Ministry of Energy

Nuclear Agency and for Radioactive Waste (ANDR)

ROMANIA STRATEGY FOR RADIOACTIVE WASTE AND SPENT NUCLEAR FUEL ACCORDING WITH THE DEVOLEPMENT OF THE EXPENDING NUCLEAR PROGRAM

IAEA TECHNICAL MEETING ON BACK END OF THE FUEL CYCLE CONSIDERATIONS FOR SMALL MODULAR REACTORS

MS . ALICE MARIANA DIMA, DIRECTOR, ANDR

20 -23 SEPTEMBER 2022, VIENNA, AUSTRIA

alice.dima@andr.ro

www.andr.ro

INTRODUCTION

Romania has nuclear sector covering most stages of the nuclear fuel cycle

- ✓ uranium mining and milling
- ✓ nuclear fuel fabrication
- ✓ nuclear power generation (CANDU reactors)
- ✓ nuclear research facilities
- ✓ radioactive waste and spent fuel storage facilities
- ✓ repositories for final disposal

Government's Decision no. 102/2022, regarding the approval of the National Strategy on medium and long-term management of spent nuclear fuel and radioactive waste

National Strategy

A. Policy

B. National Programme

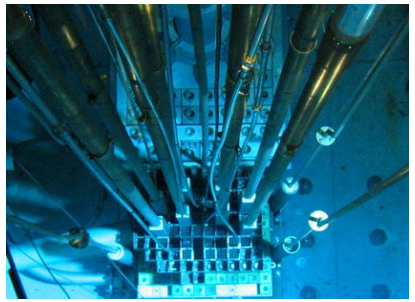
Elements of RWM Policy

- Currently, 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 sites for new disposal facilities must be selected in accordance with the requirements of national regulations and taking into account international best practices
- The final disposal of spent nuclear fuel and radioactive waste will only be carried out by state organizations (ANDR)
- The import, export and intra-Community transfer of radioactive waste is prohibited, with the some exceptions from Law 111/1996
- 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.
- 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

CERNAVODA NPP

- 2 x CANDU 6 reactors (each 700 MW)
- Unit 1 commissioned in 1996, due for refurbishment in c. 2026
- Unit 2 commissioned in 2007
- Units 3 and 4 – to be commissioned

Research Reactors

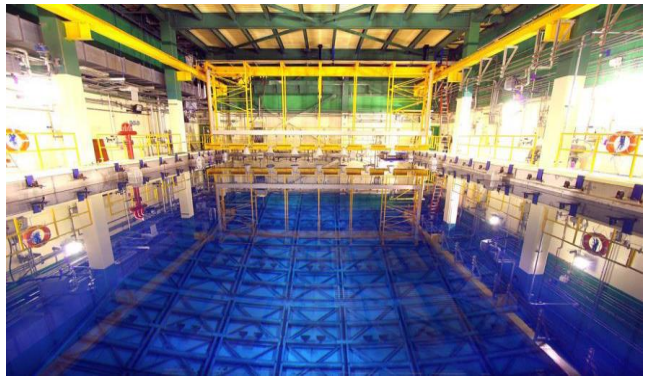


- **TRIGA** 14 MW – in operation from 1979 (ICN Mioveni)
  - all HEU SF was sent back to USA
  - core conversion since 2004 - LEU SF management by Romanian authorities
- Waste type
  - Spent nuclear fuel assemblies resulted from the operation of TRIGA research reactor;
  - Radioactive waste (solid, liquid, spent sealed sources) generated by nuclear and radiological ICN facilities.

Research reactor **VVER** – shutdown in 1997, already decommissioned (IFIN-HH Bucharest)

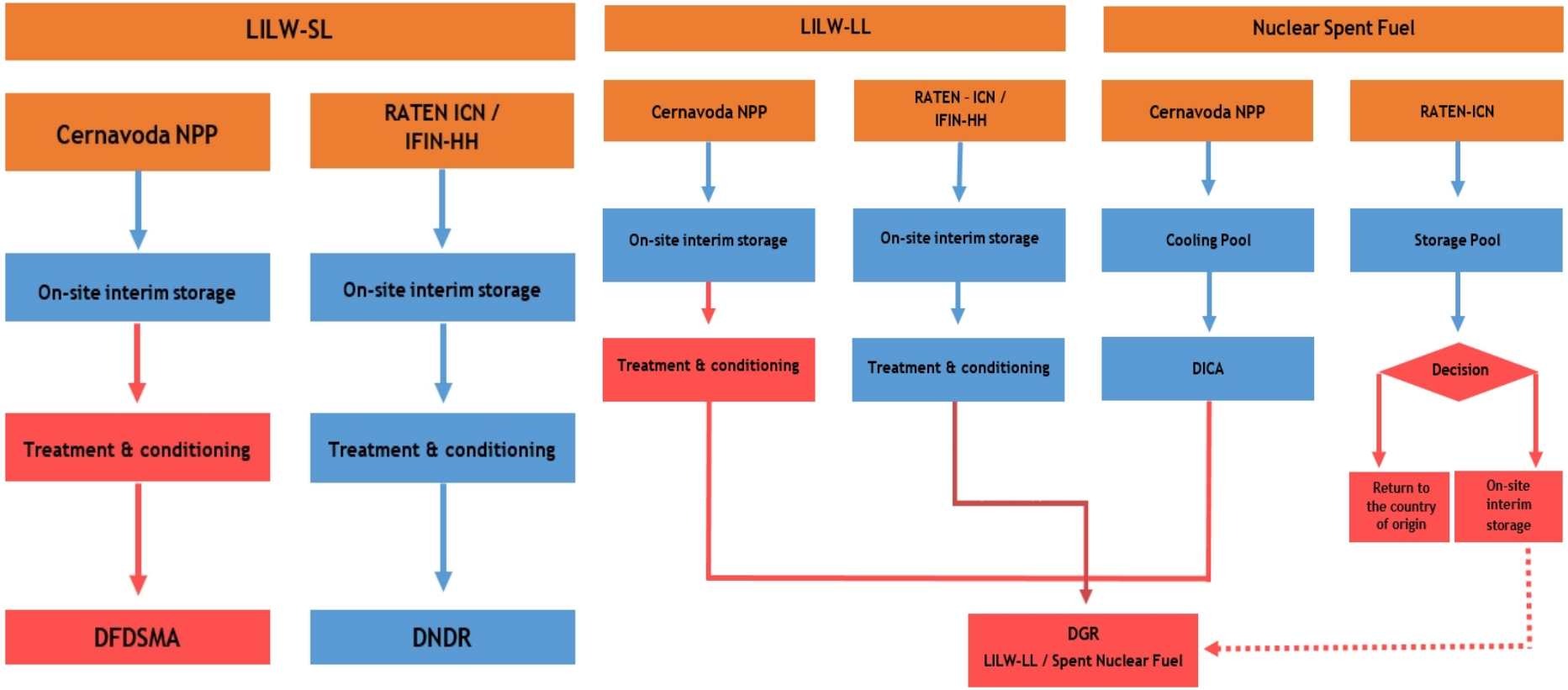
- all SF (enriched U) was sent back to the Russian Federation
- Radioactive waste generated from the decommissioning of VVR-S research reactor.

CERNAVODA NPP



- Wet storage in the spent fuel bay for minimum 6 years cooling
- Dry storage in the Intermediate dry spent fuel storage facility (DICA) for 50 years
  - 13 modules under operation
  - the 14th module under construction
- The MACSTOR design ensures that the containment of fission products is maintained during all phases of the fuel handling operations

SAFE MANAGEMENT OF SNF AND RW



Proposed objectives for the final disposal

The National Strategy establishes two main solutions for the safe management of radioactive waste and spent nuclear fuel:

- Implementing a **Near surface repository** for low and intermediate level, short lived waste **(DFDSMA);**
- Implementing a **Deep Geological Repository** for long lived radioactive waste & spent nuclear fuel.

SAFE MANAGEMENT OF RADIOACTIVE WASTE AND SPENT NUCLEAR FUEL

DFDSMA (Surface Repository for LILW-SL)

1992 – start of site selection process;

2009 -2018 – feasibility study and site investigation;

2023 – application for site licence

2024 – site licence granted & application fo construction licence

2026 – the construction of DFDSMA

2028 – DFDSMA is operational.

DGR (for LILW-LL & SNF)

2023 – reference concept selected

2025 – host rock selection process and R&D activities

2030 – site characterization and URL construction

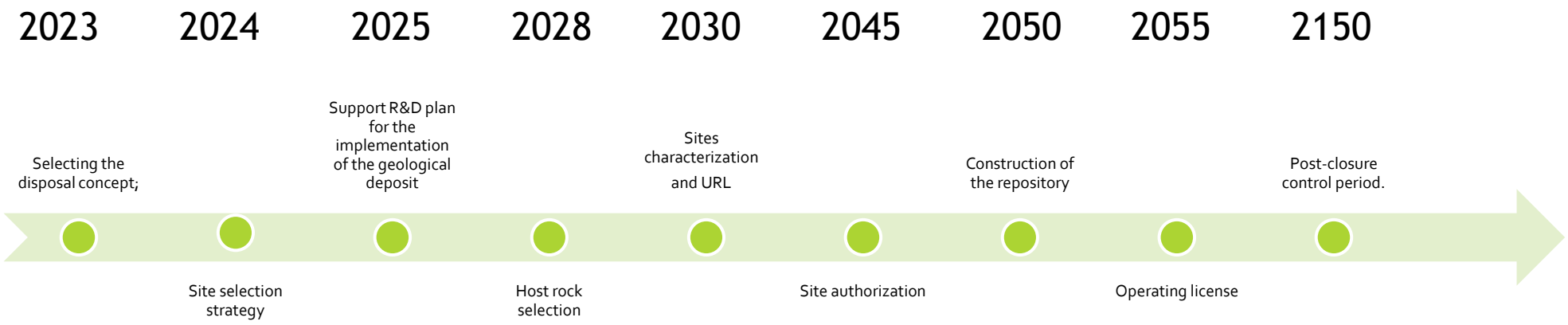
2045 – DGR construction begins

2055 – repository becomes operational

2150 – DGR closure

Schedule for implementing DGR

Future stages regarding the development of the geological disposal program in Romania, which will ensure the commissioning of the repository around 2055.



Deep Geological Repository

planning activities for the DGR on short time 2023-2025

An Action Plan for the development of the DGR and technical studies will be perform by ANDR:

- Assessment of the legislative and regulatory framework
- Preparation of an initial strategy and development of a management plan for DGR
- Evaluation of technical studies from ANDR database and updating of the candidate formations based on national and international requirements issued
- Develop a strategy for modern methods of characterisation and comparison of candidate sites, in compliance with current national and international criteria
- Issue a preliminary assessment of potential host formations, reducing to the 2-3 host formations
- Evaluation and development of the concept design specific for the Romania geological disposal, including the cost estimation
- Developing a proposal for the implementation of the Underground Research Laboratory

ANDR will contract in the tendering processes an engineering services and external technical support in order to implement the DGR project

Update the Government's Decision no. 1259/2004, regarding the approval of the National Strategy for development of the nuclear activities in Romania

ANDR work on updating other important programmatic document related to the development of nuclear activities in Romanian that presents the policy for the future of nuclear applications in Romania and the medium- and long-term priority directions on the basis of which decisions and priorities can be evaluated in a coordinated manner, so that the development of nuclear plans and actions is carried out in compliance with the principle of sustainable development

National Strategy for development of the nuclear activities

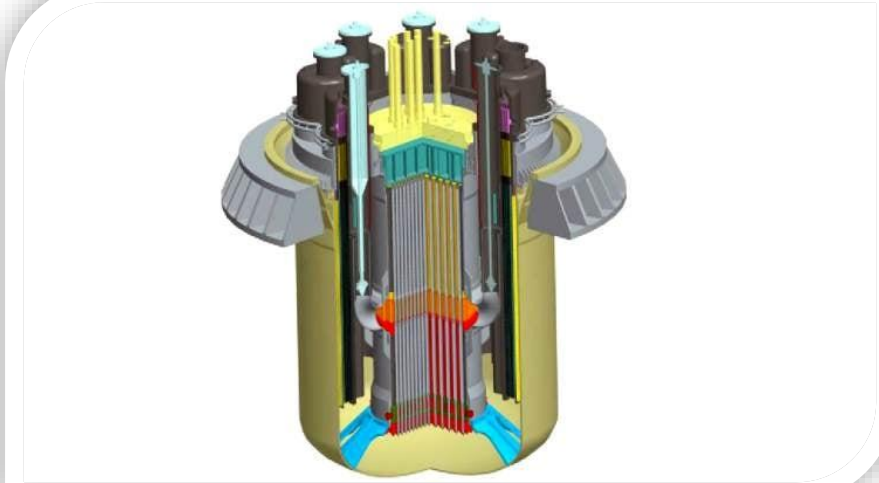
National Nuclear Program

National Nuclear Program
New nuclear installation

Advanced Lead Fast Reactor European Demonstrator (ALFRED)

Main objective of ALFRED:

- to demonstrate the viability of LFR technology
- to perform all preparatory activities (technical design, licensing, siting,…)
- to build a demonstration installation of 125 MWe



Extreme Light Infrastructure-Nuclear Physics (ELI-NP)

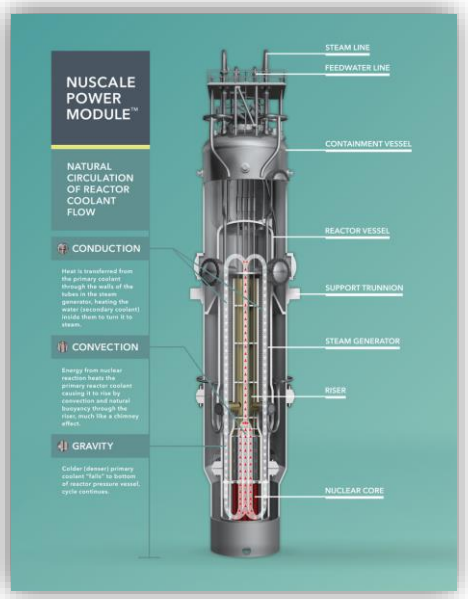
- co-financed by the European Regional Development Fund
- ELI-NP is going to be the research facility focusing on the study of photonuclear physics and its applications, comprising a very high intensity laser (two 10PW ultra-short pulse lasers) and the most brilliant gamma-ray beam.

First SMR from Europe

- In 2021, an agreement between SNN and NuScale Power was signed at COP26 to advance the deployment of NuScale's small modular reactor (SMR) technology in Romania.
- International interest in SMR development is directly proportional to countries' interest in ensuring energy security and achieving decarbonisation goals.
- The NuScale SMR technology is the first and only SMR project to receive approval from the US Nuclear Regulatory Commission (NRC). NRC certification means that the project meets applicable NRC safety requirements.

Small Modular Reactor

- The NuScale NPP is based on a modular Pressurized Heavy Water Reactor (PWR), which will contain 6 modules, each with an installed electrical capacity of 77 MWe.
- The PWR technology is a world-proven nuclear reactor technology, and the design of this reactor uses natural processes that do not require any intervention by the operator or an active source (so-called "passive processes") in the operating systems and safety features of the reactor
- An in-depth study conducted with $1.2 million in funding received by Nuclearelectrica in early 2021 under a USTDA grant to identify and to preliminary asses various sites for the deployment of small modular reactors in Romania was developed by an American company with local subcontractor (RATEN CITON). Following the study, several potential suitable sites were identified
- A preliminary phase of engineering and design studies is still underway to provide essential data for the development of Romania's first small modular reactor plant



CITON's involvement in the development and implementation of SMR in Romania

Center of Technology and Engineering for Nuclear Projects (CITON) is typically structured for to be a design and engineering institute for nuclear projects.

CITON's interest for national & international cooperation in R&D studies

- **Methodologies specific to innovative SMR technologies developed worldwide**
- **Design studies, technological engineering and siting of SMR type reactors**
- **Analysis of technological systems, equipment, electrical systems and automation**
- **Summary analysis of the worldwide evolution of advanced nuclear reactors and the identification of sustainable solutions for Romania**

NEXT STEPS

The next update of the ***National strategy for safe management of SNF and RW in Romania*** will need to take into consideration the new project that the Romanian Government announced

Related to the back end of the SNF from the Romanian Nuclear Program (ALFRED, SMR, Cernavoda NPP) ANDR need to carried out on the next revision national strategy the *result of the economically feasible* solutions for integrating CANDU fuel cycles with new generation plants as well as strategic options on how to address *the alternative of spent nuclear fuel recycling* or conditions for the implementation of *DUPIC cycle (Direct Use of Spent PWR Fuel in CANDU)* in Romania, taking into account the most recent national and international experience on the technical progress of R&D study results for advanced CANDU fuel use

NEXT STEPS

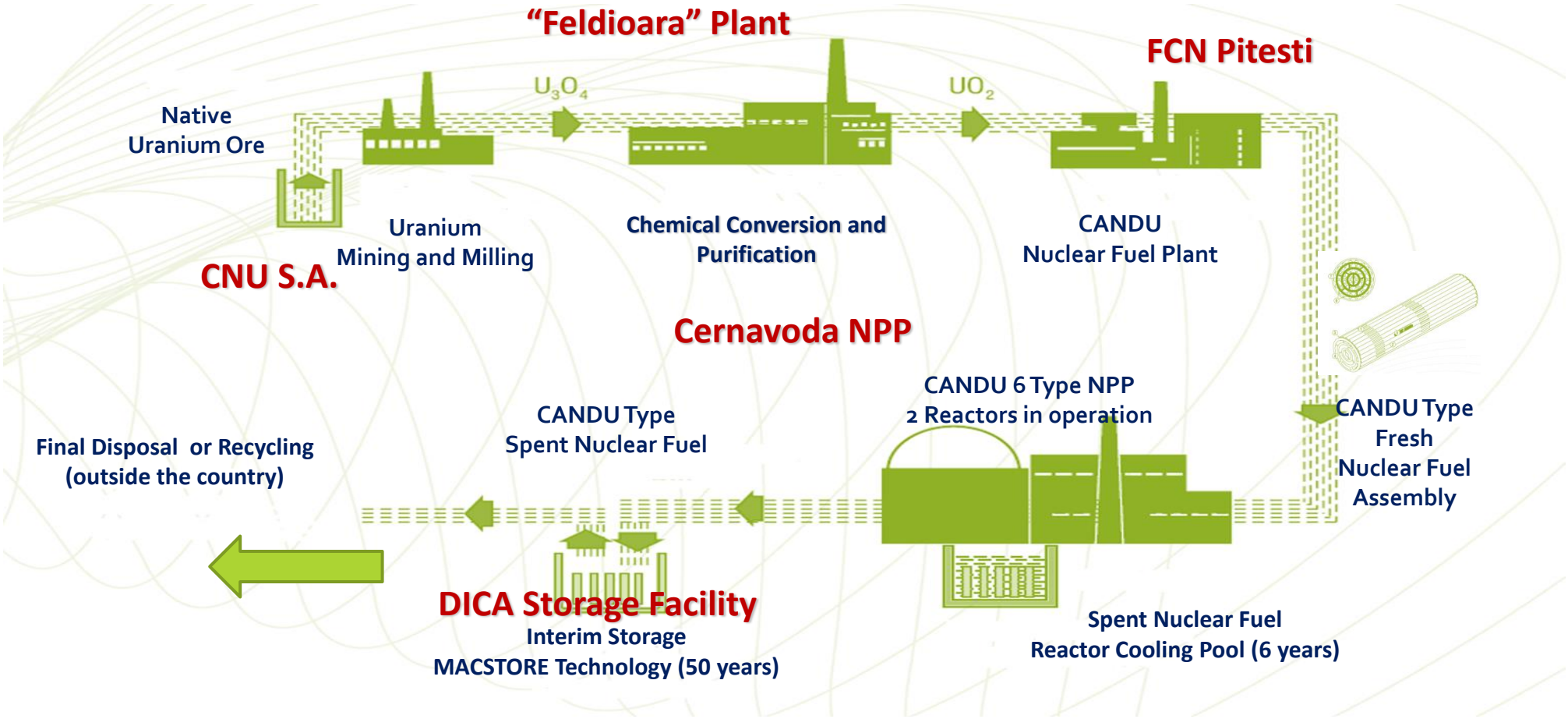
For the time being, the strategy in Romania is the open fuel cycle without reprocessing. Both options have advantages and disadvantages.

- Some of the advantages of direct disposal would be:
  - It is technologically easier and probably cheaper than reprocessing (at current uranium prices);
  - small amount of additional low-level and environmentally active waste generated.

However, the advantages are counterbalanced by the following disadvantages, which are similar to those of any burned fuel:

- environmental hazard for a long time (even more than 250 thousand years)
- the need for longer-term safety of engineering and geological barriers, perhaps different from ordinary spent fuel
- the need to accumulate and secure additional funds for geological repository surface expansion

Romanian Nuclear Fuel Cycle options



NEXT STEPS

As many other countries, with relatively recent nuclear and power programs, the geological repository program in Romania is at an early stage, and take in the consideration all technical solution for disposal of the SNF and HLW. In order to choose the technical solution of the final disposal of SNF , Romania take in the consideration to analyze ***the deep borehole solution*** as an alternative for the DGR.

ANDR have in intention to contract in 2023 a ***study related to the Deep borehole*** disposal of Romania's spent nuclear fuel with impact on the future planning strategy. Implementation of the Deep borehole in Romania could have some ***benefits*** on cost and time savings as well as the a alternative solution for the implementation of SMR

Factors influencing the development of DGR

THANK YOU FOR YOUR ATENTION