MINISTRY OF ENERGY
NUCLEAR AND RADIOACTIVE WASTE AGENCY

Radioactive Waste Management in Romania

Present and Future

Strategies for managing radioactive waste in the context of nuclear energy expansion, including Cernavoda Units 3 & 4, Small Modular Reactors, and advanced Generation IV technologies.

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Introduction to Romania's Nuclear Program

Established Nuclear Infrastructure

Romania operates the Cernavodă Nuclear Power Plant with two CANDU-6 reactors, forming the backbone of the country's nuclear energy program.

Energy Independence

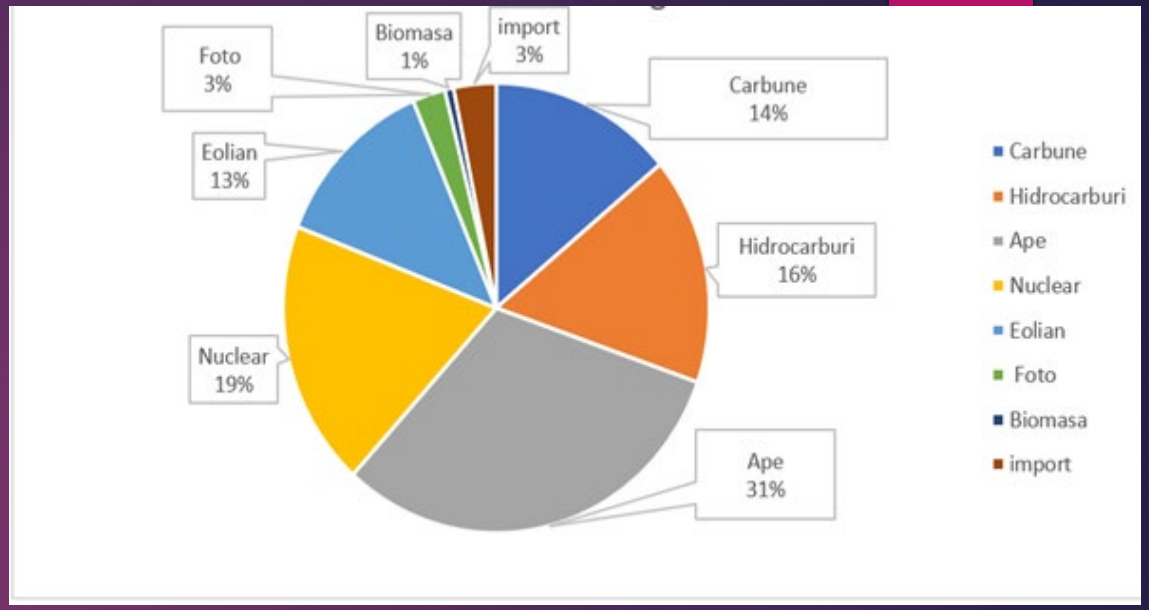
Nuclear energy plays a crucial role in Romania's strategy to reduce energy dependence on imports and enhance national energy security.

Decarbonization Goals

Romania's nuclear program is strategically vital for meeting the country's ambitious climate targets and reducing greenhouse gas emissions.

Current Contribution

The two operational Cernavodă units contribute approximately 19% of Romania's electricity supply, demonstrating the significant role of nuclear energy in the country's energy mix.



Cernavoda Nuclear Power Plant's contribution to Romania's electricity supply

Strategic Vision

Romania is expanding its nuclear capacity to meet future energy demands while maintaining a balanced energy mix that supports both economic development and environmental sustainability.

Current Nuclear Infrastructure

Cernavodă Nuclear Power Plant

Romania's primary nuclear facility, located on the Danube River, serves as the country's main nuclear energy center.

Technical Specifications

Reactor Type: Two operational CANDU-6 pressurized heavy water reactors

Current Capacity: Approximately 1,400 MWe (700 MWe per unit)

Annual Waste Production: About 100 cubic meters of low- and intermediate-level radioactive waste

Waste Management

100 m³/year

The waste produced consists primarily of Low- and Intermediate-Level Short-Lived Waste (LILW-SL), which requires proper management and disposal.

Romania is developing the DFDSMA repository at Saligny to manage this increasing waste inventory.

Elements of RWM Policy

Financial aspects

Fund for RW and decommissioning: All waste generators must have the financial resources to implement the National Program through contributions to the Radioactive Waste Management Fund and to the Decommissioning Fund.

Annual Waste Producer: pay 4 euro/MWH

1,2 euro/MWh for the decommission of nuclear and radiological facility

2,8 euro /MWh for management of RW and SNF

Site selection for disposal

The sites for new disposal facilities must be selected in accordance with the requirements of national regulations and taking into account international best practices

Safe Management

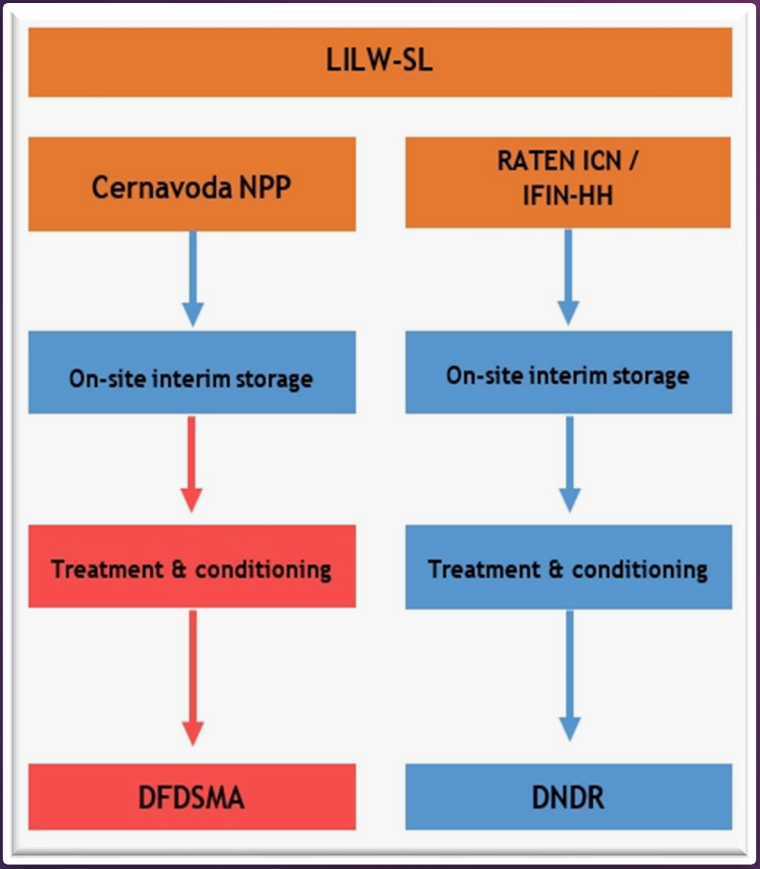
National Strategy for safe management of RW and SNF approved by the Romania Government in 2022 GD 102/2022

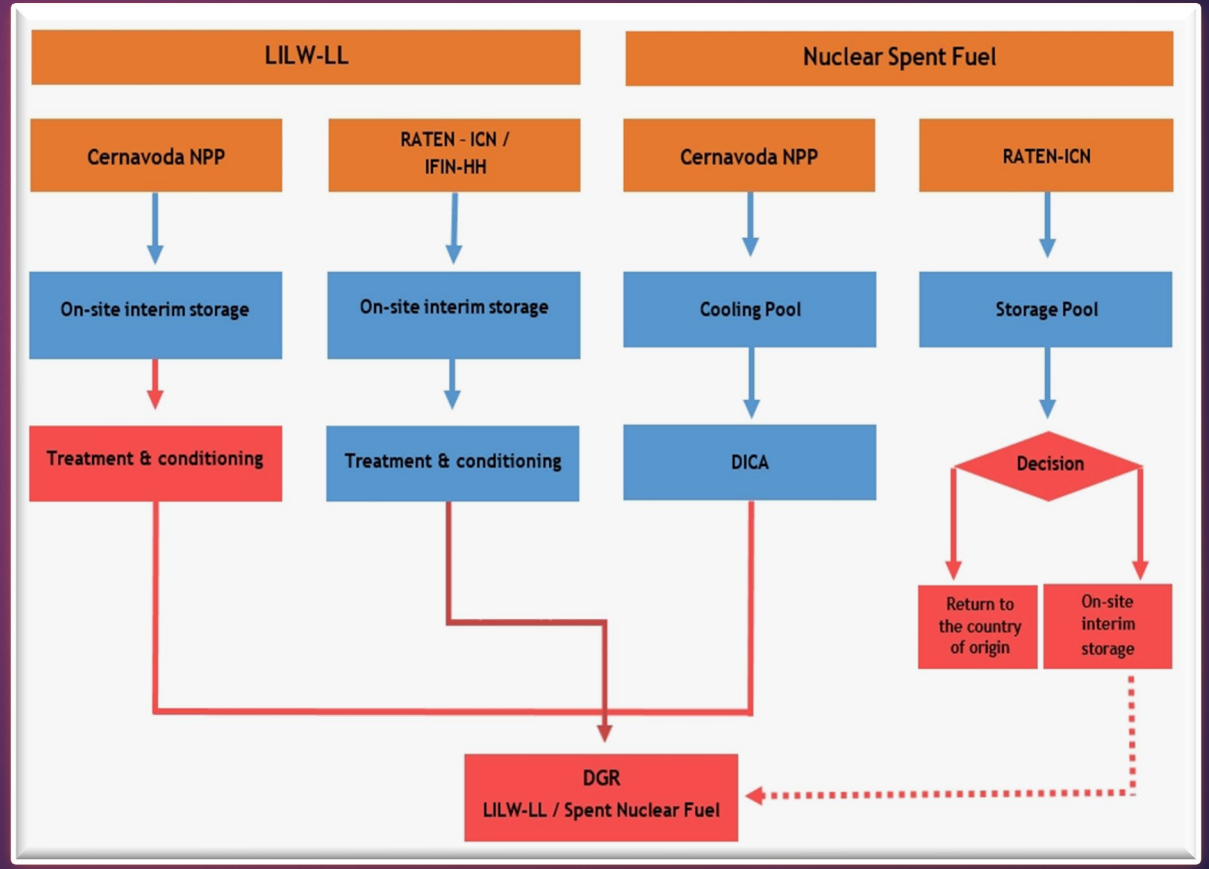
Romania has decided to use open-cycle nuclear fuel, considering spent nuclear fuel as high-level waste, which is to be permanently deposited in a deep geological repository. Should future policies consider other options for waste fuel management (e.g. reprocessing), the National Strategy will be updated accordingly.

The final stage in the process of safe management of spent nuclear fuel and radioactive waste is final disposal, in specific repositories for each category

Radioactive Waste Management in Romania

Romania follows an established classification system for radioactive waste management, categorizing waste based on radioactivity levels, half-lives, and disposal requirements.





Current Waste Management Facilities

Romania manages its radioactive waste from interim storage to final disposal facilities, ensuring safe handling of all waste categories.

DFDSMA (Saligny Repository)

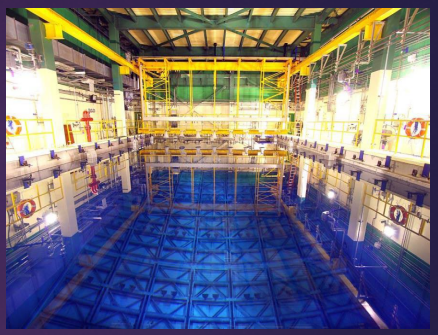
Final Disposal Facility for Low- and Intermediate-Level Short-Lived Waste, located within the exclusion zone of Cernavoda NPP.

Design capacity: 122.000 cubic meters

Located at Saligny, Constanta County

Baita Bihor National Repository

Current national repository for low- and intermediate-level waste only from institutional activities.



Radioactive waste storage facilities on Cernavoda NPP site

Interim Storage Facilities

Romania maintains interim storage for different waste categories:

Spent Nuclear Fuel
High-level waste, awaiting permanent disposal

Short-Lived Waste
Interim storage before final disposal

Long-Lived Waste
Specialized storage for long-term isolation

Institutional Waste
Non-nuclear sector waste

Future Nuclear Expansion: Cernavodă Units 3 & 4

Project Overview

Romania is actively progressing with the completion of Cernavodă Nuclear Power Plant Units 3 and 4, which will utilize CANDU-6 pressurized heavy water reactor technology, similar to the existing operational units.

Key Specifications

Each unit: 700 MWe

Total new capacity: 1,400 MWe

Unit 3: Commissioning 2030

Unit 4: Commissioning 2031

Additional Project Information

The project also includes the refurbishment of the operational Unit 1, which will extend its operational life by an additional 30 years.

- **Unit 1 refurbishment:** Full works expected to begin in 2027, returning to operation in 2029

Project Timeline

2027

Full refurbishment works begin for Unit 1

2029

Unit 1 returns to operation following refurbishment

2030

Unit 3 commissioned and begins operation

2031

Unit 4 commissioned and begins operation

Small Modular Reactors (SMRs) Development

SMR Project

This project represents a strategic shift toward nuclear energy as a sustainable solution for Romania's energy mix.

Technical Specifications

Six modules, each with 77 MWe capacity, totaling 462 MWe

Location

Site of former thermal power plant in Doicești, Dâmbovița county

Strategic Replacement

Replaces coal-fired generation, significantly reducing carbon emissions

Target Completion

Aiming for operation by 2030, contributing to Romania's decarbonization goals

NuScale Voygr SMR Technology

Romania has selected the NuScale Voygr design for its SMR program, featuring innovative modular architecture that enables flexible deployment and simplified maintenance.

Strategic Significance

The SMR project is considered one of the most advanced SMR initiatives in the European Union, serving as a demonstration of Romania's commitment to sustainable nuclear energy as part of its broader energy diversification strategy.

ALFRED: Advanced Generation IV Technology

Project Overview

The Advanced Lead Fast Reactor European Demonstrator (ALFRED) is Romania's investment in advanced Generation IV nuclear technology. This lead-cooled fast reactor will demonstrate the viability of this advanced technology.

Electrical Output

125 MWe

Thermal Capacity

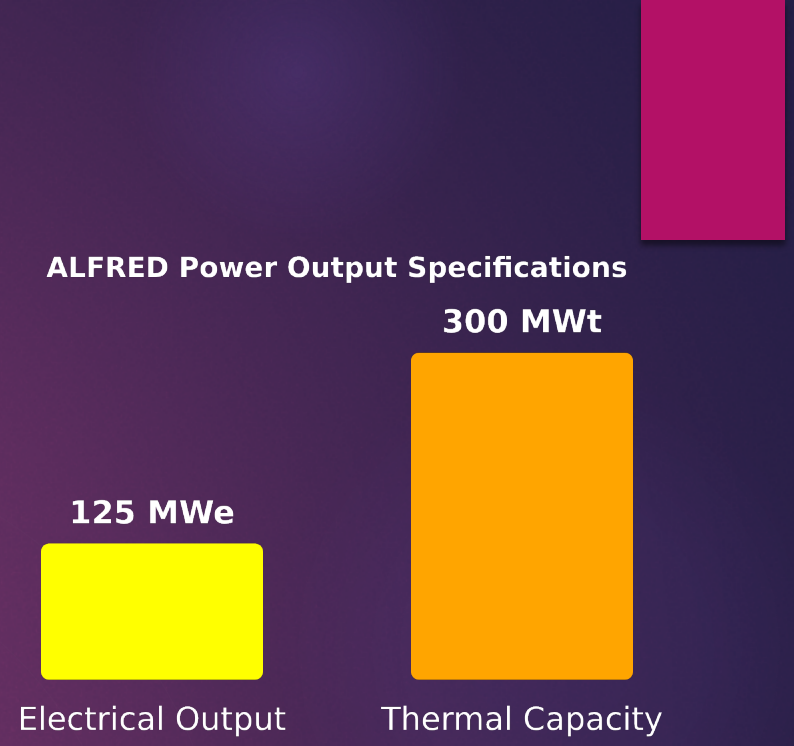
300 MWt

Location

The demonstration unit will be located at Mioveni, near Pitesti, Romania.

Strategic Importance

ALFRED is a key component of Romania's long-term nuclear research and development strategy, exploring sustainable solutions for future nuclear applications.



Technical Innovation Focus

Sustainable Solutions
Advanced designs for future nuclear applications

Research Platform
Facility for testing advanced nuclear technologies

Enhanced Safety
Improved safety features compared to Gen II/III reactors

Versatile Applications
Multi-purpose design for various energy needs

National Strategy for RW and SNF Management

Romania's comprehensive approach to managing radioactive waste in the context of nuclear energy expansion

DFDSMA Development

The Final Disposal Facility for Low- and Intermediate-Level Short-Lived Waste (DFDSMA) at Saligny serves as an engineered surface repository within the Cernavoda NPP exclusion zone.

Facility Advancement

The DFDSMA project has made significant progress with environmental permits as well as the site licensses

Strategic Evolution

Romania's waste management strategy is continuously evolving to accommodate increased volumes from future nuclear projects, including Cernavoda Units 3 & 4, SMRs, and advanced Generation IV systems like ALFRED.

Future Strategy Focus

Integration of institutional waste management following Baita Bihor repository closure

Development of comprehensive safety assessment for the DFDSMA

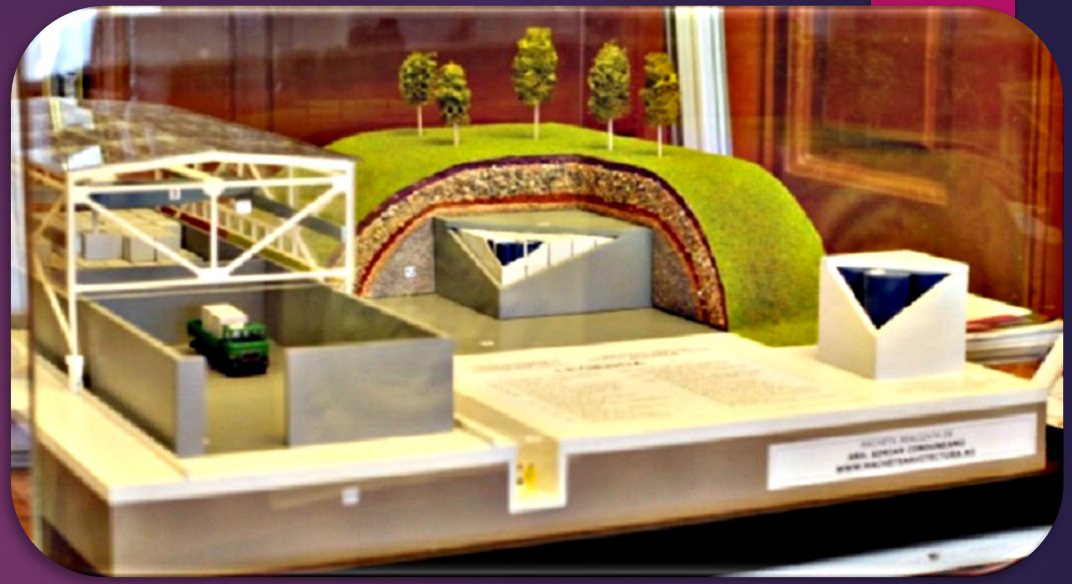
Implementation of robust waste volume forecasting for future nuclear expansion

Enhanced stakeholder engagement and public information campaigns

DFDSMA: Near-Surface Disposal Facility

What is DFDSMA?

The Final Disposal Facility for Low- and Intermediate-Level Short-Lived Waste (DFDSMA) at Saligny is an engineered surface repository for managing specific types of radioactive waste in Romania's nuclear energy program.



Key Features

Location

Located at Saligny, within the exclusion zone of the Cernavoda NPP

Waste Type

Designed for Low and Intermediate-Level Short-Lived Waste (LILW-SL)

Waste Packaging

High-integrity concrete containers to support specialized waste packaging requirements

Current Status

Environmental and site Permit

Environmental permit and site authorization by regulatory body

Construction Preparation

Preparations underway for the construction of high-integrity concrete containers

Strategic Importance

Critical component of Romania's radioactive waste management infrastructure, supporting the country's nuclear energy expansion

Projected Waste Volume Increase

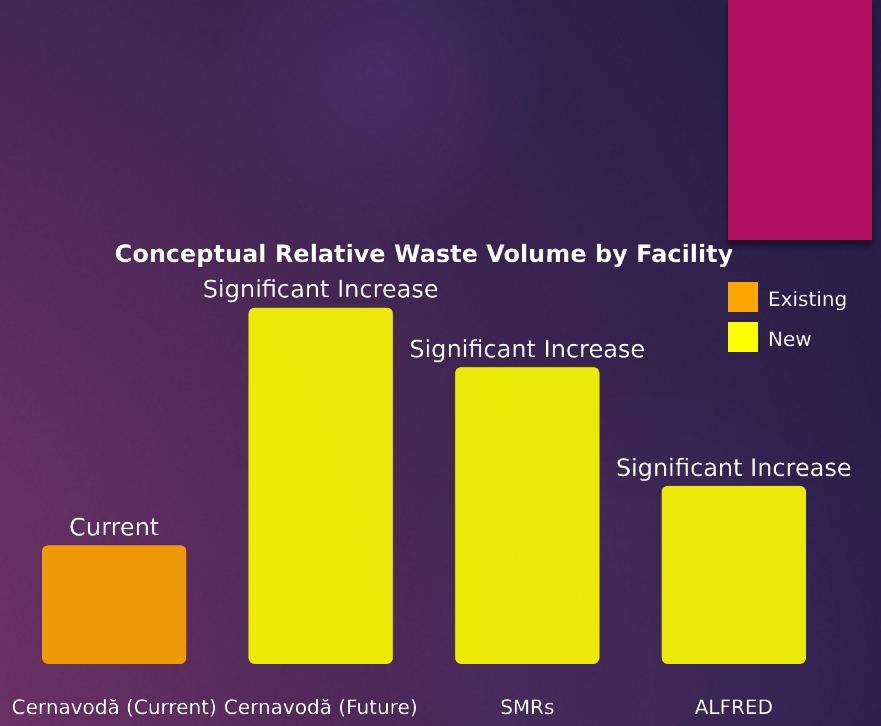
The expansion of Romania's nuclear program, including new units and SMRs, is projected to significantly increase the volume of radioactive waste requiring management and disposal.

Key Sources of Increased Waste

- **Cernavodă Units 3 & 4**
  700 MWe each, total 1,400 MWe
- **Small Modular Reactors**
  6 modules, 462 MWe total
- **ALFRED Project**
  125 MWe, 300 MWt thermal
- **Extended Unit 1 Life**
  Additional 30 years operation

Implications for Waste Management

- Increased storage capacity requirements for all waste categories
- Long-term isolation needs for long-lived waste from advanced reactors
- Integration of new waste streams into existing management framework



Conceptual representation of relative waste volume increase by facility type

Spent Nuclear Fuel

High-level waste requiring permanent disposal

Short-Lived Waste

LILW-SL with shorter half-lives

Long-Lived Waste

LILW-LL requiring long-term isolation

Current Reference: Two operational Cernavodă units produce ~100 cubic meters of LILW annually

Challenges in Waste Management

Key challenges facing Romania's radioactive waste management strategy as nuclear capacity expands

Projected Waste Volume Increase

The expansion of Romania's nuclear program, including new units and SMRs, is projected to significantly increase the volume of radioactive waste requiring management and disposal.

Infrastructure Expansion Needs

The current waste management infrastructure will need significant expansion to accommodate increased waste volumes from future nuclear projects.

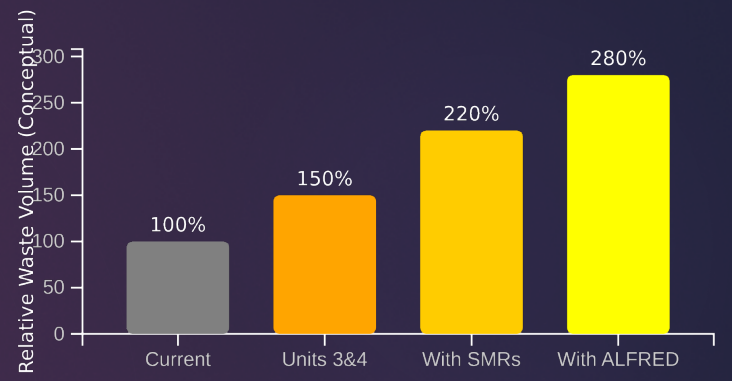
Technological and Safety Requirements

Advanced Generation IV technologies like ALFRED present new challenges in terms of waste management, requiring new estimation and management solutions.

Long-Term Storage Solutions

Development of sustainable long-term storage solutions for various types of radioactive waste remains a significant challenge.

Waste Volume Challenge



Projected increase in waste volume with nuclear expansion

Key Consideration

Romania must balance nuclear expansion with sustainable waste management, ensuring that increased capacity can be adapted in the disposal program approved into the National Strategy

Innovative Solutions for Waste Management

Addressing Romania's growing radioactive waste management needs through technological innovation and advanced approaches

Advanced Disposal Technologies

Development of advanced grouting and encapsulation methods for DGR

Geological repository optimization for long-term waste isolation

Innovative container materials for extended storage

Waste Reduction Approaches

Volume reduction technologies for LILW-SL

Separation techniques for mixed waste streams

Long-term stability studies for institutional waste

Integrated Management Systems

Complete lifecycle assessment for waste management

Adaptive management approaches for evolving waste

Public engagement strategies for sustainable solutions

Advanced Storage Solutions

Development of high-integrity concrete containers for DFDSMA to support waste packaging requirements

Supporting DFDSMA implementation

Future-Generation Technologies

Research into advanced materials and processes for ALFRED and future Generation IV reactors

Enhancing sustainability

International Cooperation and Best Practices

Global Engagement

European Union

Active participation in EU programs on nuclear safety and waste management, harmonizing standards across the region.

International Atomic Energy Agency

Member state of the IAEA, implementing agency safety standards and participating in technical cooperation programs.

Research Collaboration

Participation in joint research projects with international partners, contributing to global knowledge on advanced waste management techniques.

Best Practices Adoption

Implementation of international standards and guidelines for radioactive waste management, continuously updating national approaches.

Benefits of International Engagement

- Enhanced safety standards
- Knowledge exchange
- Improved technologies
- Expertise development

"International cooperation is essential for Romania's nuclear waste management program, providing access to cutting-edge technologies and practices while ensuring alignment with global safety standards."

Conclusion: Romania's Path Forward

Integrated Management Approach

- Balanced strategy addressing waste management alongside nuclear expansion
- DFDSMA repository for LILW-SL a solution for the waste generated on Cernavoda site
- International cooperation enhancing safety and innovation

Sustainable Expansion Vision

- Cernavodă Units 3&4 adding 1,400 MWe by 2031
- SMR deployment at Doicești with 462 MWe by 2030
- Advanced ALFRED project exploring Generation IV solutions

Future Outlook

Romania's nuclear program will continue to expand while maintaining safety and supporting decarbonization goals. The country will balance new conventional reactors with innovative SMR and Generation IV technologies.

Sustainability

Energy

Safety

Innovation