Romania

Report on National Programme

Notification to the European Commission in relation to Directive 2011/70/EURATOM on the responsible and safe management of spent fuel and radioactive waste.

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Version 1.0

Summary

This report presents the Romanian "National Programme" for spent fuel and radioactive waste management. It has been prepared by the Romanian Nuclear Agency and for Radioactive Waste (ANDR) to meet the obligation to notify the European Commission on the content of the National Programme under Article 15(4) of Council Directive 2011/70/Euratom on the responsible and safe management of spent fuel and radioactive waste.

This report may also be of interest to members of the public and other stakeholders by providing a concise overview of the current situation, and future plans and programmes.

According to the Law 378/2013 for the transposition of Council Directive 2011/70/Euratom establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste the National Programme is part of the National Strategy .This report presents the current situation and the plans for management of radioactive waste and spent nuclear fuel.

Romania has an established nuclear sector, and is active in most aspects of the nuclear fuel cycle, including mining, fuel manufacture and civil nuclear power generation. There are currently 2 operating CANDU reactor units in Romania, both at the Cernavoda site. It is planned that a further 2 CANDU reactor units will be commissioned at the Cernavoda site in the coming years. This report is therefore based on estimations for spent fuel and radioactive waste arising from all 4 reactor units.

The spent fuel and radioactive wastes arising from the Cernavoda NPP are, by far, the largest from all the nuclear sites in Romania but other sites do contribute significant quantities of waste to be managed.

Spent fuel and both short and long-lived radioactive wastes (LILW-SL and LILW-LL) are produced during normal operations of the CANDU reactors. Spent fuel is stored at the reactor site, first in cooling ponds and then transferred to a MACSTORE type interim dry fuel store. The operational LILW-SL and LILW-LL are also stored on site, after some segregation and packaging operations.

Romania adopts an open fuel cycle and consequently spent fuel from the power reactors is considered as a waste, and is expected to be disposed to a geological repository. Assuming 50 years operation of all 4 reactors, the total quantity of spent fuel that will need to be disposed is around 20,000 tonnes U metal. The LILW-LL from reactor operations and decommissioning will be co-disposed in the same geological repository as the spent fuel. The current estimate of the total amount of LILW-LL to be disposed is around 2,200 m^3.

Since the interim dry fuel store has a design life of around 50 years, there is no requirement for the geological repository to be operational before about 2050. As a consequence, current activities are limited, and focussed on the preparation of a long-term repository implementation programme and supporting RD&D plan. The reference disposal concept is based on the Canadian deep geological repository for spent CANDU fuel. Preliminary geological studies in Romania have identified a number of potentially favourable host rock types, and a national site selection process is being prepared.

The CANDU reactors are expected to undergo refurbishment half way through their design life (after around 25 years of operation) during which some reactor internal components will be replaced. Most of these components will be LILW-LL. Assuming 50 years operation of all 4 reactors, the total quantity of packaged and conditioned LILW-SL from routine operations, refurbishment and decommissioning that will need to be disposed is around 30,000 m^3.

To dispose of this LILW-SL, a new surface repository is planned to be constructed within the Cernavoda NPP exclusion zone, subject to regulatory approval. This repository will have a modular cell design which will allow it to be built in phases, and to adapt to future decommissioning and

LILW-SL management decisions. The reference concept is based on the French Centre de l'Aube repository. It is anticipated that the first phase of the new repository will be built and licensed for waste disposals starting in around 2021.

There are two nuclear research sites in Romania, both with research reactors and other facilities that produce radioactive waste. The VVR-S type research reactor at the IFIN-HH research site at Magurele has been defueled and is being decommissioned. All HEU and LEU spent fuel from this reactor has been repatriated under agreement to Russia. The TRIGA type research reactor at the RATEN ICN research site at Pitesti has been converted to operate with LEU fuel. All of the HEU fuel has been repatriated under agreement to the USA. Future spent LEU fuel arising from continued operation of this reactor is intended to be returned to its country of origin.

Both the IFIN-HH and RATEN ICN research sites produce LILW-SL and LILW-LL from their own research activities and from facility decommissioning. They also collect radioactive wastes and spent sources from other research, industrial and medical institutions around Romania. RATEN ICN also stores small amounts of spent fuel that have been transferred from the Cernavoda NPP for post-irradiation examination.

The LILW-LL produced by IFIN-HH and RATEN ICN is stored on their sites, and will eventually be conditioned, packaged and transferred for disposal to the geological repository when it is operational (along with the spent fuel in storage at RATEN ICN).

Both IFIN-HH and RATEN ICN have their own on-site waste treatment plants that condition and package LILW-SL. These wastes are disposed to the operating repository at Baita Bihor. This repository is located within a redundant uranium mine and, following modernisation in 2010/11, is expected to continue operations until around 2040. After this date, any further LILW-SL produced by the research sites and other institutions will be sent for disposal to the new surface repository that will, by then, be operational near the Cernavoda NPP.

Specific laws have established the national framework for the responsible and safe management of spent fuel and radioactive wastes, to avoid imposing undue burdens on future generations. The National Commission for Nuclear Activities Control (CNCAN) has the authority to license and regulate all nuclear activities, including disposal. ANDR is the competent national authority responsible for planning the National Programme, implementing disposal of spent fuel and radioactive waste, and for coordinating the pre-disposal management of spent fuel and radioactive wastes arising from operations and decommissioning.

Two funds have been established to finance all decommissioning and waste disposal activities. The operators of the Cernavoda NPP pay into these funds according to a pricing mechanism based on a fee per unit electricity generated. The funds are managed by ANDR which also has the responsibility for periodically updating the cost estimates for decommissioning and waste disposal, and ensuring adequate funds will be available.

The Romanian National Programme will continue to evolve as decisions are made and new waste management facilities are implemented. Significant changes to the National Programme will be notified to the European Commission in accordance with Article 13(1) of the Waste Directive.

Glossary and abbreviations

The following list provides definitions for names, terms and abbreviations, including those with specific Romanian usage.

ANDR	Agenţia Nucleară şi pentru Deşeuri Radioactive (Nuclear Agency and Radioactive Waste), the national agency with responsibility for implementing radioactive waste management and disposal
CNCAN	Comisia Nationala pentru Controlul Activitatilor Nucleare (National Commission for Nuclear Activities Control), the national authority with responsibility for regulation of nuclear activities
DICA	Depozitul Intermediar de Combustibil Ars, the MACSTORE type interim dry storage facility for spent CANDU fuel on the Cernavoda NPP site
DIDR	Depozitul Intermediar de Deşeuri Radioactive, the interim radioactive waste storage facility on the Cernavoda NPP site
DFDSMA	Depozitul Final de Deşeuri de Slabă şi Medie Activitate (Final Repository for Low and Intermediate Radioactive Waste), the planned surface repository for LILW-SL to be built in the vicinity of the Cernavoda NPP
DNDR	Depozitul National de Deseuri Radioactive (National Repository Radioactive Waste), the operating repository at Baita Bihor used for the disposal of institutional LILW-SL
EC	European Commission
EIA	Environmental impact assessment
HEU	Highly enriched uranium (fuel)
HLW	High level waste (also high heat generating waste)
IAEA	International Atomic Energy Agency
ICN	Institutul de Cercetari Nucleare (Institute for Nuclear Research) at Pitesti, a leading national nuclear research institute and a subsidiary of RATEN
IFIN-HH	Institutul National de Cercetare-Dezvoltare pentru Fizica si Inginerie Nucleara Horia Hulubei (National Institute for R&D in Physics and Nuclear Engineering at Horia Hulubei), a leading national nuclear research institute
KPI	Key performance indicator
LEPI	Post irradiation examination laboratory at the RATEN ICN site.
LEU	Lightly enriched uranium (fuel)
LILW-LL	Low and intermediate level radioactive waste (long lived), non-heat generating wastes with half-lives > 30 years
LILW-SL	Low and intermediate level radioactive waste (short lived), non heat generating wastes with half-lives < 30 years
NPP	Nuclear power plant (reactor)
Nuclearelectrica	SN Nuclearelectrica SA, the company that owns the CANDU nuclear reactors at Cernavoda and the fuel manufacturing plant at Pitesti

RATEN	Regia Autonoma Tehnologii pentru Energia Nucleara (State Owned Company Technologies for Nuclear Energy), the national technical support organisation responsible for maintaining nuclear competence
RD&D	Research, development and demonstration
SEA	Strategic environmental assessment
TRIGA	Training, Research, Isotopes, General Atomics - a type of research reactor.
VLLW	Very low level waste
VVR-S	A type of water-cooled research reactor

Contents

1 Introduction

1.1 Background

This report presents the Romanian "National Programme" for spent fuel and radioactive waste management. It has been prepared by the Romanian Nuclear Agency and for Radioactive Waste (ANDR) to meet the specific obligation for the first time to notify the EC on the content of the National Programme under Article 15(4) of Council Directive 2011/70/Euratom on the responsible and safe management of spent fuel and radioactive waste (the "Waste Directive").

This report has been prepared following the guidelines established by the European Nuclear Energy Forum (ENEF) Working Group on National Programmes (the "NAPRO Guide"), specifically Annex VI on a proposed generic structure for a Lead Document for the National Programme.

In accordance with the NAPRO Guide, this report is considered to be a "Lead Document" that provides an overview of the Romanian National Programme. More comprehensive detail and underpinning explanations can be found in other related, publically available documents, as indicated in Figure 1, specifically:

- The medium and long-term National Strategy for spent fuel and radioactive waste management (Order 844/2004)[1]. This strategy sets out the approach to management of operational and decommissioning wastes, and the future need for additional facilities, including for final disposal.
- The first national report to the EC on the implementation of the Waste Directive.
- The fifth national report to the IAEA Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management (CNCAN, 2014)

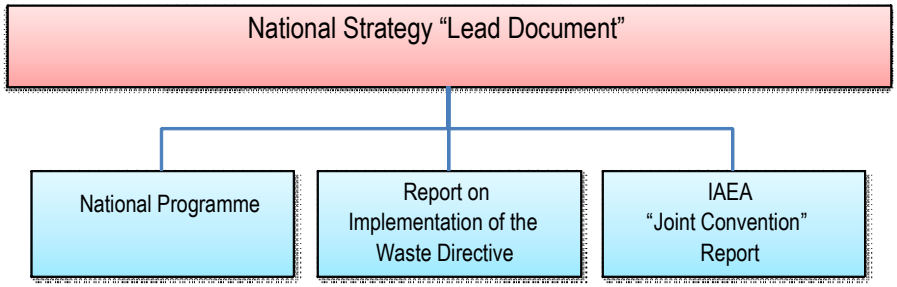

Figure 1: *This National Strategy "Lead Document" is completed by other key documents that explain spent fuel and radioactive waste management in Romania.*

In Romania, spent fuel and radioactive wastes are produced by civilian nuclear power generation, and by research, industrial and medical activities. Facilities are available for treating and storing these wastes, and for the disposal of institutional[2] LILW-SL at the operating repository at Baita Bihor. The safety of these facilities is ensured by arrangements established under a comprehensive set of laws and regulations, as described in Section 2.

[1] Section 7 of this report provides a list of the laws and regulations referred to in this report, together with their complete title (English translation), bibliographic reference and weblink, where available.
[2] In this report, the term 'institutional waste' refers to all radioactive wastes arising from sites not directly involved in nuclear power generation. It includes radioactive wastes from sites engaged in research, industrial and medical activities etc.

Note that there are currently 2 operating CANDU power reactor units in Romania, both at the Cernavoda site. It is planned that a further 2 CANDU reactor units will be commissioned at Cernavoda in the coming years. This report is therefore based on estimations for spent fuel and waste arisings from all 4 reactor units.

This National Programme report describes the current spent fuel and radioactive waste management activities, and the strategy and programme for implementing future activities leading to disposal. It is based on Order 844/2004 but also incorporates more recent decisions and developments, notably the transposition of the Waste Directive into Romanian Law (Law 378/2013) and revisions to certain milestones dates contained in the National Strategy. Although this report presents an update on the current situation in Romania, and describes future plans and programmes, it does not replace the statutory laws and regulations which continue to remain in force.

The Romanian National Programme will continue to evolve as decisions are made and new waste management facilities are implemented. Significant changes to the National Programme will be notified to the EC in accordance with Article 13(1) of the Waste Directive.

1.2 Purpose of the report

The primary purpose of this report is to meet the obligation to notify the EC on the content of the Romanian National Programme under Article 15(4) of the Waste Directive. Note that this is separate to the obligation under Article 14(1) to notify the EC on implementation of the Directive.

This report may also serve other purposes. For instance, by providing a concise overview which can be used to inform interested stakeholders about the current situation, and future plans and programmes, for spent fuel and radioactive waste management in Romania.

1.3 Compliance with the requirements of Articles 15(4) and 12(1)

As previously mentioned, this report follows the NAPRO Guide for the structure of a Lead Document.

The requirement to notify the EC on the content of the National Programme is defined in Article 15(4) of the Waste Directive, whilst Article 12(1) sets out what those contents should include. Table 1 shows explicitly where in this report the specific requirements of Article 12(1) are addressed.

Table 1: *compliance between this report and the requirements of Article 12(1).*

Article 12(1) Requirements		**Section of report where addressed**
The national programmes shall set out how the Member States intend to implement their national policies referred to in Article 4 for the responsible and safe management of spent fuel and radioactive waste to secure the aims of this Directive, and shall include all of the following:		
(a)	the overall objectives of the Member State's national policy in respect of spent fuel and radioactive waste management;	Section 2.1
(b)	the significant milestones and clear timeframes for the achievement of those milestones in light of the over-arching objectives of the national programme;	Section 3.1 Section 3.2

Article 12(1) Requirements		Section of report where addressed
(c)	an inventory of all spent fuel and radioactive waste and estimates for future quantities, including those from decommissioning, clearly indicating the location and amount of the radioactive waste and spent fuel in accordance with appropriate classification of the radioactive waste;	Section 2.6.2
(d)	the concepts or plans and technical solutions for spent fuel and radioactive waste management from generation to disposal;	Section 3.1 Section 3.2
(e)	the concepts or plans for the post-closure period of a disposal facility's lifetime, including the period during which appropriate controls are retained and the means to be employed to preserve knowledge of that facility in the longer term;	Section 3.1.3 Section 3.1.6 Section 3.2.3
(f)	the research, development and demonstration activities that are needed in order to implement solutions for the management of spent fuel and radioactive waste;	Section 4
(g)	the responsibility for the implementation of the national programme and the key performance indicators to monitor progress towards implementation;	Section 2.3 Section 6
(h)	an assessment of the national programme costs and the underlying basis and hypotheses for that assessment, which must include a profile over time;	Section 5.1
(i)	the financing scheme(s) in force;	Section 5.2
(j)	a transparency policy or process as referred to in Article 10;	Section 2.4
(k)	if any, the agreement(s) concluded with a Member State or a third country on management of spent fuel or radioactive waste, including on the use of disposal facilities.	Section 2.5

2 National policy framework

2.1 Main objectives and principles

Romanian national policy is aligned with the fundamental principles for safe, secure and sustainable management of spent fuel and radioactive wastes, as generally expressed by international authorities including the EC and the IAEA. The principles and obligations of the Waste Directive and of the Joint Convention are transposed into Romanian law (Law 378/2013 and Law 105/1999, respectively).

The national policy is expressed across several laws, orders and regulations (listed in Section 7): notably in the medium and long-term National Strategy for spent fuel and radioactive waste management which is set out in Order 844/2004. This strategy is a part of the National Nuclear Plan (Government Decision 1259/2002) whose objectives relevant to the management of spent fuel and radioactive waste are:

1. Specific objectives derived from the National Nuclear Plan:
   - to manage spent fuel and radioactive waste in accordance with international requirements;
   - to assure the safety of the public and workers by keeping exposures to radiation below levels set in national laws, and to minimise the impact on the environment;
   - to develop RD&D programmes to support management of spent fuel and radioactive waste, including for final disposal.

2. Specific objectives derived from requirements of European Directives:
   - to seek continuous improvement in nuclear and radiological safety performance, including from the disposal of spent fuel and radioactive waste;
   - to assure the physical protection of spent fuel and radioactive waste, including during transport;
   - to deliver environmental restoration of sites following the cessation of nuclear and radiological activities.

These high-level objectives from the National Nuclear Plan are underpinned by key principles for the management of spent fuel and radioactive waste that are set out in the National Strategy:

- Romania adopts an open fuel cycle and consequently spent fuel from power reactors is not recycled and is planned to be disposed as a waste. According to the definition of the Law 378/2013 (which transposed the EC Directive 2011/70/Euratom), spent fuel could also be considered as a resource to be reprocessed. Pending on evidence-based research and appropriate amendments to the National Strategy for spent fuel and radioactive waste management, this option could be developed.
- The import, export and intra-Community transfer of radioactive wastes is prohibited subject to the following exemptions:
  a. spent fuel from research reactors will be returned to the country of origin, under agreement;
  b. the transfer of disused sealed sources, which must be returned to the supplier or manufacturer;
  c. the transfer of radioactive waste for treatment or spent fuel for processing, with subsequent return of the waste product for final disposal;
  d. the transfer of radioactive waste or spent fuel to another country for final disposal but only when the receiving country has the technical and administrative capability to meet international standards.

- The generation of radioactive waste is to be kept to the minimum practicable level in terms of activity and volume through appropriate design measures, facility operation and decommissioning practices. To meet this requirement, the license holder must ensure:
    a. selection and control of materials;
    b. recycling and reuse of materials, including clearance of materials;
    c. implementing adequate operating procedures, including those referring to the physical, chemical and radiological characterisation of the waste, and sorting of different type of materials.

- All spent fuel and radioactive wastes are to be safely managed using a graded approach, applying an appropriate combination of engineered systems and management controls.

- All spent fuel and radioactive wastes are to be managed according to an integrated strategy that addresses interdependencies between all waste management steps which includes pre-treatment, treatment, conditioning, storage, transport and disposal.

- Disposal is the last stage of the radioactive waste management system. Wastes are to be disposed with no intention to be retrieved. A graded approach is adopted, with the disposal concept commensurate with the level of hazard posed by the waste:
    a. spent fuel from power reactors will be directly disposed to a geological repository after an appropriate period of interim storage, together with other long-lived radioactive wastes;
    b. short-lived operational, decommissioning and institutional wastes will be disposed to surface or near-surface repositories.

- Facility decommissioning, waste management and disposal operations will be undertaken as soon as is reasonably practical to avoid placing an undue burden on future generations, and implementation programmes have been prepared with key milestone dates.

- The financial costs for waste management and disposal operations should be borne by the waste producers in accordance with the 'polluter pays' principle, and a statutory funding scheme is in place.

2.2 Legal and regulatory framework

Law 111/1996 (as amended by Law 378/2013) on the safe deployment, regulation, licensing and control of nuclear activities, provides the primary legislative framework governing the safety of nuclear installations, including those for the purpose of spent fuel and radioactive waste management. This law provides the legal basis for the nuclear regulatory authority (National Commission for Nuclear Activities Control, CNCAN) to exercise fully regulatory control over all aspects of the management of spent fuel and radioactive wastes, including disposal. Specifically the law provides for:

- a system of licensing of spent fuel and radioactive wastes management activities;
- a system to prohibit the operation of facilities without a licence (sanctions may apply in such situations);
- a system of safety requirements and regulations for radiation safety;
- a system to enforce appropriate control, regulatory inspection, documentation and reporting;
- the enforcement of regulations and of the conditions of licenses.

Under its authority, CNCAN has issued a number of regulations that implement Government policy objectives set out in primary legislation. Those that are directly relevant to the management and disposal of spent fuel and radioactive wastes are listed in Section 7.

Government Ordinance 11/2003 (as amended by Law 378/2013) establishes the national framework for the responsible and safe management of radioactive waste and spent fuel, to avoid imposing undue burdens on future generations. It reconfirms that management of spent fuel and radioactive wastes will be conducted according to rules and regulations, international agreements and conventions to which Romania is a party. Specifically this Government Ordinance:

- establishes the responsibilities of the organisations involved in all stages of spent fuel and radioactive waste management, including for decommissioning of nuclear facilities, and disposal of radioactive wastes;
- establishes the funding arrangements; and
- provides for public information and participation in relation to radioactive waste management decision making processes.

Order 844/2004 sets out the medium and long-term National Strategy for spent fuel and radioactive waste management, including disposal.

2.3 Responsibilities for implementing the National Programme

Government Ordinance 11/2003 (as amended by Law 378/2013) sets out the responsibilities of the organisations involved with radioactive waste management, and for implementation of the National Programme, as follows:

Romanian Government:

- retains ultimate responsibility for, and guarantees, the decommissioning of nuclear facilities, and the safe management of spent fuel and radioactive wastes generated within Romania;
- holds (via ANDR) all rights and obligations arising under national law and international conventions and treaties relevant to spent fuel and radioactive waste management, to which Romania is a party;
- approves by Government Decision the means for establishing and managing the financial resources (funds) necessary for the safe implementation of the National Programme.

Ministry of the Environment and Climate Change:

- within Government, is the central authority for environmental protection and has specific responsibilities in the environmental licensing and control of nuclear installations, including facilities for the management of spent fuel and radioactive waste.

The Ministry of Economy, Commerce and Tourism:

- within Government, is the central authority responsible for ensuring the National Programme is implemented (by ANDR).

National Commission for Nuclear Activities Control (CNCAN):

- is the nuclear safety and security regulatory authority of Romania, responsible for the regulation of all nuclear activities and is empowered to:
    i. issue licences for all activities and facilities, and for all steps in the lifetime of a facility;
    ii. perform regulatory review and assessments;
    iii. perform inspections to verify compliance with safety requirements;
    iv. take any necessary enforcement actions;
- reports to the Prime Minister through the General Secretariat of the Government.

Nuclear Agency and for Radioactive Waste (ANDR):

- is the competent national authority responsible for planning and implementing the National Programme, including disposal of spent fuel and radioactive waste, and for coordinating the pre-disposal management of spent fuel and radioactive waste from operations and decommissioning;
- is responsible for the preparation and periodic revision (at least once every five years) of the National Strategy for spent fuel and radioactive waste management, in collaboration with licence holders, and for monitoring its implementation;
- is responsible for the establishment and maintenance of a national inventory of spent fuel and radioactive waste;
- is responsible for the preparation of RD&D programmes necessary to implement the National Programme, and benefits from the results of those programmes;
- is responsible for the recovery, treatment and disposal of orphan sources, historic wastes resulting from past practices, and wastes resulting from accidents or nuclear incidents;
- is responsible for the management and disposal of radioactive wastes and radiation sources, including the decommissioning of their nuclear installations, in cases where an operator is bankrupt, in liquidation or their financial resources resulting from judicial liquidation are insufficient;
- is responsible for the management of the financial resources (national funds) to cover the full costs for disposal of all spent fuel and radioactive waste - this includes periodically updating the cost estimates, and ensuring adequate funds will be available;
- is independent from a functional perspective of the regulatory authority CNCAN, and the nuclear license holders;
- reports to Government via the Ministry of Economy, Commerce and Tourism.

The license holders generating spent fuel and radioactive waste:

- are responsible, in accordance with their licence conditions and in a manner consistent with the National Strategy, for pre-disposal management of all spent fuel and radioactive waste resulting from the operation and decommissioning of their sites and facilities;
- are required to finance all pre-disposal management activities including collecting, sorting, treatment, conditioning, storage and transportation to final disposal of the spent fuel and radioactive waste resulting from the operation and decommissioning of their sites and facilities;
- are required to contribute to raising the financial resources for the safe disposal of radioactive waste, and decommissioning of nuclear and radiological installations.

The main license holders generating spent fuel and radioactive waste are:

- Nuclearelectrica, the owner of the Cernavoda NPP and the fuel manufacturing plant at Pitesti;
- National Institute for Research and Development in Physics and Nuclear Engineering-Horia Hulubei (IFIN-HH) at Magurele, responsible for institutional waste management including disposal at the Baita Bihor repository;
- Institute for Nuclear Research (ICN) at Pitesti, the owner of TRIGA research reactor and post irradiation laboratory, and a subsidiary of RATEN.

Technical support organisation (RATEN):

- is the national strategic state-owned organisation in the nuclear field;

- provides technical support and performs research, including for radioactive waste and spent fuel management and disposal; and
- develops and maintains technical competence, and provides training, in the nuclear field.

The National Authority for Scientific Research and Innovation (ANCSI):

- within Government (the Ministry of Education and Scientific Research), is the specialist body responsible for implementing the national policy for scientific research, technological development and innovation, including in the nuclear field.

2.4 Transparency policy and public involvement

Government Decision 564/2006 transposes Directive 2003/35/EC and provides for public participation in the drawing up of certain plans and programmes relating to the environment, and so requires an SEA. Any significant future revisions to this National Programme will fall under this regime.

Government Decision 445/2009 sets out the permitting regime for public and private developments which may have a significant environmental impact, and so require an EIA. The development of a new radioactive waste management facility would fall under this regime.

Order 135/2010 sets out the EIA methodology. Procedures for both SEA and EIA require stakeholder engagement and public hearings. Stakeholders may address questions related to the project and its potential impacts on the environment both in writing (during the consultation phase) or verbally (during the public hearing). The developer is required to address the stakeholder's questions in a revised EIA report.

If a proposed development has a potential transboundary impact, Order 864/2002 will apply which transposes the Espoo Convention. If changes to radioactive waste disposal or discharge practices form part of a proposed development, then a Euratom Treaty Article 37 submission will also be required to determine whether this will result in radioactive contamination of another Member State. Under both the Espoo Convention and Article 37, potentially impacted countries may participate in the EIA stakeholder engagement processes.

Romania has participated in several international projects related specifically to public and stakeholder engagement in radioactive waste disposal programmes, including:

- IPPA: Implementing public participation approaches in radioactive waste disposal
- COWAM2: Community Waste Management Phase 2
- CIP: COWAM in Practice

Recommendations from these international projects are applied to the siting of the planned new surface repository for LILW-SL anticipated to be built close to the location of the Cernavoda NPP. Site investigations began in 1992 but did not involve the public. Within the environmental permitting process, public engagement is not mandatory in the early stages. Learning from COWAM2 project was used in 2004 to establish a systematic dialogue process between representatives of the local community and local authorities, and of the nuclear industry. This dialogue has addressed key themes including health monitoring and environment surveillance, and community benefits.

Public engagement for the geological disposal programme has adopted the recommendations from the IPPA project, and a Romanian Stakeholders Group has been established that involves representatives from industry, government, national agencies (including CNCAN and ANDR) and non-governmental organisations. The siting methodology has not yet been established and,

consequently, there can be no potential host communities involved at his stage. The proposed strategy for further public engagement in the geological disposal programme requires:

- the implementer (ANDR) should propose a 'vision' for the public participation process;
- the Romanian Stakeholders Group should debate the vision and produce recommendations for improvement to transform it into a strategy;
- an independent facilitator should moderate the discussions on the strategy;
- public engagement will follow once a siting programme is implemented.

2.5 Agreements with other countries

Key government-to-government agreements with other countries relate to the conversion of research reactors and the repatriation of spent fuel from research reactors.

In 2006, under the IAEA's technical cooperation programme and with the support of the US Department of Energy, the TRIGA research reactor at Pitesti was converted to burn LEU instead of HEU fuel. All spent HEU fuel from the TRIGA research reactor has since been returned to the USA, under agreement with the US Government. The first shipment was in 1999, and the second and final shipment was in 2008. This agreement has ended, now that all spent HEU fuel has been repatriated.

Other agreements are in place for the repatriation of spent LEU fuel from continued operation of the converted TRIGA reactor, which will all be returned to its country of origin.

Similarly, the entire inventory HEU and LEU spent fuel from the VVR-S research reactor at Magurele was returned to Russia under agreement with the Russian Government as part of the Russian Research Reactor Fuel Return (RRRFR) programme. This agreement has ended, now that all of the fuel has been repatriated, and the VVR-S reactor is being decommissioned.

A number of commercial agreements are in place with private companies in other countries for the treatment of radioactive wastes. Starting in 2010, a total of 39,000 kg of combustible VLLW (in several shipments) has been characterised and transferred to Sweden for treatment by incineration. The incinerator ash waste product has been returned to Romania. This is consistent with Romanian policy to permit the transfer of radioactive waste to another country for treatment, with subsequent return of the waste product for final disposal.

2.6 Waste classification system and inventory

2.6.1 Waste classification system

The radioactive waste classification system used in Romania is defined by CNCAN in Regulation NDR-03 (Norms on the classification of radioactive waste, CNCAN President Order 156/2005), and is set out in Table 2. This system is fully consistent with the IAEA's recommendations (IAEA, 2009).

Table 2: *the classification scheme used in Romania for radioactive wastes.*

Waste Class	Typical Characteristics	Management options
VLLW (Very Low Level Waste)	This type of waste consists of short lived radionuclides, and activity concentration above clearance levels but below the threshold for LLW.	Near surface disposal in a repository with less complex arrangements than needed for LLW-SL.

Waste Class	Typical Characteristics	Management options
LILW-SL (Short Lived, Low and Intermediate Level Waste)	This type of waste contains radionuclides with half-life < 30 years and activity concentration above the threshold for VLLW, but whose radioactive contents and heat output are lower than those of HLW.	Near surface disposal in an engineered repository.
LILW-LL (Long Lived, Low and Intermediate Level Waste)	This type of waste contains radionuclides with half-life > 30 years and activity concentration above the threshold for VLLW, but whose radioactive contents and heat output are lower than those of HLW.	Interim storage prior to geological co-disposal with spent fuel.
HLW (High Level Waste)	This type of waste contains long-lived radionuclides and has a radiogenic heat output which requires special considerations for handling or final disposal. Spent fuel belongs to this class.	Interim storage to allow for cooling prior to geological co-disposal with LILW-LL.

There are two other classes of radioactive waste in Romania: exempt wastes and transition wastes (very short-lived wastes suitable for decay storage prior to release). These fall outside of the scope of the Waste Directive.

Each waste producer and waste management organisation may also apply an 'operational classification scheme' to enable sorting, segregation and treatment of wastes for pre-disposal waste management activities. The operational classification scheme may take account of the origin and types of the waste, their radiological properties as well as their physical, chemical and biological properties (e.g. water content, volatility, flammability, swelling potential, reactivity, hazardous substances content etc).

The operational classification scheme is not a replacement for the statutory classification scheme.

2.6.2 Waste inventory

The largest producer of spent fuel and radioactive waste in Romania, by far, is the Cernavoda NPP. There are currently no disposal routes available for any of these wastes and, consequently, they are all stored on site. This means that the majority of the existing national inventory by both activity and volume is now stored on the Cernavoda site (see Section 3).

Other significant waste producers are the IFIN-HH and RATEN ICN research sites. The general approach at these sites is that LILW-SL is disposed to the operating repository at Baita Bihor (see Section 3.1.2). The only wastes that are stored at IFIN-HH and RATEN ICN are institutional wastes that do not meet the waste acceptance criteria for the Baita Bihor repository.

Table 3 (over page) provides a summary of the quantities of spent fuel and radioactive waste in the national inventory, reported for:

- the statutory waste classes for each waste producer (site); and
- current quantities and best estimates for future quantities that will arise both from operations and decommissioning.

The future quantities are based on the assumptions that (i) there will be 4 CANDU reactors, each operational for a period of approximately 50 years, (ii) all spent fuel will be directly disposed to a geological repository, and (iii) decommissioning of the reactors will take place promptly within a few years of defuelling.

Quantities are reported as either raw (untreated) arisings or as conditioned volumes in cases where the treatment and packaging methods are known or can be reasonably assumed. The waste acceptance criteria and packaging requirements for the future geological repository are not known, and so quantities of spent CANDU fuel are given as tonnes of U metal.

The quantities of VLLW are included within the estimates for LILW-SL. The largest quantities of VLLW will arise from decommissioning of the CANDU reactors but reliable estimates have not yet been made because this will depend on future decisions regarding techniques for the segregation of VLLW from other decommissioning LLW waste streams.

The reference date for this inventory is December 2013, which is also the reference date for the inventory reported in the latest (5th) Joint Convention report, for consistency.

Table 3: *the summary inventory of spent fuel and radioactive waste quantities in Romania.*

Waste producer	Waste class	Current quantities	Future quantities		Total quantity	Brief description of waste materials
			Operation/ refurbish	Decommission		
SPENT FUEL						
Cernavoda NPP Units 1&2	HLW	2,289 tonnes U metal	7,911 tonnes U metal	-	10,200 tonnes U metal	CANDU fuel
Cernavoda NPP Units 3&4	HLW	-	10,200 tonnes U metal	-	10,200 tonnes U metal	CANDU fuel
RATEN ICN	HLW	0.001 tonnes U metal 0.055 tonnes U metal	0.35 tonnes U metal 0.15 tonnes U metal	- -	0.35 tonnes U metal 0.20 tonnes U metal	TRIGA LEU fuel CANDU fuel rods
Total quantity of spent fuel for geological disposal					**20,400 tonnes U metal**	

LILW-LL						
Cernavoda NPP Units 1&2	LILW-LL	-	450 m^3 Cond.	580 m^3 Cond.	1,030 m^3 Cond.	Operational, refurbishment and decommissioning wastes
Cernavoda NPP Units 3&4	LILW-LL	-	450 m^3 Cond.	580 m^3 Cond.	1,030 m^3 Cond.	Operational, refurbishment and decommissioning wastes
RATEN ICN	LILW-LL	0.5 m^3 Raw	5 m^3 Cond.	100 m^3 Cond.	105 m^3 Cond.	Institutional and decommissioning wastes
IFIN-HH	LILW-LL	4 m^3 Raw	10 m^3 Cond.	60 m^3 Cond.	70 m^3 Cond.	Institutional and decommissioning wastes
Total quantity of LILW-LL for geological disposal					**2,235 m^3 Cond.**	

LILW-SL						
Cernavoda NPP Units 1&2	LILW-SL	650 m^3 Raw	7,000 m^3 Cond.	7,100 m^3 Cond.	14,700 m^3 Cond.	Operational, refurbishment and decommissioning wastes
Cernavoda NPP Units 3&4	LILW-SL	-	7,650 m^3 Cond.	7,100 m^3 Cond.	14,700 m^3 Cond.	Operational, refurbishment and decommissioning wastes
Total quantity of operational LILW-SL for disposal at DFDSMA					**29,500 m^3 Cond.**	

IFIN-HH/ RATEN ICN	LILW-SL	22 m^3 Cond.	78 m^3/year Raw	1,900 m^3 Cond.	2,870 m^3 Cond.	Institutional & Decommissioning waste
Baita Bihor Repository	LILW-SL	2,130 m^3 Disposed			5,000 m^3 total capacity	Institutional & Decommissioning waste
Total quantity of institutional LILW-SL for disposal at Baita Bihor repository					**2,870 m^3 Cond.**	

3 Spent fuel and radioactive waste management

The Romanian spent fuel and waste management strategy is shown illustratively in Figure 2 (over page). This is an indicative representation of the flows of the different classes of wastes from the main waste producing sites to the final disposal facilities. This figure also shows the main waste management infrastructure facilities, and identifies those that are current operating and those that are planned. The number and location of these future facilities, and the waste management technologies to be deployed, has yet to be determined. It is possible that several facilities could be co-located on the same site.

The following text is divided into two parts related to the intended disposal end-point for different classes of waste. The first part describes management of wastes to be disposed to surface or near-surface facilities, and the second part describes management of wastes to be disposed to a geological repository.

3.1 Management of wastes suitable for surface or near-surface disposal

The policy in Romania is for surface or near-surface disposal of LILW-SL, and the simplified management strategy for these wastes is shown in Figure 3. The main waste streams considered are:

- operational and decommissioning LILW-SL from the Cernavoda NPP and associated ancillary facilities;
- operational and decommissioning LILW-SL from the TRIGA and VVR-S research reactors, and associated ancillary facilities at IFIN-HH and RATEN ICN;
- other institutional wastes from sites around the country, including from medical and industrial applications.

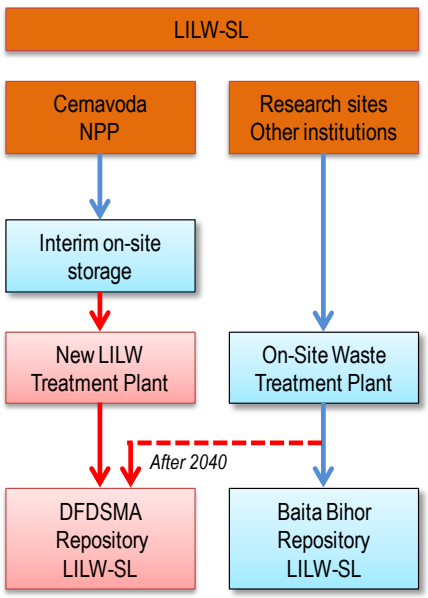

Figure 3: *the simplified management strategy for LILW-SL showing existing facilities (blue) and those that are planned for the future, subject to further approvals (red).*

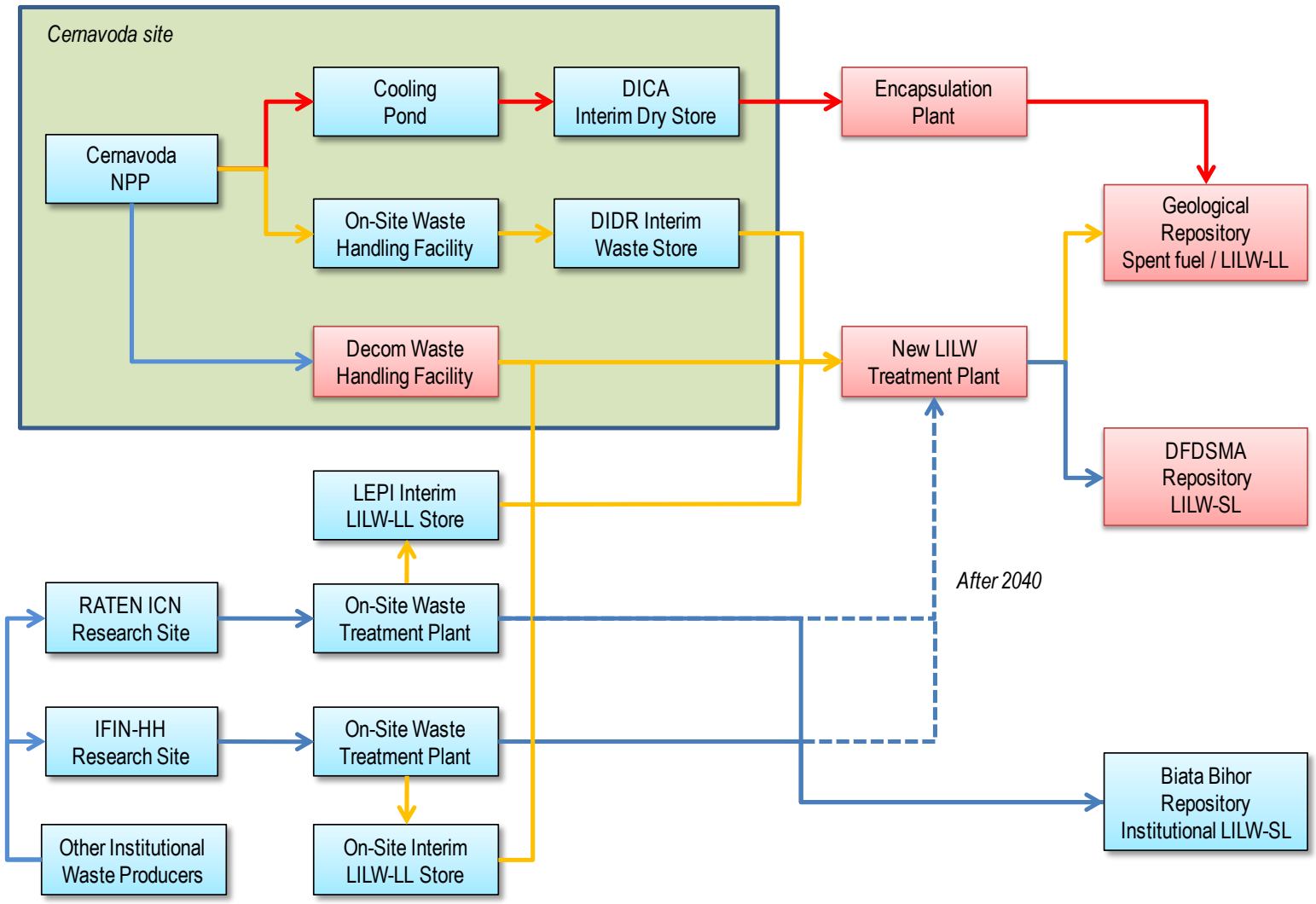

Figure 2: *An indicative representation of the flows of the different classes of wastes from the main waste producing sites to the final disposal facilities. Red arrows are spent fuel; yellow arrows are LILW-LL; blue arrows are LILW-SL. The red boxes are infrastructure that is planned but not yet built, subject to further approvals*

3.1.1 Existing pre-disposal related management arrangements

According to the National Strategy, there are separate management arrangements for operational LILW-SL from the Cernavoda NPP, and institutional wastes from other sites.

Management of operational LILW-SL at the Cernavoda NPP

The waste management system at the Cernavoda NPP is based on experience from Canadian CANDU reactor operations. The objectives of this system are primarily safe pre-treatment (to minimise the volume of the wastes), packaging for storage, and interim storage.

The main operational LILW-SL wastes are solids (plastics, cellulose, glass, wood, filters etc.), organic and inorganic liquids (oils, solvents, scintillation liquids etc.) and flammable solid-liquids mixtures.

The solid LILW-SL consists of materials from routine operations of the NPP, and from decontamination and maintenance activities, such as contaminated materials and redundant equipment. These wastes are handled in the Service Building, where they are inspected and monitored, and sorted according to the operational classification scheme. The C-14 contaminated wastes are not compacted and are packaged separately.

After pre-treatment and treatment, solid wastes are packaged into 220 litre stainless steel drums and then transported for storage in the Solid Radioactive Waste Interim Storage Facility (DIDR) which is located within the inner security fence at the Cernavoda site. This facility is designed for the storage of all low and intermediate operational wastes, except for spent fuel, spent ion-exchange resins and activated control rods.

The DIDR facility consists of three above ground, concrete structures: a storage building, cylindrical cells and concrete cubes. The storage building is used for storing the 220 litre drums containing compactable and non-compactable solid waste. The building has a net capacity of 1,408 m^3 of which 650 m^3 is filled (as of the end of 2013). The cylindrical cells have a capacity of 57.77 m^3 and are designed to accommodate spent filter cartridges from plant operations. The concrete cubes have a capacity of 41 m^3 and are designed for highly contaminated components but do not currently contain any waste.

Spent ion-exchange resin management is carried out in the resins handling facility. The fuel-contact and non-fuel contact resins are segregated, and stored in 3 concrete vaults (200 m^3 each), located in the basement of the Service Building. These will remain in storage for at least 20 years before being conditioned and packaged for final disposal.

The pre-treatment of organic liquid waste (oils, solvents and flammable liquid-solid mixtures) involves collection, segregation and storage in the basement of the Service Building. These wastes are processed using NOCHAR polymer, then stored for future incineration campaigns.

Management of institutional LILW at the IFIN-HH research site

IFIN-HH is the main organisation handling institutional wastes in Romania. The waste treatment plant at IFIN-HH handles liquid and solid wastes from the decommissioning of the VVR-S research reactor, and from the operation and decommissioning of other research facilities on the site. It also handles institutional wastes collected from off-site facilities, including medical, biological, and industrial sources. The facility performs treatment (compaction), conditioning (cementation), decontamination and long-term storage.

Wastes that meet the acceptance criteria for the operating repository at Baita Bihor are conditioned and packaged for disposal. Those that do not meet the waste acceptance criteria for this repository

(such as Ra-226 sources and Am-241 sources from smoke detectors), remain in long-term storage on the IFIN-HH site in purpose built storage facilities.

The waste treatment plant is expected to continue to operate for as long as needed to support continued operations and decommissioning activities on the IFIN-HH site.

Management of institutional LILW at the RATEN ICN research site

Institutional LILW is produced by the TRIGA research reactor, the post-irradiation examination laboratory (LEPI) and other nuclear installations on the RATEN ICN site. Institutional wastes are also transferred to RATEN ICN from other medical and industrial institutions across the country.

These institutional wastes are managed using the on-site waste treatment plant. This facility performs collection, transport, characterisation, treatment (incineration, evaporation, ionic exchange, chemical precipitation, compaction), conditioning (cementation, bituminisation), decontamination and temporary storage. The facility underwent a modernisation programme in 2010/12.

Wastes from RATEN ICN that meet the acceptance criteria for the operating repository at Baita Bihor (see below) are conditioned and packaged for disposal. Those that do not meet the waste acceptance criteria for this repository, such as high activity sealed sources, remain in storage at the LEPI facility.

The waste treatment plant is expected to continue to operate for as long as needed to support continued operations and future decommissioning activities on the RATEN ICN site. A preliminary decommissioning plan for the waste treatment plant proposes a staged approach, with a decontamination and clean-out phase followed by a 50 year period of care and maintenance to allow for radioactive decay of activation products (mostly Co-60) before final dismantling work.

3.1.2 Existing disposal arrangements at the Baita Bihor repository

The existing repository for institutional LILW-SL disposal at Baita Bihor (DNDR) is owned and operated by IFIN-HH. It is located within the galleries of an exhausted uranium mine, excavated into the side of the Apuseni mountains. The repository began disposal operations in 1985. Disposal takes place in disused exploration galleries within the mine at an elevation of 840 m. Due to the steepness of the topography, the disposal galleries are several hundred metres below the ground surface. The repository was significantly modernised in 2010/11.

The repository is used for disposal of institutional LILW-SL produced at the waste treatment and conditioning facilities at IFIN-HH and RATEN ICN. The waste streams include conditioned solid wastes (such as shredded plastics and small components), activated materials, ion-exchange resins, used sealed sources and components from decommissioning of the VVR-S research reactor. These wastes are conditioned using an Ordinary Portland Cement based grout and packaged into drums (originally 220 litre carbon steel drums were used but these are now mostly replaced with larger 420 litre drums).

3.1.3 Closure and post-closure arrangements at the Baita Bihor repository

The Baita Bihor repository is designed to accommodate around 5,000 m^3 of conditioned waste. Currently the total volume of disposed waste is 2,130 m^3. The repository will close when the available disposal capacity has been filled. This is expected to be around 2040, based on the rate of LILW-SL waste arisings from IFIN-HH and RATEN ICN.

Given that the repository will operate for about another 25 years, a detailed closure plan has not yet been established. An ongoing RD&D project is, however, considering a preliminary closure strategy and plan for the repository. This is intended to define the backfilling, seals and engineering structures, and procedures. The closure plan has to take account of the situation of the repository built into the mountainside, which means that radionuclide release and transport pathways, and scenarios for accidental human intrusion are different to surface or near-surface repositories located on flat ground.

The preliminary closure strategy also addresses institutional controls for closure, such as radiological monitoring during the closure phase, and the requirements for the post-closure period. The preliminary closure plan proposes an active institutional control period of 100 years during which there will be restricted site access and surveillance and monitoring, followed by a passive institutional control period of a further 200 years when the site perimeter will be fenced and marked. After this time (300 years total), the site will be release for unrestricted access. The indicative timeline for closure is shown in Figure 4.

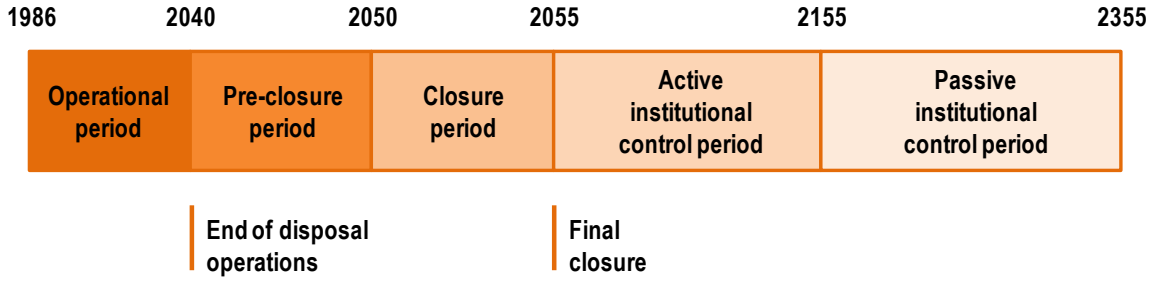

Figure 4: *The indicative timeline for closure of the Baita Bihor repository, subject to further approvals*

3.1.4 Future pre-disposal related management arrangements

The operational wastes currently produced at the Cernavoda NPP are pre-treated to enable them to be stored, but they will require additional treatment, conditioning and packaging before disposal to the planned new surface repository for LILW-SL (see below). The design of this repository and its waste acceptance criteria have not yet been finalised. Consequently, the necessary arrangements for pre-disposal treatment and conditioning have yet to be confirmed.

The CANDU reactors will require mid-life refurbishment to replace components such as the pressure and Calandria tubes, and associated components. These additional wastes will be largely LILW-LL but will also include some LILW-SL components. Additional interim storage capacity may therefore be required on the Cernavoda site to store the refurbishment LILW.

Much larger volumes of waste will be produced in the future by decommissioning of the CANDU reactors. Estimates for these waste volumes vary depending on the assumptions made for the decommissioning strategy. A strategy and infrastructure to manage these decommissioning wastes will need to be developed. Decisions on how waste management is done will affect the relative quantities of the different classes of waste. Some wastes may be classed as VLLW and could be disposed to a facility with less complex arrangements than needed for other LLW-SL.

3.1.5 Future disposal related management arrangements

The National Strategy includes construction of a new engineered surface repository for LILW-SL (the DFDSMA). This will be based on a modular design with concrete disposal cells, similar in concept to the Centre de l'Aube facility operating in France and the El Cabril facility in Spain.

This new repository is primarily intended for the disposal of the LILW-SL from operations, refurbishment and decommissioning of the 4 CANDU reactors at Cernavoda. It will also be used for the disposal of institutional LILW-SL after the Baita Bihor repository is closed, which is expected to be around 2040.

It is anticipated that this new repository will be built within the exclusion zone of the Cernavoda NPP, subject to regulatory approval. The modular cell design will allow the repository to be built in phases and to adapt to future decommissioning and LILW-SL management decisions.

It is planned that the first phase will be built and licensed for waste disposals starting in around 2021. The main milestones in the implementation of the first phase of the repository are shown in Figure 5, below. The second and subsequent phases will be constructed on a schedule depending on the rate of future waste arisings.

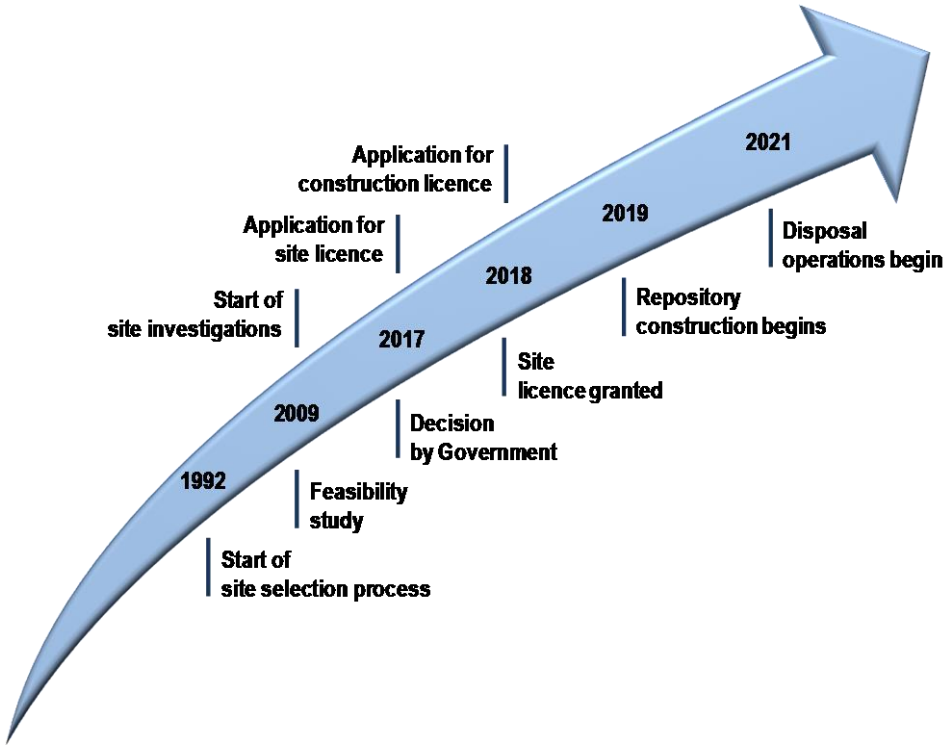

Figure 5: *The indicative timeline with key milestone dates for the implementation programme for Phase 1 of the new surface repository and subject to further approvals*

Strict waste acceptance criteria will apply to disposals in the new repository, and all wastes will need to be conditioned to be in an inert solid form. To meet these criteria, additional waste treatment facilities will need to be commissioned to enable the repository to operate.

3.1.6 Closure and post-closure arrangements for the planned surface repository

The planned new repository will remain operational until after the Cernavoda NPP and its ancillary facilities have been decommissioned, which is anticipated to be around 2090. A detailed closure plan for the repository has, therefore, not yet been developed, although a reference closure concept was considered in the preliminary safety assessment. This closure concept is based on a multi-layer soil, stone and geomembrane cap, several metres thick.

The preliminary closure plan is broadly the same as for Baita Bihor (Figure 4) although it will not start at the same time. This closure plan proposes an active institutional control period of 100 years during which there will be restricted access and surveillance and monitoring, followed by a passive institutional control period of a further 200 years when the site perimeter will be fenced and marked. After this time (300 years total), the site will be release for unrestricted access.

Since closure of the repository is not anticipated for several decades, no detailed plans have yet been developed for the preservation of knowledge of that facility in the longer term.

3.2 Management of spent fuel and LILW-LL

The policy in Romania is for geological disposal of both spent fuel from power reactors and long-lived LILW, and the simplified management strategy for these wastes is shown in Figure 6. The main waste streams considered are:

- spent fuel from the operating CANDU reactors at the Cernavoda site (Units 1 and 2);
- spent fuel from the planned new-build CANDU reactors at the Cernavoda site (Units 3 and 4);
- operational LILW-LL from the Cernavoda NPP and associated ancillary facilities;
- operational and decommissioning LILW-LL from the TRIGA and VVR-S research reactors, and associated ancillary facilities at RATEN ICN and IFIN-HH;
- decommissioning LILW-LL from the Cernavoda NPP and associated ancillary facilities.

The total anticipated volume of wastes considered for geological disposal is 42,500 m^3 (packaged volume) of which around 95 % is spent fuel from the Cernavoda NPP.

Note that Government policy is for all spent fuel from the research reactors to be repatriated under agreement, and so will not be disposed in Romania.

Romania does not have military or defence programmes that produce spent fuel or LILW-LL.

The spent CANDU fuel from the Cernavoda NPP will be disposed after a period of cooling with no treatment (other than packaging for disposal), and the LILW-LL will be appropriately conditioned and packaged to produce a solid waste form suitable for disposal.

There is no geological repository currently operating in the country, so existing management arrangements focus on pre-disposal waste treatment and interim storage, and on preparatory works to implement geological disposal.

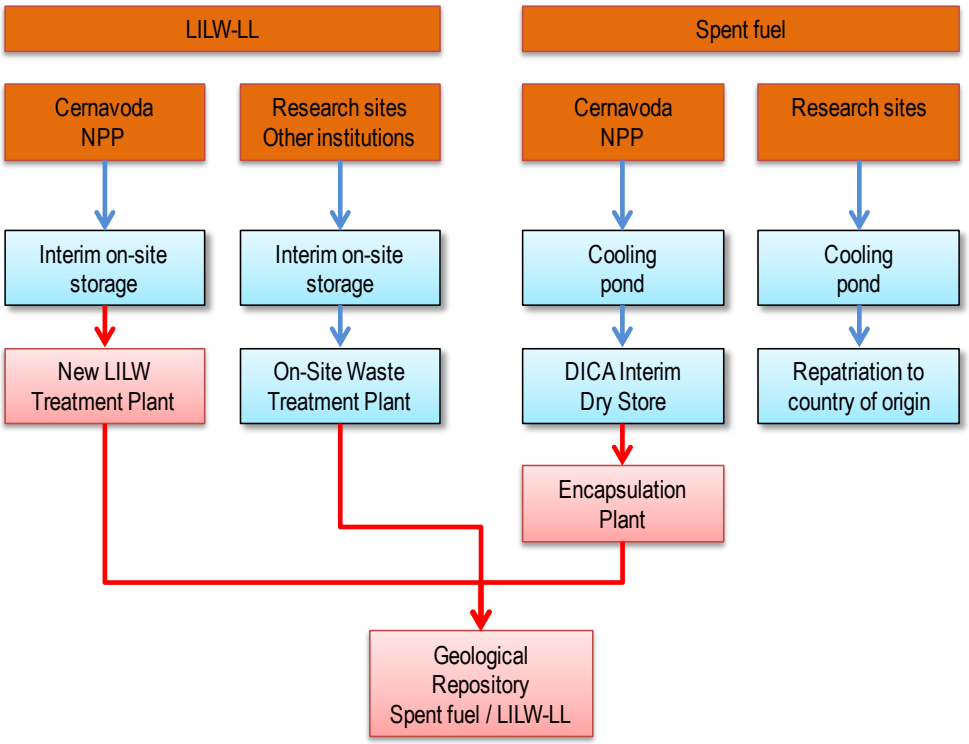

Figure 6: *the simplified management strategy for spent fuel and LILW-LL showing existing facilities and transfers (blue) and those that are planned for the future, subject to further approvals (red).*

3.2.1 Existing pre-disposal related management arrangements

Management of spent fuel and LILW-LL at the Cernavoda NPP

Spent fuel from the operating CANDU reactors is first held in cooling ponds (one at each reactor unit) for a minimum of 6 years, after which it is transferred to an on-site Interim Dry Storage Facility (DICA).

The DICA facility is based on MACSTOR 200/400 type modules which are passively air-cooled. Each module comprises a massive concrete structure containing an embedded galvanized carbon steel cylinder. Spent fuel bundles are held in stainless steel baskets and emplaced inside the steel cylinder, which is then sealed by welding.

The MACSTOR modules have a design life of 50 years. After storage and cooling, the spent fuel will be transferred to the planned deep geological repository for final disposal when this becomes available.

Currently, 7 MACSTOR modules have been licensed at the DICA facility. It is planned to expand the facility in stages to store all spent fuel from both Units 1 and 2 from 50 years reactor operation. It is anticipated that the DICA facility will be further expanded to store the additional spent fuel that will arise from the planned Units 3 and 4.

The Cernavoda site also has designated facilities to manage operational LILW-LL, such as spent ion-exchange resins, filters and activated components. The LILW-LL is stored in reinforced concrete lined vaults in the Service Building.

It is anticipated that all operational LILW-LL will remain in interim storage on the Cernavoda site until it can be transferred to the planned deep geological repository for final disposal when this becomes available.

Management of spent fuel and institutional LILW-LL at the RATEN ICN research site

The TRIGA research reactor was originally design to operate with HEU fuel with an enrichment of > 90 %. It has since been converted to operate with LEU fuel with an enrichment of < 20 %. All HEU spent fuel from the TRIGA reactor has been repatriated under agreement to the USA. LEU spent fuel is held in on-site cooling ponds for a period around 20 - 30 years, and Romanian policy is that this fuel will also be repatriated to the country of origin under agreement at some point in the future.

The TRIGA reactor is expected to operate until 2035 when it will be shut down, and decommissioning is scheduled to start in 2040. Decommissioning wastes from TRIGA will include some LILW-LL and other wastes that are unlikely to meet the waste acceptance criteria for surface disposal (including irradiated graphite).

Solid LILW-LL produced during post irradiation examination of research and Cernavoda CANDU reactor fuel is stored in 13 stainless steel tubes ('pits') set into the basement of the hot-cells within the Post Irradiation Examination Facility (LEPI). This facility is also used to store high activity, short-lived spent radioactive sources collected from all around the country. It is expected that the LEPI facility will continue to operate for at least another 50 years to support continued reactor operations at the Cernavoda site.

Other operational LILW-LL waste streams produced at RATEN ICN are managed and stored within the on-site radioactive waste treatment plant. These will eventually need to be conditioned, packaged and transported for disposal to the planned geological repository when that becomes available (see below).

Management of institutional LILW-LL at the IFIN-HH research site

The VVR-S research reactor has been defuelled and is undergoing decommissioning. The entire inventory of spent fuel has been repatriated under agreement to the Russian Federation. No spent fuel now remains on site.

Decommissioning wastes from the VVR-S reactor will include some LILW-LL and other wastes that are unlikely to meet the waste acceptance criteria for surface disposal (including irradiated graphite and activated aluminium).

Operational and decommissioning LILW-LL waste streams produced at IFIN-HH are managed and stored within the on-site radioactive waste treatment plant. This plant also stores institutional LILW-LL collected from other institutions around the country. These will eventually need to be conditioned, packaged and transported for disposal to the planned geological repository when that becomes available (see below).

3.2.2 Future pre-disposal related management arrangements

There are some additional pre-disposal management arrangements to be planned and developed that are relevant to spent fuel and LILW-LL.

The operational LILW-LL from the Cernavoda NPP will need to be conditioned, packaged and transported for disposal to the planned geological repository when that becomes available (see below). The design of this repository and its waste acceptance criteria, have not yet been finalised,

and so the waste form and disposal package, and the packaged volume, still need to be clarified. Some technical solutions will be developed to implement this treatment plant.

Similarly, decisions have yet to be made on the disposal technology and canister design for spent CANDU fuel needed for geological repository. A spent fuel encapsulation strategy and technical solutions for implementation will be developed.

An integrated decommissioning strategy for CANDU Units 1 and 2 is being developed. This strategy assumes dismantling of the reactors will be deferred for a few years after shutdown and defuelling (17 years for Unit 1 and 9 years for Unit 2). A immediate decommissioning strategy is also anticipated for Units 3 and 4. The majority of the radioactive wastes from decommissioning will be LILW-SL but there will also be some LILW-LL (e.g. activated reactor internal components and highly contaminated pipework). The decommissioning waste management strategy has yet to be finalised. Decisions on how dismantling is done and how the wastes are managed will affect the total amount of LILW-LL that can be efficiently segregated and sentenced for disposal to the geological repository.

3.2.3 Existing and future disposal-related management arrangements

The agreed management end-state for spent fuel and LILW-LL is geological disposal, and a single repository will be constructed for all spent fuel from the 4 CANDU reactor units at the Cernavoda site, plus all LILW-LL.

Given that the dry store for spent fuels at the Cernavoda site has a design life of 50 years, there is no requirement for a geological repository to be operational before about 2050. As a consequence, current activities are limited, and focussed on planning and preparation of a long-term programme for the implementation of the geological repository.

For planning purposes, an indicative timeline with key milestone dates has been set out for the geological repository implementation programme, as shown in Figure 7. This anticipates an underground research laboratory (URL) will be constructed at the chosen site to confirm the suitability of the underground conditions. The repository will then become operational in around 2055 and there will be parallel phases of construction and operation until the repository is closed in around 2150.

No repository design concept has yet been chosen but, purely for preliminary planning and costing purposes, the Canadian repository for spent CANDU fuel has been used as a reference. This reference concept assumes:

- disposal at a depth of between 500 and 1000 m below ground;
- encapsulation of spent fuel within steel containers with a copper overpack;
- emplacement of containers aligned horizontally along the axis of long disposal tunnels, backfilled with bentonite;
- retrievability is not a design requirement.

An earlier countrywide assessment of geological environments identified 6 potentially suitable rock types including granite, green schists, basalt, clay, salt and volcanic tuffs. No decision on a preferred host rock and geological environment has been made, and a future site characterisation and selection process will be established.

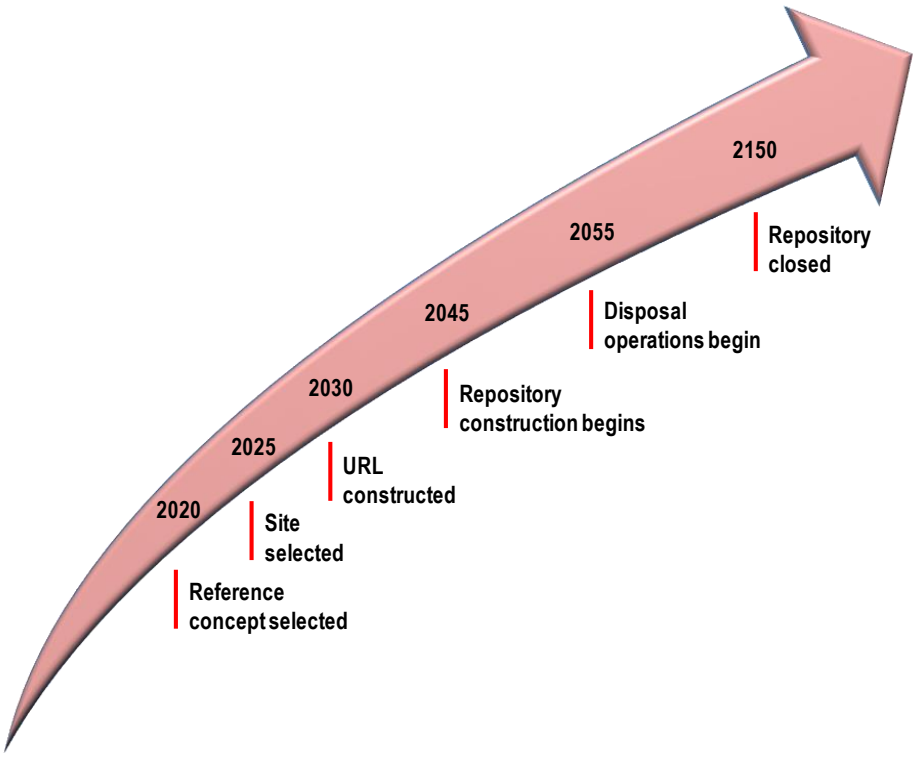

Figure 7: *The indicative timeline with key milestone dates for the Romanian geological repository implementation programme, subject to further approvals*

Previous preliminary planning studies for geological disposal were supported by an IAEA Technical Cooperation project (2007-2008) which also recommended the following key activities to progress repository implementation (note these are not necessarily sequential):

A. Define the general framework
B. Planning and performing the supporting RD&D activities
C. Site selection and characterisation
D. Repository design
E. Repository construction
F. Repository operation
G. Interaction with stakeholders
H. Planning and performing the programme administration activities
I. Establishing an inventory of wastes that will be disposed in the repository

Each of these key stages and activities will require technical solutions to be developed. It is intended to achieve this through:

- continued active participation in international RD&D projects;
- national research on issues that have specific waste, site or regulatory aspects;
- transfer of relevant experience, knowledge and data from other programmes;
- continued skills development to ensure an in-country capability to implement the geological disposal programme; and
- continued involvement of the Romanian Stakeholders Group.

Those activities needed to support implementation of the geological repository are now being planned. This work includes developing an outline programme, with emphasis on the activities that are required in the short to medium term.

In addition to the implementation of the geological repository, a spent fuel encapsulation plant will also need to be built and operated. The design of the spent fuel packages will need to be consistent with the design of the overall repository concept (and site and host rock). For planning purposes, the Canadian disposal package design for spent CANDU fuel has been used as a reference and it has been assumed that the encapsulation plant will be constructed near to the DICA spent fuel storage facility at the Cernavoda site.

Since the geological repository is anticipated to operate well into the next century, no detailed closure plans or means for the preservation of knowledge of that facility in the longer term have yet been developed, although closure of the Canadian spent fuel repository provides a reference.

The post-closure safety of the geological repository will not rely on any active institutional controls, although monitoring may be undertaken by future generations if they decide to do so.

4 RD&D plans and activities

Historically, RD&D activities in Romania associated with radioactive waste management and disposal have been dispersed amongst various national organisations. The largest effort has been undertaken by RATEN ICN, RATEN CITON and IFIN-HH which maintain active programmes of research addressing the following main topics:

- radioactive waste characterisation;
- technologies for treatment and conditioning of radioactive wastes;
- interim storage of spent CANDU fuel;
- technologies for surface disposal of LILW-SL;
- technologies for geological disposal of spent fuel and LILW-LL; and
- long-term behaviour of spent fuel in a geological repository.

Several international cooperation agreements have been signed for joint RD&D in the field of spent fuel and radioactive waste management with other national research organisations in Europe and North America. Romanian organisations have also actively participated in FP6 and FP7 Euratom projects, including:

- Horizon 2020 CEBAMA: Cement-based material properties, evolution and barrier functions
- CAST: Carbon 14 source term
- IPPA: Implementing public participation approaches in radioactive waste disposal
- FORGE: Fate of repository gases
- CARBOWASTE: Treatment and disposal of irradiated graphite and other carbonaceous waste

Romania has also benefitted from a number of EC Phare and IAEA Technical Assistance projects, before and since accession to the EU in 2007, including several related to RD&D for spent fuel and radioactive waste management, including:

- Upgrading of the Baita Bihor LILW-SL repository
- Upgrading of the radioactive waste treatment plant at IFIN-HH
- Design and safety assessment for licensing the construction of a new LILW-SL repository
- Support to improve the management of spent fuel and radioactive waste
- Development of a geological disposal concept for spent fuel

Institute for Nuclear Research coordinated the site selection and characterization program for LILW-SL disposal and the Centre of Technology and Engineering for Nuclear Project (RATEN CITON) performed together with RATEN ICN the first Safety Report for LILW-SL disposal on Saligny site.

Since the establishment of ANDR in 2009 as the lead national agency responsible for implementing radioactive waste management and disposal activities, a new integrated national plan for RD&D to support spent fuel and radioactive waste management has been under development. This plan will follow the recommendations from EC's Implementing Geological Disposal of Radioactive Waste Technology Platform (IGD-TP) for establishing and prioritising RD&D objectives, and be based around a gap analysis.

The developing RD&D plan will align with a revision of the National Strategy for spent fuel and radioactive waste management, and the planned geological repository implementation programme, with emphasis on activities to support the key early stages, notably:

- establishing a detailed implementation plan for the geological disposal programme, identifying the necessary supporting infrastructure and skills base, plus a robust cost estimate;
- comparison of alternative disposal concepts, and adoption of a preferred design for further development and programme planning;
- site selection methodologies, including establishing the decision-making process and the involvement of stakeholders in it, and the specification of site requirements; and
- surface-based site characterisation plans and technical requirements.

In addition, preliminary planning is being done for RD&D needed to support activities in the medium to long-term, and those that may require long lead-times, such as:

- development of a URL, and establishing a plan for underground investigations and site confirmation studies;
- staged post-closure and operational safety case development; and
- closure methods, and post-closure institutional control and monitoring arrangements.

This RD&D will be based on continued international cooperation and participation in European Framework projects, and focussed research through Romanian national organisations.

5 Economical and financial issues

5.1 Assessment of financial costs

The cost assessment has been developed in accordance with the legal framework in Romania. The objective is to ensure adequate funds are available to cover both short and long-term liabilities associated with current and future operational and decommissioning waste management activities, including disposal. The costs are borne by waste producers according to the 'polluter pays' principle in the following way:

1. For the operating Cernavoda NPP Units 1 and 2, the costs related to pre-disposal management of radioactive wastes (e.g. collection, handling, transport, treatment, conditioning, and storage) and spent fuel management (dry storage, encapsulation and transport) are borne directly by the plant owner Nuclearelectrica.

2. For the planned new Cernavoda NPP Units 3 and 4, the costs related to pre-disposal management of radioactive wastes (e.g. collection, handling, transport, treatment, conditioning, and storage) and spent fuel management (dry storage, encapsulation and transport) will be borne directly by the new owner.

3. The cost associated with disposal of spent fuel and radioactive wastes arising from civil nuclear power are borne by the Waste Disposal Fund, which is managed by ANDR, and into which monies are paid by the power reactor operators (see below).

4. The cost associated with decommissioning civil power reactors will be borne by the Decommissioning Fund, which is managed by ANDR, and into which monies are paid by the power reactor operators (see below).

5. The cost for operation, maintenance, upgrading, closure and post-closure monitoring of the Baita Bihor repository are assured from the state budget.

6. The cost for decommissioning of the two research reactors in Romania, and the management of the institutional radioactive wastes from RATEN ICN and IFIN-HH, are assured from the state budget.

7. The costs for management and disposal of institutional wastes generated by commercial companies in Romania will be borne by the waste producers.

The National Strategy estimated in 2004 the total cost for all spent fuel and radioactive waste management activities, including disposal, to be €3,000–3,500 million. This top down figure was derived by comparison with cost estimates from other national programmes with similar nuclear programmes.

In 2006, the total costs for facility decommissioning, and for the disposal of spent fuel and radioactive wastes, were assessed (Table 4) in relation to the new national law for establishing and managing the financial resources (funds) necessary for the safe management of radioactive waste and for the decommissioning of the nuclear and radiological facilities (Government Decision 1080/2007).

The total cost estimated in 2006, assuming 4 CANDU reactors, was US$ 3,920 million which is approximately equivalent to €3,500 million. These costs are dominated by the geological repository, with the cost for the planned new LILW-SL repository being only about 15% of the overall total.

Table 4: *the 2006 cost estimate for decommissioning and disposal of spent fuel and radioactive wastes arising from civil nuclear power generation in Romania.*

Cost component	Two CANDU Units US$ million	Four CANDU Units US$ million
Decommissioning NPP	640	1,280
Geological repository	1,020	2,040
New LILW-SL repository	300	600
TOTAL	1,960	3,920

These costs for waste management and disposal will be spread over more than 100 years due to the anticipated long operational life of the geological repository. The costs will not, however, be evenly distributed over time, as shown indicatively in Figure 8. The earliest costs relate the construction of Phase 1 of the LILW-SL repository which is due to start operations in around 2021. After that, the costs for the geological repository begin to dominate, with construction of the URL planned for around 2030. The peak annual cost will occur around 2045–2050 with the beginning of construction of the repository in 2045 and construction of the encapsulation plant at around the same time. Costs then remain broadly constant during the phased construction / operation period, until closure of the geological repository starts in around 2150.

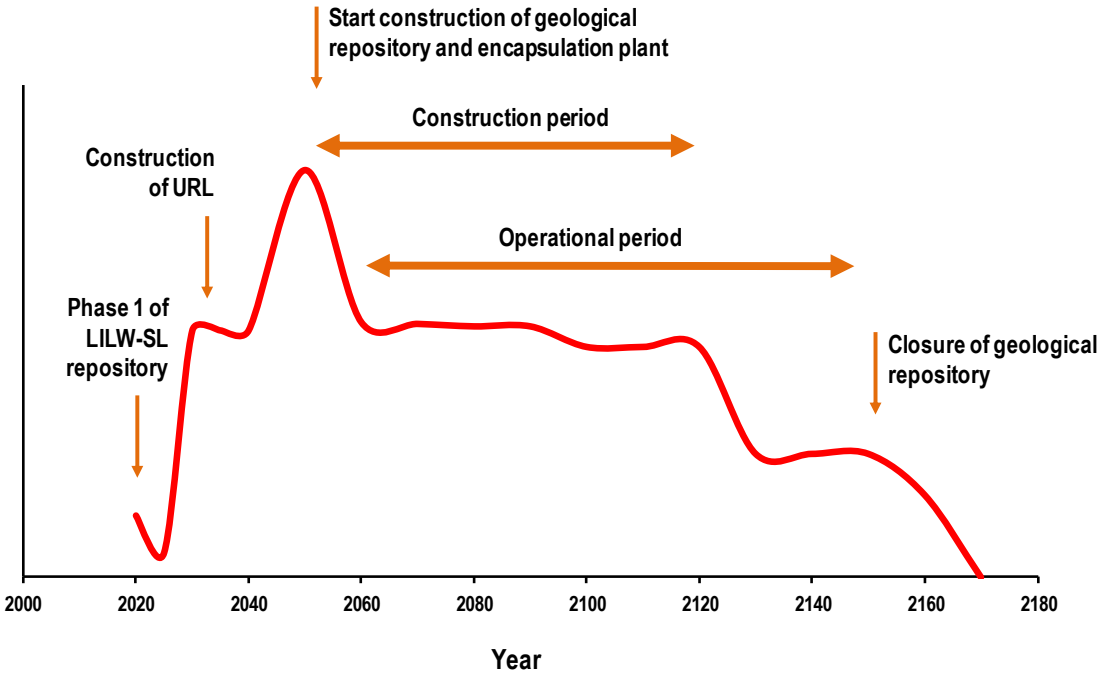

Figure 8: *an indicative profile of the management and disposal costs over time.*

5.2 Financing schemes, needs and estimations

A fee system was established by the Government in 2007 (Government Decision 1080/2007). This requires financial provisions to be made by the operators of the Cernavoda NPP and paid into two segregated funds, one to cover the costs for decommissioning (Decommissioning Fund), and the other to cover the costs for safe disposal of spent fuel and radioactive waste (Waste Disposal Fund).

Provisions are set on the basis of a fee chargeable on the net electric energy produced by the reactor operators at the rate of:

- €1.4 per MWh per reactor unit paid to the Waste Disposal Fund, and
- €0.6 per MWh per reactor unit paid to the Decommissioning Fund.

The two funds are managed by ANDR, and are invested conservatively in low-risk arrangements (through the State Treasury), but earn commensurately low returns.

The reactor operators cannot directly withdraw money from the funds, but can request money to cover the costs of legitimate decommissioning activities.

These funds only accrue money when electricity is produced. Consequently there is a risk that early shutdown of the reactors may mean that the funds accrued may be insufficient to cover the future total costs of decommissioning and waste management.

The annual payment to both funds based on current rates of electricity generation from Units 1 and 2 is approximately €20.8 million. Over 50 years of operation, this would mean the two funds would collect €1,040 million (without interest). However, since the funding scheme was not established until 2007, the total amount collected over the remainder of the operating lifetime will be somewhat less.

According to the most recent accounts (2014), the financial resources paid into the funds by the operators of Cernavoda NPP Units 1&2 are (assuming current exchange rates of €1 = 4.41 Lei):

- Waste Disposal Fund: 451 million Lei (€102 million)
- Decommissioning Fund: 209 million Lei (€47 million)

To offset a predicted shortfall in funds, ANDR has started the process of reviewing and approving the fees to finance the National Programme. It is anticipated that an amendment to Government Decision 1080/2007 on the setting up and management of financial resources will be issued before the end of 2015.

6 Key performance indicators

Work is underway to develop a suite of key programme milestones and performance indicators (KPIs) against which progress of the Romanian National Programme can be measured and reported. Milestones will be significant achievements in the programme such as gaining regulatory approval to construct a disposal facility; first waste emplacement; closure of a disposal facility etc.

Note that in this context, KPIs are specific to the overall National Programme. Other KPIs that relate to particular business objectives or the operational performance of individual nuclear sites or plant are not described here.

The KPIs chosen for the National Programme will be 'SMART' (i.e. specific, measureable, achievable, relevant and time bound). Separate sets of milestones and KPIs are likely to be set for near-surface disposal and geological disposal programmes because of the different implementation timescales. Examples of the KPIs being considered include:

Public and stakeholder:

- public approval rating (e.g. percent of national and local public in favour of programme)

Safety:

- public radiological safety (e.g. collective dose)
- worker radiological safety (e.g. occupational dose rate)
- worker conventional safety (e.g. number of reportable incidents or lost time injury; injury rate)

Environmental:

- sustainability (e.g. use of natural resources)
- environmental protection (e.g. emissions to the environment, impact to sensitive species and habitats)
- waste minimisation (e.g. amount of secondary, non-radioactive waste generation)

Technical and regulatory:

- viability (e.g. number of outstanding technical issues to be resolved through RD&D)
- regulatory approval (e.g. number of regulatory approvals obtained / still to be obtained)
- completeness (e.g. number of orphan waste streams with no defined end-point)

Programme schedule and achievement:

- progress (e.g. number of key programme milestones achieved or delayed)
- waste management (e.g. quantity of waste processed ready for final disposal and in storage)
- emplacement (e.g. quantity of waste disposed)

Financial:

- total programme costs (e.g. best estimate of total cost of the National Programme)
- sunk costs (e.g. total amount spent to date)
- capital (e.g. total amount of money collected in the decommissioning and waste funds)

Each KPI will have an objective or target associated with it against which performance can be measured. Once confirmed, the suite of milestones and KPIs will be used for future reporting of the National Programme to national stakeholders and to the EC.

7 References and supporting documentation

7.1 Romanian laws, orders and regulations

Law 111/1996 on the safe deployment, regulation, authorization and control of nuclear activities, republished with subsequent completion and modification.
http://www.agentianucleara.ro/legislatie/LEGE%20nr%20%20111%20din%201996.pdf

Law 105/1999 on the ratification of Joint Convention on the safe management of nuclear fuel and on the safe management of radioactive waste.
http://www.agentianucleara.ro/legislatie/LEGE%20nr%20%20105%20din%201999.pdf

Law 378/2013 for the transposition of Council Directive 2011/70/Euratom establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste.
http://www.agentianucleara.ro/wp-content/uploads/2010/05/LEGE.pdf

Government Ordinance 11/2003 regarding the management of nuclear spent fuel and radioactive waste, including their disposal, with subsequent modifications and completions.
http://www.agentianucleara.ro/legislatie/OG%20nr.%2011%20din%202003.pdf

Government's Decision 1259/2002, regarding the approval of the National Strategy for the development of the nuclear field in Romania and of the plan of action for the implementation of this strategy.
http://www.agentianucleara.ro/legislatie/HG%20nr.1259%20din%202002.pdf

Government Decision 564/2006 regarding the framework of public participation in elaborating certain plans and programs.
http://lege5.ro/Gratuit/ha2timjq/hotararea-nr-564-2006-privind-cadrul-de-realizare-a-participarii-publicului-la-elaborarea-anumitor-planuri-si-programe-in-legatura-cu-mediul

Government's Decision 1080/2007 regarding the constitution and management of financial resources necessary for the safe management of waste.
http://www.agentianucleara.ro/legislatie/HG%20nr.%201080%20din%202007.pdf

Government Decision 445/2009 on environmental impact assessment pertaining to certain public and private projects.
http://www.anpm.ro/documents/12220/2054068/HG.+445_2009+privind+evaluarea+impactului+anumitor+proiecte+publice+si+private+asupra+mediului.pdf/f1a35934-96d5-4167-bdc5-337454661ca3

Order 864/2002 for approving the Procedure for Environmental Impact Assessment in a Transboundary Context and public participation in decision-making for projects with transboundary impact.

Order 844/2004 for approving the National Strategy on medium and long-term management of spent nuclear fuel and radioactive waste, including final disposal and decommissioning of nuclear facilities.
http://www.agentianucleara.ro/legislatie/Ordin%20nr.%20844%20din%202004.pdf

Order 135/2010 for approving the methodology for implementing environmental impact assessment for public and private projects.

http://www.anpm.ro/documents/12220/2054068/HG.+445_2009+privind+evaluarea+impactului+anumitor+proiecte+publice+si+private+asupra+mediului.pdf/f1a35934-96d5-4167-bdc5-337454661ca3

NSR-01: Radiological safety fundamental regulations, which transposes Council Directive 1996/29/Euratom (the Basis Safety Standards) for protection of the health of workers and the general public against the dangers arising from ionizing radiation (CNCAN President Order 14/2001).

NSR-016: Norms on control of orphan sources and high-activity sealed radioactive sources which transposes Council Directive 2003/122/ Euratom (CNCAN President Order 356/2005).

NDR-01: Fundamental norms for the safe management of radioactive wastes (CNCAN President Order 56/2004).

NDR-02: Norms for the clearance levels of radioactive wastes originating from nuclear activities (CNCAN President Order 62/2004).

NDR-03: Norms on the classification of radioactive waste (CNCAN President Order 156/2005).

NDR-05: Regulation for general requirements for near-surface disposal of radioactive waste (CNCAN President Order 400/2005).

NDR 06: Norms on the supervision and control of shipments of radioactive waste and spent nuclear fuel which transposes Council Directive 2006/117/Euratom (CNCAN President Order 443/2008).

7.2 Other references

CNCAN (2014) Romania. Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management. The Fifth National Report.
http://www.cncan.ro/stiri/romania-joint-convention-on-the-safety-of-spent-fuel-management-and-on-the-safety-of-radioactive-waste-management/

IAEA (2009) Classification of Radioactive Waste. IAEA Safety Guide, GSG-1.