already from the phase of conceptual planning of the programme. It needs to be implemented as soon as feasible to be an integral part of radioactive waste disposal implementation process.

The necessity of KM integration into RMW programmes, including RD&D, is also identified through the EURAD Founding documents (EURAD Roadmap [1], Vision Document [5], Strategic Research Agenda [6], Deployment Plan [12]), in the field of radioactive waste disposal and complemented with PREDIS KM strategy dedicated to the pre-disposal activities.

The produced pilot Guide on Cost Assessment and Financing Schemes of Radioactive Waste Management aims to fill identified gap and orient the early stages RWM programmes including those programmes dealing with small inventories on how to plan budget activities with special impact on radioactive waste disposal. This pilot guide may contribute to the learning process on costing strategy and methodology as well as on establishing and operating a funding scheme. The experience gained during the drafting of the pilot guide can serve as a sound basis for the development of further guides the topics of which will be defined based on a systematic and transparent selection process.

Conflict of interests

The authors declare that they have no competing interests to report.

Acknowledgements

The authors are grateful to all EURAD KM programme members. We want to thank Tara Beattie and Piet Zuidema for the fruitful discussions and support. Our thanks also to the anonymous reviewers for their comments.

Funding

The EURAD programme has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N° 847593. The PREDIS project has received funding from the Euratom research and training programme 2019–2020 under grant agreement N° 945098.

Data availability statement

This article has no associated data generated.

Author contribution statement

Mr. Peter Ormai prepared the basic version based on the initial discussion. The PREDIS detail were provided by Anthony Banford and Erika Holt. The EURAD details were provided by Bálint Nős, Peter Ormai, Nadja Železnik, Irena Mele, Paul Carbol, Jitka Mikšová and Jiří Faltejsek. The article was produced as teamwork with participations of all co-authors.

References

1. EURAD ROADMAP, A generic framework to organise typical scientific and technical domains/subdomains in a logical manner against different phases of a RWM programme (Sept. 2018), <https://www.ejp-eurad.eu/publications/eurad-roadmap>
2. T. Beattie, N. Belmans, P. Carbol, M. Cowley, J. Faltejsek, B. Grambow, E. Holt, E. Salat, A. Tatomir, L. Théodon, R. Winsley, P. Zuidema, *Overview of Knowledge Management in EURAD*, EURADWASTE'22, 30 May–3 June 2022, Lyon, France (2022)
3. T. Knuuti, A. Tatomir, A. Göbel, C. Franzen, D. Abbasova, T. Arnold, V. Brendler, K. Fuzik, State of knowledge, in *EURAD Knowledge Management – What We Know and Why it is Important*, EURADWASTE 2022 (2022)
4. P. Carbol, E. Holt, M. Oksa, L. Theodon, *EURAD-PREDIS Knowledge Management Interactions*, EURAD-WASTE 2022, 30 May–3 June 2022, Lyon, France (2022)
5. EURAD Vision document: A step change in European collaboration towards safe radioactive waste (2019), <https://www.ejp-eurad.eu/publications/eurad-vision>
6. Strategic Research Agenda, The scientific and technical domains and sub-domains and knowledge management needs of common interest between EURAD participants (2019), https://www.ejp-eurad.eu/sites/default/files/2020-01/2._eurad_sra.pdf
7. L. Nachmilner, L. Karaskova-Nenadalova, International approaches to establishing a waste acceptance system, The Euratom research and training programme 2019–2020, Grant agreement No 945098
8. P. Carbol, D. Matějů, N. Železnik, O. Tokarevsky, I. Yarmosh, J. Mikšová, P. Molnár, B. Nős, M. Dohnáková, Quality management procedure for guidance development, D12.2 (Jun. 2020)
9. P. Carbol, J. Faltejsek, J. Mikšová, B. Nős, N. Železnik, O. Tokarevsky, I. Yarmosh, Approved list of prioritized topics for further guidance documents and selection process of one topic for the development of a pilot guide Work Package 12, D12.3 (2021) <https://www.ejp-eurad.eu/publications/guidance-approved-list-prioritized-topics-further-guidance-documents-and-selection>
10. P. Carbol, J. Faltejsek, I. Mele, N. Železnik, P. Ormai, B. Nős, J. Mikšová, K. Fuzik, Guidance on cost assessment and financing schemes of radioactive waste management programmes, D12.3 (Jan. 2022)
11. Joint Statement on knowledge management – EURAD/PREDIS (2021), <https://www.ejp-eurad.eu/publications/joint-statement-knowledge-management-euradpredis>
12. Deployment Plan 2019–2024, A step change in European collaboration towards safe radioactive waste management, <https://www.ejp-eurad.eu/sites/default/files/2020-01/4.%20EURAD%20Deployment%20Plan.pdf>

Cite this article as: Peter Ormai, Bálint Nős, Jiří Faltejsek, Jitka Mikšová, Nadja Železnik, Irena Mele, Kateryna Fuzik, Paul Carbol, Anthony Banford, and Erika Holt. Development of Guidance Documents in the EURAD and PREDIS Projects, EPJ Nuclear Sci. Technol. 8, 39 (2022)