MINISTERUL ENERGIEI

RATEN

REGIA AUTONOMĂ
TEHNOLOGII pentru ENERGIA NUCLEARĂ

Technologies for Nuclear Energy State Owned Company

RATEN DEVELOPMENT STRATEGY

FOR 2026-2036

Approved by the Scientific Board of RATEN ICN

and the Technical, Economic and Scientific Board of RATEN CITON

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Abbreviations

ALFRED – Advanced Lead Fast Reactor European Demonstrator
AMR – Advanced Modular Reactor
ANDR – Agenția Nucleară și pentru Deșeuri Radioactive (Nuclear and Radioactive Waste Agency)
ANUEN – Alianța Națională Universitară pentru Energie Nucleară (National University Alliance for Nuclear Energy)
ATHENA – Advanced Thermal-Hydraulic Experiment for Nuclear Applications
ATF – Accident Tolerant Fuel
CANDU – CANada Deuterium Uranium
CHEMLAB – Lead Chemistry Laboratory
CID – Clean Industrial Deal
CNCAN – Comisia Naţională pentru Controlul Activităţilor Nucleare (National Commission for Nuclear Activities Control)
CTRF – Cernavodă Tritium Removal Facility
DFDSMA – Depozitul Final Deşeuri Slab şi Mediu Active (Final Repository for Low- and Intermediate-Level Radioactive Waste)
EAGLES – European Advanced Generation IV Lead-Cooled Energy System
EC – European Commission
EERA – European Energy Research Alliance
ELF – Experimental Lead Fluid facility
ELI-NP – Extreme Light Infrastructure - Nuclear Physics
ENEN – European Nuclear Education Network
ESNII – European Sustainable Nuclear Industrial Initiative
EU – European Union
EURATOM – European Atomic Energy Community
FCN – Fabrica de Combustibil Nuclear (Nuclear Fuel Factory, subsidiary of SNN)
FEED – Front End Engineering Design
FID – Final Investment Decision
HELENA2 – Heavy Liquid Metal Experimental Loop for New Applications 2
IAEA – International Atomic Energy Agency
ICERR – International Center based on Research Reactors
IFIN HH – Institutul Național de Cercetare-Dezvoltare pentru Fizică și Inginerie Nucleară „Horia Hulubei" (Horia Hulubei National Institute for R&D in Physics and Nuclear Engineering)
IPCEI – Important Projects of Common European Interest
iPWR – integral Pressurized Water Reactor
LEPI – Laboratorul de Examinare Post-Iradiere (Post-Irradiation Examination Laboratory)
LEU – Low Enriched Uranium
LFR – Lead-cooled Fast Reactor
MID – Maşina de Încărcare-Descărcare (Fuel Handligh Machine)
MOX – Mixed Oxide fuel
NEA/OECD – Nuclear Energy Agency of the Organisation for Economic Co-operation and Development
NPP – Nuclear Power Plant
NZIA – Net-Zero Industry Act
RATEN – Regia Autonomă Tehnologii pentru Energia Nucleară (Technologies for Nuclear Energy State Owned Company)
RATEN CITON – Center of Technology and Engineering for Nuclear Projects, RATEN Subsidiary
RATEN ICN – Institute for Nuclear Research, RATEN Subsidiary
RDI – Research, Development, Innovation
SET PLAN – Strategic Energy Technology Plan
SMR – Small Modular Reactor

SNETP – Sustainable Nuclear Energy Technology Platform
SNN – Societatea Națională Nuclearelectrica SA (Nuclearelectrica National Company, operator of Cernavodă NPP)
SO – Strategic Objective
STC – Euratom Scientific and Technical Committee
STDR – Staţia de Tratare Deşeuri Radioactive (Radioactive Waste Treatment Plant)
TAR – Teste în Afara Reactorului (Out of Pile Testing)
TRIGA-ICN – TRIGA Research Reactors (SSR – Steady State Reactor; ACPR Annulus Core Pulsed Reactors)
TSO – Technical support organization

1 Introduction

The Development Strategy of the Technologies for Nuclear Energy State Owned Company (RATEN) for 2026–2036 is the fundamental policy document that sets out the directions for the administration's institutional, technological, economic, and human resources development, in accordance with national policies in the fields of nuclear energy, research and development, and national security.

The RATEN Strategy was developed based on the company's status, as defined by its founding legislation, as a critical nuclear infrastructure of Romania, with a central role in ensuring the continuity of nuclear expertise, developing technological autonomy, and providing ongoing technological support for Romania's entire civil nuclear program.

2 Legal and Strategic Framework

RATEN's development strategy for the period 2026–2035 has been developed in accordance with the national and European legislative framework applicable to the civil nuclear sector, as well as to the field of research, development, and innovation, including:

- Emergency Ordinance No. 144/1999 approving the continuation and funding of research, applications, and technological engineering related to national technical support for the nuclear energy sector within the Nuclear Activities State Owned Company, as well as for the approval of the financing of activities specific to international cooperation in the field of nuclear energy;
- Emergency Ordinance No. 54/2013, regarding certain measures for the reorganization through the partial division of the Drobeta Turnu-Severin Nuclear Activities State Owned Company and the establishment of the Technologies for Nuclear Energy State Owned Company – RATEN, a document approved by Law No. 302 of November 15, 2013;
- Law No. 183 of June 10, 2024, on the Status of Research, Development, and Innovation Personnel;
- LAW No. 324 of July 8, 2003, approving Government Ordinance No. 57/2002 on scientific research and technological development, as subsequently amended and supplemented;
- Law No. 111 of October 10, 1996, on the safe conduct, regulation, authorization, and control of nuclear activities, as republished, with subsequent amendments and additions;
- Regulations and guidelines issued by the National Commission for Nuclear Activities Control (CNCAN);
- Government Decision No. 600/2014 on the National Strategy for Nuclear Security and Safety;
- The National Medium- and Long-Term Strategy for the Safe Management of Spent Nuclear Fuel and Radioactive Waste, approved by Decision No. 102, January 2022;
- Romania's Energy Strategy 2025–2035, with a vision for 2050, approved by Government Decision No. 1491, December 2024;
- National Strategy for the Development of the Nuclear Sector in Romania for the period 2021–2030, with a vision to 2050, draft 2026;

- National Integrated Energy and Climate Change Plan 2025–2030;
- Law No. 25/2023 on the voluntary integration of Romanian research, development, and innovation organizations into the European Research Area, as well as amending Government Ordinance No. 57/2002 on scientific research and technological development;
- Status as a Member State of the European Union:
  - EURATOM Treaty;
  - The EURATOM Framework Programme for Research and Innovation;
  - European Commission – Communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee, and the Committee of the Regions: "A European Strategic Energy Technology Plan (SET-PLAN), COM (2007) 723 final";
  - Council Directive 2009/71/EURATOM of June 25, 2009, establishing a Community framework for the nuclear safety of nuclear facilities;
  - Council Directive 2011/70/EURATOM of 19 July 2011 establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste;
  - European Council Recommendation of 18 December 2023 on a new European framework for attracting and retaining high-caliber talent in research, innovation, and entrepreneurship in Europe – "The European Charter for Researchers" (C/2023/1640);
  - Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee, and the Committee of the Regions. Clean Energy Investment Strategy (COM (2026) 116 final);
  - Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee, and the Committee of the Regions. Strategy for the Development and Deployment of Small Modular Reactors (SMRs) in Europe (COM(2026) 117 final);
  - Commission Communication. Informative nuclear program presented pursuant to Article 40 of the Euratom Treaty – final (following the EESC opinion) (COM (2026) 120 final);
- Status as Member State of the International Atomic Energy Agency:
  - The Convention on Nuclear Safety, ratified by Romania through Law No. 43 of May 24, 1995;
  - The Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, ratified by Romania through Law No. 105 of June 16, 1999;
  - Requirements, standards, and guidelines for the nuclear energy sector;
- Status as Member State of NEA/OECD

3 RATEN's Role, Positioning and Mission

RATEN is a strategic organization of national importance that plays a vital role in supporting Romania's civil nuclear program through research and development, engineering, technological support, and the development of nuclear expertise.

RATEN is positioned as a national center of nuclear expertise, responsible for applied research, the operation of experimental nuclear infrastructure, and the provision of technical support for CANDU 600 reactors, the SMR program, and the development of Generation IV reactors through LFR (EAGLES/EAGLES-300).

RATEN's strategic mission is to provide scientific and technological support for the National Nuclear Energy Program and to ensure technical expertise throughout the entire operational life of nuclear facilities by:

- developing the technologies necessary to provide national scientific and technical support for the nuclear energy sector, with a view to ensuring the safe operation of related facilities;
- developing technologies for new types of Generation IV nuclear power reactors;
- developing technologies for the management of spent nuclear fuel and radioactive waste;
- producing radioisotopes for medicine and industry;
- conducting scientific research, design, and technological engineering, and training specialists in the nuclear field;
- specialized training as a technical support organization for the central public administration;
- public information programs;
- activities specific to international cooperation in the field.

RATEN comprises two branches without legal personality: the Institute for Nuclear Research in Pitești (RATEN ICN) and the Center of Technology and Engineering for Nuclear Projects in Măgurele (RATEN CITON).

4 The Current Situation and the Need for a Strategy

RATEN possesses technological and human resources of strategic importance to Romania, as it is one of the few institutions capable of operating experimental nuclear facilities and providing specialized technical support to the nuclear sector.

However, there are structural vulnerabilities, such as aging infrastructure, pressure on existing specialized human resources, and a lack of appeal to new employees—exacerbated by uncompetitive salaries, dependence on fragmented annual funding, and insufficient integration into major European programs.

In the absence of an integrated strategy, Romania risks losing essential nuclear expertise, increasing its dependence on foreign technologies, and diminishing its capacity for technological development in the nuclear field.

The new RATEN strategy proposes solutions designed to mitigate these risks.

5 Short-, Medium- and Long-Term Vision and Mission for RATEN

5.1 RATEN's Mission

RATEN's mission is to operate its own experimental nuclear infrastructure under conditions of maximum nuclear safety, to develop the ALFRED reactor, to actively participate in the European EAGLES consortium for the development of LFR technology through the EAGLES-300 project, to provide ongoing technological support through development, design, and technological engineering for CANDU technology and SMR technologies of interest to Romania, and to maintain the national capacity for research, development, and innovation in the field of nuclear energy.

5.2 RATEN's Vision

By 2036, RATEN will become a strategic pillar of Romania's research, development, and innovation, playing a leading role in the implementation of major nuclear energy projects at national and European levels — from critical technical support in the form of design and technological engineering activities for the Cernavodă NPP and CANDU technology, including through participation in activities developed by Conexus Nuclear Inc. (successor to the CANDU Owners Group), to the implementation of next-generation technologies (SMR, iPWR, and LFR), contributing, through scientific excellence and professionalism, to energy security and autonomy and the transition to a carbon-neutral economy.

5.2.1 Short-Term Vision (2026-2030)

In the short term, RATEN aims to be recognized as a TSO by all stakeholders involved in the implementation of the National Nuclear Program (CNCAN, ANDR, Cernavodă NPP, etc.) and to gain recognition through the transition from experimental research to essential technical support and technology transfer for major national projects in the field of nuclear energy, aiming to:

- strengthen the role of technical support for Cernavodă NPP by providing the necessary expertise, demonstrated through design and process engineering activities, for the life extension of Units 1 and 2 and the construction of Units 3 and 4;
- develop research infrastructure dedicated to LFR technology and modernize existing infrastructure to ensure the safe nuclear operation of experimental facilities critical to the nuclear sector (the TRIGA reactor, LEPI, STDR) and the entire RATEN platform;
- establish RATEN as a Center of Expertise for the safety of SMR and AMR reactors to be built in Romania. RATEN will operate experimental facilities for testing and qualifying materials, testing and demonstrating components and subassemblies, and will conduct nuclear safety analyses specific to new SMR reactor concepts;
- intensify RATEN's participation in the EAGLES consortium;
- create a Center for Nuclear Energy Education to attract and train the new generation of specialists needed to support and develop the National Nuclear Program, by expanding collaboration with universities in Romania and Europe.

5.2.2 Medium- and Long-Term Vision (2030-2036)

In the medium and long term, RATEN aims to become **one of Europe's leaders in the development of nuclear technologies** by:

- active participation in the EAGLES consortium, the licensing and construction of the ALFRED demonstrator in Mioveni, thereby ensuring Romania's presence on the European map of advanced fast reactors, which promise much more efficient fuel utilization and a reduction in the amount of radioactive waste;
- developing innovative solutions related to the fuel cycle, focusing on the management of high-level radioactive waste and the testing of new types of advanced nuclear fuel (ATF, MOX, etc.).

RATEN's strategic vision is defined by the dual focus on maintaining nuclear safety in the operation of existing infrastructure and playing a pioneering role in the development of next-generation technologies. Fulfilling this mandate requires transforming the institution by 2030 so that it is capable of providing multidimensional support for both the established CANDU technology, as well as for emerging solutions such as SMRs, fast reactors, and the necessary auxiliary solutions regarding heavy water and tritium management, spent nuclear fuel and radioactive waste management—including final disposal—maintenance, life extension, reliability, and the decommissioning of nuclear facilities. In this context, operating experimental infrastructure under maximum safety conditions is not merely a procedural obligation, but the foundation upon which the entire national capacity for research and innovation in the field of nuclear energy is built.

Central to this development strategy is the ALFRED project, as well as active participation in the EAGLES consortium, where RATEN serves as the technical leader in research on liquid-lead-cooled systems. The EAGLES-300 project represents the spearhead of this international collaboration, offering Romania the opportunity to transition from being a technology user to a developer of Generation IV nuclear solutions. This transition requires a deep integration of domestic technical expertise with European research requirements, while ensuring the necessary infrastructure for the design, licensing, commissioning, testing, and/or validation of computational codes specific to new advanced reactor architectures.

5.3 Strategic Principles and Priorities

The main principles of this strategy are:

- national interest and national energy security,
- nuclear safety as a fundamental value of the company's organizational culture,
- compliance with the OECD principles on corporate governance of state-owned companies,
- professional excellence,
- human resources as a strategic asset.

6 Nuclear Energy at International Level

Against the backdrop of concerns regarding the impact of climate change and the effects of the energy crisis stemming from the international geopolitical context, nuclear energy is increasingly being recognized as part of the solution for reducing greenhouse gas emissions and ensuring energy independence at the European level.

It is estimated that over the next 10 years, global energy demand will double as a result of the need to sustain economic growth, living standards, and the energy required to power data centers.

The International Energy Agency (IEA) estimates that nuclear power generation will reach an all-time high in 2025–2026 (IEA, 2025), surpassing the previous record set in 2021, as France completes maintenance on its fleet, Japan restarts reactors, and new units are built and connected in China and India.

A new multinational initiative has been launched that aims to triple global nuclear capacity by 2050, recognizing the role of nuclear energy in achieving energy security and climate goals, while complementing the leading role played by renewable energy.

Around the world, several IAEA member states continue to research, develop, or deploy advanced fission reactors. There is growing global interest in the development and deployment of fast reactors. In addition, the role of SMRs in meeting energy demands is gaining attention due to the need for more flexible power generation and economic affordability. The use of passive safety features based on natural forces, such as gravity and natural circulation, as opposed to the use of active components, such as electric pumps, diesel emergency engines and generators, is among the features of SMRs that can also ensure continuous operation and provide enhanced nuclear safety performance.

At the start of 2026, the sector is marked by a level of optimism not seen in the past decade, driven by:

- Record-breaking construction of new capacity, with approximately 60 reactors under construction worldwide, totalling over 65 GW of capacity (WNA, 2025);
- Extension of the operating life of existing reactors (U.S., France) and the reopening of some closed units (e.g., the Palisades plant in Michigan);
- Increased interest in SMRs, as SMR technology moves from the concept phase to implementation, with the first operational units in China and Russia and advanced projects in the US, Canada, and Romania. Small modular reactor concepts, whether conventional (SMR) or advanced (AMR), promise advantages in nuclear safety, increased fuel efficiency — leading to reduced radiotoxicity and radioactive waste volume — mass production, shorter construction times, and economic competitiveness.

6.1 Current Status of Nuclear Energy in Europe

6.1.1 EU Policies in the Nuclear Sector

In 2026, Europe's nuclear landscape is more active than at any time in the past three decades. European Union policies from 2024 to 2025 mark a radical paradigm shift, moving from a reluctant or neutral stance toward nuclear energy to an official recognition of it as a strategic technology for achieving climate neutrality. This "European Nuclear Renaissance" is supported by five major legislative and policy pillars:

1. **Inclusion of nuclear energy in the Net-Zero Industry Act (NZIA)** (EC, 2024)

Officially adopted in 2024 and actively implemented in 2025, the NZIA is likely the most significant recent policy signal. Nuclear energy (both traditional nuclear power and future technologies, such as SMRs) has been included on the list of strategic zero-emission technologies, granting it strategic status. Under this Act, nuclear projects can now benefit from accelerated authorization procedures ("fast-tracking") and reduced bureaucracy, as they are considered essential for the competitiveness of European industry.

2. **EU Taxonomy and Access to Financing** (EC, 2022)

The 2024–2025 period has further solidified the status of nuclear energy through the EU Taxonomy (the classification system for sustainable investments). Nuclear energy is officially recognized as an activity that contributes to climate change mitigation. This allows companies and member states to access "green" capital markets and loans with preferential interest rates for the construction of new reactors or the refurbishment of existing ones.

3. **European Industrial Alliance on SMRs** (SMR, 2024)

Launched by the European Commission in February 2024, this alliance became operational in 2025, with the primary objective of accelerating the deployment of the first small modular reactors (SMRs) in the EU by the early 2030s. A total of nine SMR projects were selected in October 2024 and re-evaluated in 2025, two of which involve Romania (the NuScale Project – Doicești and the EU SMR LFR – EAGLES 300 – RATEN Mioveni Project).

4. **"Nuclear Alliance" of Member States** (EU, 2023)

Under France's leadership, a group of more than 12 member states (including Romania) has established the Nuclear Alliance, a coalition within the Council of the EU aimed at increasing the EU's installed nuclear capacity from approximately 100 GW today to 150 GW by 2050.

5. **Clean Industrial Deal – CID** (CE, 2025)

The Clean Industrial Deal (CID) is the European Commission's new pilot strategy, considered the "successor" and economic driver of the European Green Deal. While the Green Deal focused on environmental targets, the Clean Industrial Deal focuses on how to ensure that industry survives and thrives throughout the decarbonization process.

This new strategy is the European Commission's response to the issues raised in the report published by Mario Draghi, former President of the European Central Bank (Draghi, 2024) in September 2024, titled "The Future of European Competitiveness," which warned of the high cost of energy in Europe and concluded that it cannot survive industrially without a massive reduction in prices through long-term contracts (PPAs—Power Purchase Agreements) and CfDs (Contracts for Difference).

Furthermore, in his report, Draghi clearly states that nuclear energy is indispensable for competitiveness, due to the stability it provides to the grid. As a result, the Clean Industrial Deal has included "nuclear energy in all its forms" (large reactors, SMRs, and fusion) in its fast-track financing mechanisms, eliminating the historical distinction between renewables and nuclear energy. With regard to innovation, Draghi's recommendation to shorten the time from lab to market is reflected in the CID Pact through the possibility of direct funding for technology demonstrators (such as ALFRED).

In conclusion, nuclear energy is no longer viewed in Europe as a transitional solution, but rather as a necessary complement to renewable energy, capable of providing the "baseload" power required for grid stability and to meet the needs of large industrial consumers.

6.1.2 The Current State of Nuclear Programs in Europe

A number of Member States have adopted policies and projects to expand their existing nuclear capacity or to launch a nuclear program.

> **France** has launched the EPR2 program, with plans for six new reactors and the possibility of expanding to 14 units. Additionally, EDF is implementing the "Grand Carénage" program, an investment of over €50 billion to modernize the entire reactor fleet, enabling them to operate beyond the 40-year threshold, with the aim of bringing the existing reactor fleet back into service. The **United Kingdom**, through its "Civil Nuclear Roadmap to 2050" plan, formalized in 2024–2025 a strategy aimed at reaching a capacity of 24 GW by 2050 (approximately 25% of the country's electricity needs). Hinkley Point C is currently under construction, Sizewell C has received official approval for construction in 2025, and in June 2025, the Great British Nuclear consortium officially selected Rolls-Royce to build the first units at the Wylfa site (Wales), transforming the region into a major technology hub. **Sweden** has announced plans for a "massive expansion," aiming to build the equivalent of two large reactors by 2035, followed by others by 2045. **Belgium** repealed the law in May 2025 that provided for a complete phase-out of the nuclear program.

Poland plans to begin construction of its first nuclear power plant (using Westinghouse's AP1000 technology) in 2026 in Choczewo, with the goal of operating six reactors by 2040. **The Czech Republic** is building two new units at Dukovany, and **Bulgaria** is moving forward with plans for Units 7 and 8 at Kozloduy (AP1000 technology), aiming to commission the first unit in 2033. **Hungary** plans to begin construction in 2026 of two new VVER-1200 units at the Paks II plant, while **Slovakia**, with over 60% of its energy coming from nuclear power, is in the final phase of testing and commissioning Mochovce 4, which will become fully operational in 2026, and has signed an agreement with the U.S. (Westinghouse) to build a new reactor of over 1,000 MW at Jaslovské Bohunice. **Slovenia** plans to build a large reactor (up to 1,600 MW) or two smaller reactors to ensure grid stability following the closure of the current Krško reactor (scheduled in over 20 years).

Romania plans to refurbish Unit 1 at the Cernavodă Nuclear Power Plant, starting in 2027, involving complex work (replacement of fuel channels and pressure tubes). To this end, work has begun on developing engineering packages related to design modifications and improvements, constructing the tritium removal facility — CTRF (support facility for the refurbishment of Unit 1) — and the goal is to restart operations in 2029 for another 30 years of service. The project has entered the actual implementation phase of the engineering and management contracts (with partners from Canada, the U.S., and Italy). Additionally, Units 3 and 4 are in the site preparation and critical engineering phase, and the Final Investment Decision (FID) has been approved for the project of Europe's first SMR reactor, based on NuScale technology. Through RATEN and the ALFRED project, Romania is involved in the development of LFR technology and the EAGLES 300 commercial reactor.

6.2 The Current State of Nuclear Projects Worldwide

6.2.1 The Construction of New Nuclear Units

Globally, a number of countries with nuclear programs are building new reactors to increase their share of the energy mix (IAEA, 2025).

Thus, **China** is the undisputed global leader, with the largest number of reactors under construction (over 25 units). Its goal is to become the world's largest producer of nuclear energy by 2030. **India** is rapidly expanding its nuclear fleet to support economic growth, with 6 reactors currently under construction. **Russia** continues to develop Generation IV technologies and export nuclear technology through the company Rosatom. **South Korea**, under the current government, has reversed its policy of closing nuclear power plants, recently approving the commissioning of the Saeul-3 unit (2026).

In addition, an increasing number of non-nuclear states are opting for nuclear energy; they have introduced or intend to introduce nuclear energy into their energy mix and have projects at advanced stages.

In **Turkey**, the first unit of the Akkuyu nuclear power plant is scheduled to become operational as early as 2026, marking the country's official entry into the "nuclear club," while in **Bangladesh**, the Rooppur plant is nearing completion, with the first unit expected to connect to the grid in 2026. **Egypt** is building four reactors at El Dabaa, a strategic project for diversifying Africa's energy mix, and the **United Arab Emirates**, which recently became a producer (the Barakah plant), continues to serve as a model of success for newcomers, now also exploring SMR technology.

The introduction of nuclear energy is also of interest in other countries, such as **Ghana**, **Kazakhstan**, **Uzbekistan**, and **Rwanda**, where nuclear programs are at various stages of feasibility studies and planning.

6.2.2 Refurbishment and Life Extension

The massive expansion of nuclear energy relies not only on the construction of new reactors, but especially on projects to upgrade and extend the lifespan of existing reactors.

> **Canada** is a leader in large-scale projects, currently undertaking some of the world's most complex refurbishment projects, centered on CANDU technology. Darlington (Ontario) is undertaking a project worth approximately CAD 12.8 billion for the sequential refurbishment of its units, with completion of the entire complex scheduled for the end of 2026. The refurbishment of Units B at the Pickering plant (Ontario) was approved in 2024, with the critical design and procurement phase set to take place in 2025–2026 (with a budget of over CAD 4 billion for this phase alone), the goal being to extend operations by another 30 years. Bruce Power is continuing its major component replacement program, the largest private infrastructure investment project in Canada.

> **The U.S.** has moved beyond simply extending licenses (to 60 or 80 years) to restarting closed power plants. Palisades (Michigan) is the first reactor in U.S. history scheduled to be restarted after officially entering decommissioning. With $1.5 billion in federal support, the restart is targeted for early 2026. Three Mile Island (Unit 1) has announced plans to restart to power Microsoft data centers, with major investments in modernization through 2028.

> In **Japan**, following a decade of post-Fukushima stagnation, the restart of nuclear reactors is gaining momentum. In November 2025, approval was granted to restart the world's largest nuclear power plant, Kashiwazaki-Kariwa, following extensive upgrades to its safety systems.

This global trend is being driven in large part by the energy demand of data centers (AI), the 2050 decarbonization targets, and the need to ensure energy independence, a priority that developed nations are increasingly recognizing.

6.3 Growing Interest for SMRs

In addition to the construction of conventional large-capacity commercial reactors, there is growing interest in small modular reactors. In Europe, countries in Central and Northern Europe have taken the first steps toward building SMRs as a replacement for the energy produced by decommissioned coal-fired power plants.

> **Romania** remains at the forefront of Europe with the NuScale project, as NuScale Doicești moves toward a final investment decision. **Sweden** has already received the first applications for state aid for SMR fleets (BWRX-300 or Rolls-Royce) at Ringhals. Countries such as **Finland** and **Estonia** are exploring the use of SMRs specifically for district heating, not just for electricity. Through the company Fermi Energia, Estonia has completed pre-feasibility studies and is preparing to become the first Baltic country with its own nuclear energy generated by SMR reactors. In **the Czech Republic**, the ČEZ Group has acquired a 20% stake in Rolls-Royce SMR, planning an entire fleet of mini-reactors (3 GW in total) starting with the Temelín site.

Outside Europe, interest in small modular reactors (SMRs) shifted in 2025 from a phase of scientific curiosity to a race for technological dominance and export markets. The United States, Canada, China, and Russia are the leaders in this segment, each with distinct strategies.

North America is positioning itself as a commercial pioneer, holding the largest market share (approximately 33%) and focusing on technology licensing and export. In 2026, **Canada** became the first country in North America to issue a construction license for a commercial SMR. The project in Darlington (Ontario), which uses GE-Hitachi's BWRX-300 technology, is in full swing, serving as a model for similar projects in Poland and the U.S. In **the U.S.**, following the certification of the NuScale design, the focus has shifted to supporting companies such as TerraPower (the Natrium project in Wyoming, backed by Bill Gates) and X-energy. A new development momentum in 2025–2026 comes from AI data centers, allowing giants such as Microsoft and Google to explore direct partnerships with SMR developers to secure the constant energy they need.

Asia is emerging as a hub for rapid deployment. **China** already operates the world's first grid-connected commercial SMR (the HTR-PM, a gas-cooled reactor). In 2026, China is accelerating construction of the ACP100 (Linglong One) model in Changjiang, which is scheduled to be fully operational by the end of 2026. It is relying on SMRs not only for electricity generation but also for district heating and desalination. In **South Korea**, the government recently approved its own i-SMR design and began construction of a demonstration unit. South Koreans are extremely aggressive in the export market, offering integrated construction and financing packages.

Russia remains the leader in floating SMR solutions, being the only country to operate such nuclear power plants (e.g., the Akademik Lomonosov). Starting in 2025, Rosatom began deploying new RITM-200S units in the Arctic region to power large-scale mining projects (e.g., Cape Nagloynyn). Russia is also developing the Rosatom Proryv complex, which includes the BREST-OD-300 reactor, and is actively promoting SMR technology in Africa and Southeast Asia as a "turnkey" solution.

There is massive interest in SMR reactors, even in areas where the power grids cannot support large reactors of 1,000+ MW.

In the Middle East, **Jordan** and **Saudi Arabia** are in advanced discussions regarding SMRs for water desalination, a critical need in the region. In 2025, **Brazil** signed letters of intent with Chinese partners to evaluate the integration of SMRs in remote areas of the country, while **Kazakhstan** and **Uzbekistan** are exploring SMRs as a solution to replace old coal-fired power plants, similar to the Romanian model.

7 Nuclear Energy within the National Framework

Romania's nuclear sector is one of the cornerstones of national energy security.

In the field of **electricity production**, the Cernavodă Nuclear Power Plant supplies approximately 20% of Romania's electricity needs through its two operational units. Major projects associated with the Cernavodă Nuclear Power Plant over the next 10 years include:

- *Refurbishment of Unit 1:* Currently (2026), the project is in the final preparatory phase ahead of the planned shutdown in 2027. This operation will extend the reactor's operational life by another 30 years, at a significantly lower cost compared to building a new reactor.
- *Construction of Units 3 and 4:* Following the signing of financing and engineering agreements with strategic partners from the U.S., Canada, and France, the project to build the two new CANDU reactors has entered an accelerated phase of site mobilization. Their completion will double the country's nuclear power generation capacity.

- *Construction of tritium removal facility (CTRF):* This is the first tritium removal facility in Europe and the third industrial facility worldwide, following those in Canada and South Korea. This technology will enable the recovery of tritium and reduce environmental impact, while also positioning Romania as a supplier of tritium for future fusion reactors (such as the ITER project).

In the field of SMRs, Romania is the first country in the region to adopt SMR (Small Modular Reactors) technology, through a partnership with the American company NuScale for the Doicești site. Currently, the Doicești project has moved beyond the engineering and design studies phase (FEED 2), and the Final Investment Decision (FID) was made in February 2026. Romania is now in a pioneering position not only at the European level but also globally, aiming to have the first operational SMR plant with 6 modules (total capacity 462 MWe).

RATEN, through its CITON branch, has been and continues to be involved in all these major projects through the following contractual activities:

- Engineering services for the condition assessment contract in preparation for the refurbishment of Unit 1 at the Cernavodă NPP;
- Engineering services related to the characterization of the existing civil structures U3&4 at the Cernavodă NPP in preparation for their qualification for future use;
- Contract for design and engineering services for infrastructure buildings for the refurbishment of Unit 1 at the Cernavodă NPP;
- Contract for design and detailed engineering services for design modifications to be implemented during the refurbishment of Unit 1 at the Cernavodă NPP;
- Owner's Engineer services for RoPower Nuclear SA under the assistance contract for the implementation of SMR technology in Romania;
- Design services contract for the Tritium Removal Facility project at Cernavodă;
- Framework contract for engineering services for Units 1 & 2 of Cernavodă NPP;
- General engineering and consulting support services regarding the production of medical radionuclides at the Cernavodă NPP Units, including support services for representing the company in its dealings with the relevant authorities;
- Technical consulting services (Owner's Engineer) for Phase 2 of the Cernavodă NPP Units 3 and 4 Project.

Furthermore, through RATEN's participation in the EAGLES consortium, Romania is involved in the development of lead-cooled fast reactor (LFR) technology and the SMR LFR commercial reactor concept, EAGLES-300. Commercialization is planned to begin in 2040, following the demonstration of technological, industrial, and economic viability through the construction of the ALFRED demonstrator in Romania, at the Mioveni site.

Both the EAGLES-300 project and the NuScale project have been selected by the European Industrial Alliance for SMRs as two of the nine priority projects at the EU level, and Romania can be considered a key player in the implementation of SMR technology in the region.

Radioactive waste management is a strategic area closely linked to the national nuclear program (Units 1 and 2 at the Cernavodă Nuclear Power Plant) and to the use of radioactive sources in medicine and industry.

Since the coming decade will be decisive for Romania's nuclear infrastructure, given the plans to expand energy capacity, the radioactive waste management program will need to:

- Make the DFDSMA Saligny facility operational by obtaining the site and construction permit, completing construction, and beginning the storage of low- and intermediate-level waste generated by Units 1 and 2;
- Adapt the waste management strategy to include future waste streams from the planned new reactors;
- Select the site for the final disposal of spent fuel through specific site studies.

8 Nuclear Research, Now and in the Future

8.1 Research-Development-Innovation: Current Status and Outlook

In the nuclear sector, current R&D efforts are focused on the development of commercial SMRs, based on both conventional technologies (water-cooled reactors) and advanced technologies. At the European level, LFR technology is being investigated in countries such as Italy, Belgium, Romania, France, and Sweden through national research programs as well as within EURATOM projects.

The EURATOM Framework Program remains the primary financial instrument at the European level for supporting R&D in the field of nuclear fission. The targeted areas are: nuclear safety of existing power plants and research reactors and life extension, safety of new reactor concepts, closed fuel cycle, nuclear materials and fuels, radioactive waste management, radiation protection, education and training of specialists, and access to research infrastructure.

8.1.1 The EURATOM Program 2021 -2027

The EURATOM Program (the European Atomic Energy Community's Research and Training Program) is undergoing a critical period of adaptation between 2021 and 2027, as it is closely aligned with the new priorities of the Clean Industrial Deal (CID) and the recommendations of the Draghi Report. Currently (2025–2026), EURATOM intends to become a financial instrument that directly supports Europe's industrial competitiveness.

For the 2021–2025 Multiannual Financial Framework, the program received a budget of approximately €1.38 billion, of which approximately €590 million was allocated to nuclear safety, waste management, and the development of SMRs.

Under the influence of new EU policies, the EURATOM program for 2026–2027 focuses on:

- *developing SMRs* by funding consortia working on standardizing the design of modular reactors, to enable mass production in Europe;
- *non-energy applications (SAMIRA) with a focus on medical radioisotopes* – EURATOM funds research into cancer treatments, aiming to reduce reliance on imports of raw materials from outside the EU;
- *fuel cycle* with a focus on next-generation nuclear fuel (ATF—Accident Tolerant Fuel), which would make existing power plants much more resilient.

Romania is a beneficiary of EURATOM funds, particularly through RATEN and IFIN HH. Through EURATOM calls for proposals, the RATEN ICN team participates in European projects focused on nuclear safety and severe accidents, nuclear materials and advanced fuels, LFR technology, radioactive waste management, radiation protection, and environmental protection.

In 2025, a decision was made to better align EURATOM research with the free market. Thus, the results of EURATOM-funded research are to be transferred more quickly to industry through “technology transfer hubs,” and by funding doctoral work and mobility programs for young researchers, the training of the human resources needed in the nuclear field is directly supported.

Consequently, through its actions in recent years, the EURATOM program aims to serve as an “intellectual engine” for the nuclear industry, thereby providing the scientific foundation without which the massive commercial investments envisaged in the Clean Industrial Deal would not be possible or safe.

8.1.2 The EURATOM Program 2028-2034

Funding for the Euratom Program under the next Multiannual Financial Framework (MFF), which will cover the period 2028–2034, is the subject of intense negotiations in the political context of 2026. At this stage of the discussions, the draft proposes actions to support EU competitiveness in line with the objectives of the European Competitiveness Fund (ECF) ((EC), https://commission.europa.eu/publications/european-competitiveness-fund_en, 2025) and the Horizon Europe Framework Program 2028–2034, by conducting research on safe and innovative nuclear technologies for a prosperous, resilient, and sustainable EU ((EC), 2025).

The specific objectives in the field of nuclear fission aim to:

- advance research in the fields of nuclear safety, security, and safeguards; nonproliferation; radiation protection; nuclear data; security of supply; management of radioactive waste and spent fuel; and innovative uses of ionizing radiation, including in the medical sector;
- develop, maintain, and utilize expertise and skills in the nuclear field through education and professional training, and support access to state-of-the-art research infrastructure, ensuring their long-term sustainability and operational excellence.

The actions of the Euratom Program ((EC), 2025) are focused on:

– *Improving nuclear safety* by developing tools, methods, and guidelines to further strengthen the safety of existing nuclear facilities, including with a view to long-term operation and new nuclear power plant projects, as well as improving the understanding of the behaviour of energy components and systems.
– *Promoting nuclear innovation* through research and development activities that enable the assessment of the safety, security, and safeguards of advanced systems. This will address and contribute to the analysis of the needs of European supply chains, including in terms of skills. Research will also aim to advance the development of innovative fuel cycles and materials, as well as a wide range of applications of nuclear technology beyond power generation.
– *Advancing the management of radioactive waste and spent fuel* through the development of new waste management solutions. The research will support the development of safety and nuclear safeguards documentation for the geological disposal of radioactive waste, including measures to ensure the operation and monitoring of deep geological facilities. Safe solutions for pre-disposal of waste are also expected.
– *Improving the lives of European citizens* through nuclear medicine and radiation protection. Research will reduce radiation-related risks to people and the environment (i) by developing knowledge and tools and (ii) by strengthening preparedness and emergency response in the event of a radiological accident; (iii) by investigating innovative applications of ionizing radiation, including medical radionuclides, to advance treatments and optimize therapies used in the fight against cancer and other diseases; and (iv) supporting the development of

applications of energetic and non-energetic ionizing radiation in other fields, such as space, industry, environmental monitoring, and the circular economy.

- *Fostering skills, capabilities, and access to nuclear research infrastructure* for the benefit of the Community by supporting researcher mobility and improving the availability of nuclear research facilities and equipment through open-access schemes, as well as by supporting education, training, and knowledge dissemination activities, contributing to the maintenance of strategic nuclear capabilities and supporting a skilled workforce in the EU, while strengthening capabilities in all Member States.
- *Strengthening nuclear nonproliferation* at the EU and global levels by developing innovative tools and methods for measurement, containment, monitoring, and verification, by training nuclear safeguards inspectors, and through international cooperation with the IAEA. Research and development in the field of non-proliferation will also focus on strategic trade controls and support nuclear security and the prevention of illicit use of nuclear materials.

For the Fission Program (Generation IV & SMR), research funding is expected to double. Euratom will directly fund the "bankability" of advanced technologies (e.g., LFR technology), supporting the pre-construction phase of reactors in order to subsequently attract private capital through the CID.

The new financial plan will introduce the concept of "hybrid financing," putting complementary financing mechanisms into practice. Thus, Euratom will no longer operate solely through research grants (Horizon Europe), but will collaborate with the European Competitiveness Fund to scale up research results for industrial production, and with the European Investment Bank (EIB) to provide technical guarantees for large-scale loans granted to Member States developing nuclear hubs.

8.2 Nuclear Energy Research in Romania

Romanian nuclear research is undergoing a transition, shifting from operational support for CANDU technology to cutting-edge research in the field of Generation IV systems, through RATEN, and in high-energy physics (through IFIN HH and ELI-NP).

RATEN is the leading player in nuclear energy research in Romania; by virtue of its mandate, it provides critical technical support for the nuclear energy program and is actively involved in both the technological and safety aspects of CANDU technology, as well as in the development of emerging technologies (SMR and LFR SMR).

The RATEN research program is funded by the Ministry of Energy, in accordance with Government Emergency Ordinance 144/1999 and Government Emergency Ordinance 54/2013, and addresses issues related to CANDU technology and emerging technologies (SMR, LFR, tritium removal, etc.) as well as cross-cutting issues (radioactive waste management, radiation protection, education and training, international cooperation, applications of nuclear energy, etc.).

RATEN operates a research infrastructure critical to the nuclear sector (the TRIGA reactor, LEPI, STDR), which serves as the foundation for validating the technical solutions required for the refurbishment of Unit 1 at Cernavodă, and is engaged in developing a large-scale infrastructure essential for advanced reactor technology, represented by a set of supporting experimental facilities, currently at various stages of completion, which are essential for demonstrating LFR technology (ATHENA, ChemLab, HELENA2, ELF, HANDS-ON, MELTIN'POT).

Education and human resources are major concerns for both RATEN and the nuclear sector as a whole. Romania aims to become a hub for education and human resources in the field of emerging and innovative SMR technologies. To support its technological progress, it is necessary to develop the capacity of existing resources by establishing regional and even European training centers. The first steps have materialized in the implementation of Europe's first NuScale SMR simulator at the Polytechnic University of Bucharest and in the creation of the National University Alliance for Nuclear Energy (ANUEN) to address the need for training the human resources required for the nuclear program. Through the ongoing FIRST (Foundations for Innovative Resilience through Safe Technology) Program, the goal is to establish a school in Romania for future SMR plant operators from across the region (Poland, the Czech Republic, Slovakia).

Outlook for the Coming Decade (2026–2036)

Given the major nuclear energy projects in Romania, research is expected to focus on the following areas:

- **Validating and implementing LFR (Lead-cooled Fast Reactor) technology**

  Over the next 10 years, according to the EAGLES Roadmap, the ALFRED project will move from the conceptual design and pre-licensing studies phase to the construction phase. The associated research program will need to demonstrate the technical feasibility of liquid metal cooling (molten lead), the corrosion resistance of structural materials, specific technical solutions for waste management, and compliance with nuclear safety requirements for operation.

- **Extending the operational life of existing CANDU reactors and building new ones**

  By leveraging the knowledge and databases developed through research into the aging processes of materials and components, as well as advanced computational methods, the research will be able to provide predictive maintenance solutions, including through AI and Digital Twins, integrated with the implementation of innovative technological solutions to optimize operation and increase the reliability of CANDU-type NPP systems.

- **Implementing Small Modular Reactors (SMRs)**

  In this field, research plays a key role in developing professional training programs for the specialized personnel required to operate SMRs, using both traditional methods and advanced methods based on artificial intelligence algorithms and Digital Twins to predict the behaviour of SMR reactors under various operating conditions.

- **Radioactive waste management**

  Research in the field of radioactive waste management will address critical issues at all stages of the waste management cycle: characterization of radioactive waste through the development of non-destructive methods and high-precision radiochemical techniques, waste treatment and conditioning through the development of advanced treatment technologies and innovative conditioning matrices designed to reduce the volume of stored radioactive waste and generate waste forms with advanced performance, as well as waste disposal, by combining experimental studies with mathematical modelling to demonstrate the performance of engineered barriers ensuring the safety of disposal systems.

9 SWOT Analysis

Given the current national, European, and international context and the future objectives of the national nuclear program, the SWOT analysis revealed the following:

9.1 Strengths

- RATEN – the only research and engineering organization in Romania specializing in nuclear energy that covers the full range of topics relevant to the nuclear program;
- The complementary nature of the two RATEN subsidiaries' areas of activity: research and development, and design and process engineering;
- RATEN ICN – the only research organization in Europe with expertise in CANDU technology;
- RATEN CITON – lead designer with relevant experience in providing process engineering services for CANDU plants in Romania;
- CNCAN authorizations for the RATEN sector (research, design, and manufacturing activities);
- Skills for:
    - Reactor physics and thermohydraulic calculations
    - Nuclear safety analyses
    - Mechanical and chemical behaviour of structural materials
    - Nuclear fuel fabrication/development and performance evaluation
    - Post-irradiation analysis
    - Radioactive waste management (treatment, conditioning, disposal, long-term strategies)
    - Decommissioning of nuclear facilities (decommissioning planning, controlled dismantling, impact assessments)
    - Radiological characterization of materials
    - Environmental impact and radiation protection analyses (radiation monitoring, exposure assessment, protective measures)
    - Design of technological systems
    - I&C and process equipment design
    - Nuclear engineering (nuclear facility design, operational analyses, safety studies)
    - Technical-economic studies, research projects, feasibility analyses
- Unique infrastructure in România
    - TRIGA reactor
    - Post-Irradiation Examination Laboratory (LEPI)
    - Test bench for Fuel Handling Machines
    - Radioactive Waste Treatment Plant (STDR)
- Experience in the safe operation and maintenance of complex nuclear facilities (TRIGA reactor, LEPI, STDR…)
- Experience with EURATOM projects, connections with other organizations and experts
- Member of European bodies involved in shaping nuclear energy research policies (SNETP, ESNII, EURADSCIENCE, ETSON, ENEN, STC, EERA, SET PLAN, Industrial Alliance on SMRs…)
- Member of the EAGLES Consortium
- National project implementation manager for ALFRED
- Funding the 4ALFRED project and the experimental support infrastructure of ALFRED, currently under construction
- Recognition by the NPP operator and relevant regulatory authorities as a technical support organization

- Client's engineering consultant for the SMR Doiceşti project (LNTP U3/U4 phase) and the IRIS project (radioisotope production)
- Provider of process engineering services for the CTRF project, for Units 1&2 at the Cernavodă NPP (framework agreement)

9.2 Weaknesses

- Financial dependence on the state budget
- Low proportion of revenue from contracts and projects
- The advanced state of deterioration of RATEN's technical and research infrastructure
- Lack of active participation in the CANDU Owners Group (now Conexus Nuclear Inc.) research programs
- Limited/reduced connection/collaboration in the field of research with the Romanian nuclear industry
- Lack of a mechanism for technology transfer of research results to the nuclear industry
- Low level of participation in PNCDI projects
- Low visibility/profile within the country
- Limited scientific recognition at the national and international levels
- Advanced expertise limited to a small number of specialists
- Weak leadership representation
- Limited number of established, high-performing research teams
- Limited connection to international professional organizations with exceptional results in the field of nuclear engineering
- Insufficient development of the portfolio of external clients in the field of technological engineering to enable the formation of multinational teams capable of participating in competitions published in SEAP and the OJEU by SNN and ANDR
- Lack of incentives to stimulate improved researcher performance, engagement, and project initiation
- Insufficient training of recently hired staff relative to RATEN's objectives

The failure to implement the human capital strategy at RATEN is causing operational disruptions. The main technical and strategic vulnerabilities are:

- *Erosion of expertise and loss of authorizations:* the retirement of specialists without a formal transfer of know-how leads to the loss of niche skills, including in operations. A decline in the number of qualified personnel below the minimum threshold established by CNCAN regulations will result in the suspension of operating licenses for critical infrastructure. Any process of renewing the workforce must be inextricably linked to nuclear safety standards. The intergenerational transfer will place particular emphasis on Nuclear Safety Culture, ensuring that new employees possess not only technical skills but also a deep understanding of legal responsibility and nuclear safety and radiation protection regulations. An internal competency certification system to accompany the compendium of internal procedures, aligned with CNCAN requirements—drawn from global specialized technical expertise—will enable monitoring, a steady upward trajectory of the learning curve, and the progressive authorization of personnel.
- *Deterioration of the technological infrastructure and isolation:* The lack of an influx of young personnel trained in digital technologies (e.g., Digital Twin: the development of digital replicas of

experimental facilities that would allow staff training in a safe and modern virtual environment, accelerating the learning process without exposing the actual infrastructure to beginner errors), transforms RATEN from an active research center into a manager of assets that are both physically and morally obsolete. The risk/outcome is exclusion from European consortia (SNETP, the ALFRED project) and the loss of access to Horizon Europe grants.

- *Technological dependence and energy security risks:* The inability to provide specialized technical support (independent safety analyses, design, radiation protection) forces the Romanian government to rely exclusively on external suppliers. This outsourcing exponentially increases maintenance costs for Cernavodă and undermines decision-making in the national energy sector.
- *Economic impact:* Failure to implement the strategy turns a strategic asset into a budgetary liability, generating infrastructure maintenance costs without yielding any technological or research benefits, while simultaneously accelerating the brain drain to foreign competitors.

9.3 Opportunities

- EU-wide energy policies that support the nuclear sector
- The possibility to access new funding instruments for projects demonstrating innovative technologies at the European level
- Nuclear energy that enjoys political support and public acceptance in Romania
- Romania is the only European country to have CANDU technology
- Ambitious national nuclear program:
  - refurbishment of U1
  - construction of U3&4
  - implementing an SMR project - NuScale
  - doubling FCN's production capacity
  - Modernization of the production line at the CNU/SNN Feldioara plant
  - building a tritium removal facility
  - building the ALFRED demonstrator
  - management and storage of radioactive waste and spent fuel
  - radioisotope production for medicine
- Opportunities at the European and international levels for nuclear projects, with a focus on SMR
  - the launching of the European Industrial Alliance for SMRs and the EAGLES consortium
  - an increase in the Euratom program budget
  - funding of major projects of common European interest through state aid schemes (IPCEI)
- Cernavodă NPP has had difficulty accessing technical support from Canada to resolve specific technical issues related to operations
- The growing demand for personnel with training in the nuclear field at the national and international levels

9.4 Threats

- The current national economic situation and its impact on RATEN through:
  - erosion of expertise and loss of licenses
  - deterioration of the technological base and isolation
  - insufficient funding from budgetary sources

- o inadequate compensation policy, less competitive compared to the market, including the private sector;
- o career stagnation due to a lack of promotions
- o insufficient funding for the operation and maintenance of critical nuclear facilities
- o loss of competent specialists and their migration to better-paid jobs
- o lack of predictability regarding the long-term development of major projects
- o inability to promote major investment projects
- o hiring freeze and mandatory restructuring

- Competition among private nuclear companies in SNN's strategic projects
- Financial difficulties related to the completion of the ATHENA facility
- Technological dependence and energy security risks

10 RATEN's Medium and Long-Term R&D Strategy

10.1 TOWS Matrix

Based on the findings of the SWOT analysis and by expanding this analysis to include internal and external factors, the following strategic options, appropriate for RATEN, were identified:

1. Leveraging RATEN's unique position and potential by participating in major nuclear energy projects in Romania and Europe (Strategy for leveraging strengths based on opportunities)
2. Leveraging RATEN's expertise and research outcomes by developing economic activities that secure additional funding (Strategy to capitalize on strengths to mitigate and reduce the impact of threats)
3. Building strong research teams in key areas (Strategy for overcoming weaknesses by capitalizing on opportunities)
4. Securing the necessary human resources and adequate funding to continue the R&D program and projects (Survival and adaptation strategy aimed at addressing weaknesses and mitigating threats)

10.2 Short-term Research Strategy (2026 – 2030)

A strategy to leverage RATEN's unique position and potential by participating in major nuclear energy projects in Romania and Europe

This is the core strategy, focused on leveraging strengths to capitalize on opportunities, implemented through the following actions:

- *Leveraging its position as the only research and development organization in Europe specializing in CANDU technology, and capitalizing on its unique expertise and infrastructure (TRIGA, LEPI, TAR)* to become a key strategic partner in national projects in the nuclear sector, ensuring:
    - o technical support and specialized engineering services for the refurbishment of Unit 1 at the Cernavodă Nuclear Power Plant with a view to extending its service life;

  - project consulting and monitoring for the construction of Units 3 and 4, including Owner's Engineering services;
  - R&D projects and owner engineering in the SMR sector – partnerships with NuScale;
  - planning and implementing radioactive waste management and disposal solutions;
  - development of the tritium removal facility (CTRF) and management of hydrogen isotopes (H, D, T) and their compounds;
  - testing, modelling, and advanced simulations using infrastructure for safety, radiation protection, and the optimization of nuclear processes;
  - transfer of know-how and technical support to operators and authorities in the nuclear sector.
- *Leveraging our experience and membership in European consortia, particularly the EAGLES consortium,* to initiate and coordinate major projects funded through programs such as EURATOM and IPCEI, focused on LFR SMR technology.

- *Positioning the institute as a leader in the implementation of the ALFRED project,* leveraging existing expertise and the support infrastructure currently under construction to attract funding and specialists.

- *Leveraging the experience and expertise developed in the field of radioactive waste management,* as well as participating in EURAD2 to position RATEN as an active organization involved in projects under the radioactive waste management program.

- *Leveraging the experience and expertise developed in the field of radiation protection and environmental protection* to strengthen RATEN's role as a Technical Safety Officer (TSO) and its involvement in radiological and environmental impact assessments for projects in the nuclear sector (NuScale, ALFRED, Cernavodă NPP).

- *Leveraging experience in operating hot cells* for national projects to produce radioisotopes for medical use.

Strategy for leveraging RATEN's expertise and research outcomes through the development of economic activities that secure additional funding

This strategy aims to leverage strengths to mitigate identified threats and can be implemented through the following actions:

- *Expanding the range of services and products* to commercialize the results of research and technological engineering by serving as a service provider for SN Nuclearelectrica.
- *Promoting RATEN's potential within the domestic and international nuclear industry* to attract future partners for economic activities.
- *Identifying and accessing alternative sources of funding,* such as partnerships with private companies, international projects, and service/consulting contracts, to diversify revenue and reduce dependence on budgetary funds.
- *Developing an integrated marketing and promotion strategy* that includes modernizing our online presence (updated website, LinkedIn), participating in relevant industry events, creating presentation materials, and strengthening relationships with institutional partners, with the aim of increasing visibility and attracting opportunities.

Strategy for building strong research teams in key fields

This strategy aims to capitalize on the favourable environment to turn weaknesses into competitive advantages through a set of concrete actions:

- *Implementing internal mentoring and training programs,* led by experienced professionals, to develop employees' skills and prepare future leaders.
- *Launching a program to attract young professionals,* including through partnerships with universities and the use of European funding, to address the staff shortage.
- *Promoting projects to refurbish and modernize RATEN's infrastructure,* with the aim of securing the necessary funding to support operational activities and strategic projects.
- *Establishing a communications department* or appointing a dedicated communications officer with clear responsibilities to increase visibility at the national level and effectively communicate RATEN's role and achievements to the public, industry, and authorities.
- *Active involvement in international professional engineering organizations* through membership, participation in working groups and relevant events, with the aim of increasing external visibility, exchanging best practices, and facilitating access to international collaborations and projects.

Strategy for securing human resources and adequate funding to continue the R&D program and research projects

This defensive strategy aims to reduce internal vulnerabilities and limit the impact of external threats through the following measures:

- *Implementing an internal talent retention policy* based on performance incentives, competitive compensation packages (within legal limits and the budgets available from projects and economic activities), as well as genuine opportunities for professional development, with a view to reducing the risk of qualified staff leaving.
- *Maintaining a constant and structured dialogue with decision-makers* and relevant institutions (e.g., the Ministry of Energy, the Ministry of Research) to underscore the strategic importance of RATEN and the need for adequate funding, highlighting its critical role in national nuclear projects.
- *Developing strategic partnerships* with other organizations and companies in order to participate in large-scale projects that can provide additional financial resources and ensure stability in the medium and long term.

10.3 Medium and Long-term Research Strategy

The medium- and long-term strategy is an extension of the core strategy and aims to harness RATEN's existing potential to transform it into a center for disruptive innovation.

Transforming RATEN into a center for disruptive innovation over the next decade is not merely an ambitious goal, but a necessity for keeping Romania among the countries developing advanced nuclear technologies and for keeping RATEN on the map of leading European nuclear research.

The transition from traditional technical support to disruptive innovation will be based on the following strategic pillars:

- *Completion of the ALFRED project and commercialization of EAGLES-300* – the ALFRED project represents the greatest asset for a major technological leap forward, as LFR technology contributes significantly to reducing long-term radiotoxicity and the volume of radioactive waste requiring disposal. RATEN will transition from the research phase to the operational demonstration phase, becoming a European hub for testing materials and components specific to lead-cooled fast reactors.

- *Digitization and "Digital Twins"* – the development of virtual replicas of reactors (Digital Twins) that utilize machine learning will enable predictions regarding material wear and the development of innovative predictive maintenance solutions, thereby enhancing safety and reducing operating costs.

11 Strategic Objectives, Directions and Measures

GENERAL STRATEGIC OBJECTIVES FOR RATEN

The objectives, strategic directions, and measures establish the operational framework through which RATEN will implement its development strategy for the period 2026–2035, transforming the institution into an integrated national nuclear infrastructure for the technological support of the CANDU and SMR programs, and for the development of Generation IV nuclear technologies through the ALFRED and EAGLES-300 projects.

The overall strategic objectives for the period 2026–2035 are:

- SO.1. Developing LFR technology
- SO.2. Ongoing technical support for the CANDU program, including the extension of operating life and the construction of new units
- SO.3. National technical support for iPWR SMRs
- SO.4. Modernizing RATEN’s strategic nuclear infrastructure while expanding and diversifying its technical expertise to provide advanced scientific and technological support for all categories of nuclear and radiological facilities within the National Nuclear Program
- SO.5. Developing human capital
- SO.6. Establishing a Center for Nuclear Energy Education (CEEN)
- SO.7. Strengthening cooperation at the national and international levels in the field of nuclear energy
- SO.8. Strengthening EU governance and compliance

SO1 – Developing LFR technology

Transforming RATEN into a center of excellence for Generation IV reactor technologies by simultaneously developing capabilities in experimental research, engineering, and design, while

integrating technical and operational analysis and evaluation, as well as monitoring the long-term behaviour and aging of materials and systems.

The ALFRED reactor has been designated as an experimental nuclear facility of national strategic interest, operated by RATEN, and represents the cornerstone of the company's technological and scientific development for the period 2026–2035. RATEN aims to advance knowledge in the field of LFR technology and support its contribution to the development of the EAGLES-300 commercial reactor by focusing its research activities on results directly applicable to EAGLES projects.

The strategic directions will focus on developing research and support activities related to:

- SD 1.1. LFR nuclear safety analysis and reactor physics
- SD 1.2. Technical and operational analyses and assessments, including monitoring performance trends over time and evaluating component degradation
- SD 1.3. Advanced materials and their compatibility with liquid lead
- SD 1.4. Testing, demonstration, and qualification of components, structures, and subassemblies under operating conditions, using the ALFRED support infrastructure
- SD 1.5. Verification and validation of the standards and codes applied in the ALFRED design using the supporting experimental infrastructure
- SD 1.6. Management of radioactive waste and spent nuclear fuel
- SD 1.7. Environmental impact assessment, pre-operational and operational monitoring
- SD 1.8. ALFRED pre-licensing and licensing
- SD 1.9. Instrumentation and control for liquid lead environments
- SD 1.10. Funding, business, and communication strategies for ALFRED/EAGLES

Strategic measures:

- SM 1.1. Multi-year planning and implementation of research projects related to the ALFRED/EAGLES-300 project
- SM 1.2. Protecting and capitalizing on intellectual property
- SM 1.3. Securing multi-year funding for ALFRED/EAGLES-300
- SM 1.4. Commissioning of the experimental support facilities for ALFRED/EAGLES-300.
- SM 1.5. Using the ALFRED infrastructure as the primary platform for validating LFR technology
- SM 1.6. Integration of the ALFRED infrastructure into European nuclear infrastructure networks
- SM 1.7. Promoting controlled open access to the ALFRED experimental infrastructure for the European scientific community
- SM 1.8. Development of public communication and social acceptance programs for advanced nuclear technologies
- SM 1.9. Involvement in the design, permitting, construction, and preparation for commissioning of the ALFED demonstrator
- SM 1.10. Developing project proposals to secure funding for research and demonstration activities related to LFR technology through appropriate European and national mechanisms (IPCEI, Innovation Fund, etc.).
- SM 1.11. RATEN's participation in and coordination of EURATOM projects dedicated to LFR.

The expected impact is RATEN's gradual transition toward disruptive innovation, with LFR technology representing a major technological leap in the nuclear field through the use of the fast neutron spectrum, liquid lead as a coolant, a closed fuel cycle, and passive safety systems.

Indicators:

- KPI 1.1. The degree of implementation and relevance of multi-year projects for ALFRED and LFR – assessed based on the applicability of the results to design decisions and technological optimization.
- KPI 1.2. The functionality and usefulness of experimental facilities and test platforms for real-time monitoring—as assessed by their ability to generate data relevant to evaluating component performance and degradation.
- KPI 1.3. The level of competence and cohesion of internal teams specializing in research, design, and analysis of aging processes—as assessed by the quality and efficiency of the technical results produced.
- KPI 1.4. The relevance and integration of test and simulation results into design processes and operational decisions—assessed by their impact on reactor design optimization and safety.
- KPI 1.5. The quality of the adaptation and implementation of Generation IV codes and standards—assessed based on compliance with long-term safety and sustainability requirements.
- KPI 1.6. The effectiveness of public communication and acceptance programs—as measured by the level of public awareness and support for advanced nuclear technologies within the community and among decision-makers.
- KPI 1.7. Level of participation and influence in European projects (EURATOM, IPCEI) – assessed based on RATEN's contribution to the projects' outcomes and strategic decisions.
- KPI 1.8. The relevance and protection of intellectual property—assessed through the use of research and design outcomes in practical applications and technological innovation.
- KPI 1.9. The quality of applications for research and technological design/demonstration funding—assessed based on the likelihood of approval and the strategic value of the proposed projects.
- KPI 1.10. The functionality and efficiency of the internal system for monitoring technical and operational performance, as well as research and design—assessed by its ability to track the long-term behaviour and degradation of materials and systems, and by the usefulness of the reports it generates for decision-making.

Targeted results:

- R.1.1. Value share of multi-year research projects dedicated to LFR in the Annual Research Program: at least 15%
- R.1.2. Number of experimental support facilities in operation: 2 by 2027, 4 by 2028, 6 by 2029
- R.1.3. Number of test/demonstration experiments in the ALFRED infrastructure: at least 2 per year, starting in 2027
- R.1.4. Number of external researchers who have used the ALFRED infrastructure: at least 2 per year, starting in 2027
- R.1.5. Annual growth rate of the number of RATEN researchers involved in the LFR program: at least 10%
- R.1.6. Number of funding applications for LFR: at least 1 per competition
- R.1.7. Number of active EURATOM projects dedicated to LFR: at least 2/year

SO2 – Ongoing technical support for the CANDU program, including the extension of operating life and the construction of new units

RATEN will serve as a permanent institutional provider of technical and scientific support for the operation and refurbishment of CANDU reactors by maintaining its capacity for technical, scientific, and engineering support and by continuously advancing knowledge in the field of CANDU technology. The aim is to increase performance, improve nuclear safety and security during operation, extend the service life of Cernavodă NPP, and focus research activities on results directly applicable to CANDU programs.

The strategic directions will focus on developing research and support activities related to:

SD 2.1. Nuclear safety analyses and CANDU reactor physics, including simulations and technical-operational assessments
SD 2.2. The design and engineering of new CANDU units, including solutions to optimize performance, safety, and sustainability
SD 2.3. Advanced nuclear materials and fuels, including ATF
SD 2.4. Fuel channel, analysis of periodic inspections, specialized analyses, and technical and operational assessments for refurbishment and for the components and systems of new units
SD 2.5. Circuit Chemistry - research and design for the optimization of chemical parameters and functional safety
SD 2.6. Management of CANDU specific radioactive waste
SD 2.7. Radiation protection, environmental impact assessment, and emergency response plans
SD 2.8. Management of the aging of CANDU systems, structures, components, and equipment to extend their service life
SD 2.9. Development of instrumentation and control equipment for continuous operation and monitoring
SD 2.10. Digitalization, cybersecurity, and the use of digital twins for predictive assessments and decision support in design and operations
SD 2.11. Technical and operational assessments for extending the operating life and constructing new units
SD 2.12. Support through products and services for Cernavodă NPP and FCN Pitești projects
SD 2.13. Management of heavy water and tritium in CANDU units
SD 2.14. Localization of facilities and equipment projects for Cernavodă NPP
SD 2.15. Developing in-house engineering and design capabilities through multidisciplinary teams, prototyping and testing laboratories, and partnerships with national and international institutions
SD 2.16. Active participation in international projects and consortia to generate know-how applicable to new CANDU projects

Strategic measures:

SM 2.1. Signing of a Permanent Framework Service Agreement between RATEN and SNN
SM 2.2. Multi-year planning and implementation of applied research projects approved by SNN
SM 2.3. Establishing the framework for RATEN's involvement in the U1 refurbishment project
SM 2.4. Establishing the framework for RATEN’s involvement in the project to produce medical radioisotopes at the CANDU plant
SM 2.5. Establishing the framework for RATEN's involvement in the research activities of CONEXUS Nuclear Inc.
SM 2.6. Protecting and capitalizing on intellectual property
SM 2.7. Expanding participation in EURATOM projects focused on operating nuclear power plants.

SM 2.8. Development of research services/products tailored to the specific needs of the CANDU nuclear industry

The expected impact is increased involvement by RATEN in the refurbishment projects and the development of Units 3 and 4, an increase in technical and scientific support and in the number of services provided to CNE Cernavodă, as well as the expansion of the portfolio of services and contracts for the CANDU units.

Indicators:

KPI 2.1. The degree of integration of the RATEN technological support into the U1 refurbishment project – assessed by the extent to which it contributes to decisions regarding the design and implementation of technical solutions

KPI 2.2. The quality of technical support provided for Units 3 and 4 – assessed based on the effectiveness of engineering recommendations and the accuracy of safety and reactor physics analyses

KPI 2.3. The relevance and applicability of the applied research results for Cernavodă NPP – as measured by the practical implementation of the developed solutions and their impact on reactor safety and performance

KPI 2.4. The quality of RATEN services provided to Cernavodă NPP/SNN – as assessed by beneficiary satisfaction, the effectiveness of technical and scientific solutions, and the contribution to enhancing the safety, performance, and service life of CANDU units

KPI 2.5. Level of innovation and technology transfer – assessed through the implementation of new methods, technologies, and solutions designed by RATEN in day-to-day operations and refurbishment projects

KPI 2.6. Ability to respond to special situations – assessed based on the speed and efficiency of RATEN's response to technical issues, emergencies, or special requests from Cernavodă NPP/SNN

KPI 2.7. The quality of engineering and technological projects and activities for the new CANDU units – assessed by the applicability of the results to construction and operational decisions.

KPI 2.8. The relevance and effectiveness of tests and simulations – assessed by their contribution to the validation of components and subassemblies for the new units

KPI 2.9. The degree of compliance and applicability of design codes and standards – assessed by their ability to support technical decisions and reactor safety

KPI 2.10. The level of competence and cohesion of internal engineering and design teams – as assessed by the quality of technical solutions and the integrity of design processes.

KPI 2.11. The quality of fuel and waste management solutions – as measured by long-term operational safety and sustainability

KPI 2.12. The degree of integration of digitalization and digital twins – assessed by their effectiveness in supporting design and operational decisions.

KPI 2.13. The level of knowledge transfer and best practices from international projects – as assessed by their practical application in RATEN projects and the ability to adapt global standards to national needs

KPI 2.14. The impact of communication and marketing programs – as evidenced by the recognition of RATEN's expertise in the development of new CANDU units, both nationally and internationally

- KPI 2.15. The quality of technical and operational assessments and recommendations for extending service life
- KPI 2.16. The degree of effectiveness and relevance of the modernization measures implemented
- KPI 2.17. The level of competence and expertise of the in-house engineering and design teams
- KPI 2.18. The impact of monitoring systems on predictive operations and preventive maintenance
- KPI 2.19. The relevance and applicability of research and test results in operational decision-making

Targeted results:

- R.2.1. Number of contracts for the refurbishment of U1 project: *at least 2*
- R.2.2. Number of contracts for the U3&4 project: *at least 1*
- R.2.3. Number of applied research projects for Cernavodă NPP (within the Annual Research Program): *at least 5/year*
- R.2.4. Number of active contracts with Cernavodă NPP/SNN: *at least 3/year, amounting to at least €100.000/year*

SO3 – National technical support for iPWR SMRs

RATEN aims to become a national technical support organization for iPWR SMR operators by focusing its research activities on practical results and technology transfer.

The strategic directions will focus on developing competencies and carrying out support activities related to:

- SD 3.1. Independent nuclear safety assessments
- SD 3.2. Radiation protection, environmental impact, pre-operational and operational monitoring
- SD 3.3. The nuclear fuel cycle for iPWR SMRs
- SD 3.4. Circuit chemistry
- SD 3.5. Management of iPWR SMR specific radioactive waste
- SD 3.6. Non-electrical applications of iPWR SMRs
- SD 3.7. Localization of plant design projects for NPP
- SD 3.8. Technical and operational analyses and assessments for SMRs, including monitoring performance trends over time and evaluating component degradation, to optimize reactor safety and durability
- SD 3.9. Development of the national energy mix

Strategic measures:

- SM 3.1. Establishing a framework for collaboration on the development of research and technology transfer activities with the Operator
- SM 3.2. Multi-year planning and implementation of applied research projects
- SM 3.3. Conclusion of a RATEN-Operator Framework Service Agreement
- SM 3.4. Participation in the review of authorization documentation
- SM 3.5. Protection and commercialization of intellectual property
- SM 3.6. Participation in EURATOM projects dedicated to SMRs
- SM 3.7. Development of research services/products tailored to the specific needs of iPWR SMR technology

The expected outcome is RATEN's involvement in iPWR SMR projects through research contracts, commercial contracts, and the provision of technical support to national authorities.

Indicators:

- KPI 3.1. The quality and relevance of independent safety assessments for SMRs, as measured by the extent to which recommendations are incorporated into design and operational decisions
- KPI 3.2. The effectiveness of the technical and operational monitoring and evaluation system, as measured by its ability to identify deterioration trends and support operational decision.
- KPI 3.3. The degree to which radiation protection systems and environmental measures comply with national and international standards
- KPI 3.4. The relevance and applicability of the solutions developed for the SMR fuel cycle, as demonstrated by their adoption in pilot projects and technical demonstrations
- KPI 3.5. The performance and reliability of circuit chemistry, assessed by the stability and safety of critical operating parameters
- KPI 3.6. The effectiveness of waste management solutions, assessed through storage safety and long-term monitoring of radioactive properties
- KPI 3.7. The impact of non-electrical applications, assessed based on the relevance and implementation of solutions in industrial and strategic processes
- KPI 3.8. The degree of localization of SMR projects, as measured by the proportion of components and solutions developed in-house and used in the projects
- KPI 3.9. Level of integration and contribution to SMR international projects, assessed based on active participation and influence in technical and strategic decisions
- KPI 3.10. The level of development of internal research and design capabilities, assessed based on team expertise, prototype quality, and the relevance of technical studies
- KPI 3.11. Efficiency and quality of the licensing process, assessed based on the completeness and accuracy of the technical documentation, compliance with regulatory requirements, and the degree of acceptance by the authorities

Targeted results:

- R 3.1. Number of service contracts – *at least 1*
- R 3.2. Number of applied research projects dedicated to iPWR SMR in the Annual Research Program – *at least 2/year*

SO4 – Modernization of RATEN's strategic nuclear infrastructure

RATEN will pursue the modernization of nuclear research infrastructure critical to the nuclear sector (TRIGA reactor, LEPI, STDR, TAR) with a view to improving performance and operational safety, and is undertaking the refurbishment of the TRIGA reactor as a strategic alternative to decommissioning. In this way, TRIGA is maintained as a national research infrastructure, a practical training platform, and a complementary infrastructure to ALFRED. Furthermore, RATEN will work to adapt the capacity of the RATEN platform's utility system to the current requirements imposed by the expansion of the research infrastructure and applicable regulations. Additionally, RATEN will seek to participate in the implementation and development of national projects within the National Nuclear Program.

The strategic directions will focus on promoting and implementing projects related to:

SD 4.1. Refurbishment of the TRIGA reactor and management of the aging of its components, with the aim of extending its service life by at least 20 years

SD 4.2. Development of irradiation devices and facilities that utilize neutron beams

SD 4.3. Approval, manufacturing and testing for LEU ICN fuel

SD 4.4. Refurbishment of the STDR to ensure the technical capacity for pre-storage activities related to waste generated by the refurbishment and/or decommissioning of TRIGA

SD 4.5. Management of radioactive waste generated from the operation and refurbishment of the RATEN nuclear infrastructure

SD 4.6. Technical support for other facilities for the interim and final disposal of radioactive waste

SD 4.7. Refurbishment of LEPI to ensure the conditions necessary for carrying out support activities for the Cernavodă NPP

SD 4.8. Construction of an interim storage facility for radioactive waste resulting from the decommissioning/refurbishment of the TRIGA reactor and spent TRIGA fuel

SD 4.9. Refurbishing the Out-of-Pile Testing benches (TAR)

SD 4.10. Upgrading the infrastructure for the production, distribution, and supply of utilities (electricity, heat, drinking water, industrial water, and their treatment and discharge) on the ICN platform, with an expansion of its capacity to meet the needs for the implementation of ICN and FCN development projects

SD 4.11. Technical support for other facilities included in the National Nuclear Program

Strategic measures:

SM 4.1. Preparation of the feasibility study for the refurbishment of TRIGA

SM 4.2. Preparation of the feasibility study for the refurbishment of STDR

SM 4.3. Preparation of the feasibility study for the refurbishment of LEPI

SM 4.4. Preparation of a feasibility study for the construction, at the ICN Piteşti site, of a storage facility for radioactive waste generated by the decommissioning/refurbishment of the TRIGA reactor and spent fuel generated by the operation of the TRIGA reactor

SM 4.5. Preparation of feasibility studies for the rehabilitation of the infrastructure for the production, distribution, and supply of utilities at the Mioveni site

SM 4.6. Promoting projects to expand and modernize RATEN's research infrastructure, with a view to securing funding

SM 4.7. Promoting an investment project to rehabilitate the utility system of the RATEN platform

SM 4.8. Reintegrating TRIGA into research and training programs

SM 4.9. Conducting studies to maintain, modernize, and enhance institutional capacity to provide the scientific, technical, design, and engineering support necessary for conducting nuclear/radiological safety assessments and analyses, including the development of methodologies, analytical tools, computational models, design solutions, and engineering expertise to support technical decisions regarding facilities within the National Nuclear Program

The expected impact will be an improvement in the performance and operational safety of critical research and development facilities, adapted to current requirements in the nuclear sector.

Indicators:

KPI 4.1 – The quality and relevance of feasibility studies for refurbishment—assessed by the extent to which the recommendations in the studies are applicable to modernization and refurbishment projects, contributing to the optimization of infrastructure costs, safety, and performance

KPI 4.2 – The impact of the ICERR program on human capital development—assessed in terms of the level of engagement, the skills acquired by students and external researchers, and their effective contribution to modernization and research projects

KPI 4.3 – The relevance and strategic importance of the submitted funding applications—assessed based on the projects' potential value, their contribution to the modernization of the platform, and their alignment with RATEN's strategic objectives

KPI 4.4 – The quality and applicability of the developed projects—assessed based on their ability to meet the technical, safety, and operational needs of the RATEN infrastructure

KPI 4.5 – The effectiveness of the process designed to promote projects—as measured by the level of acceptance and support for the projects among funders and authorities, as well as by the anticipated impact on the modernization and expansion of the utility system

KPI 4.6 The level of efficiency, reliability, and operational continuity of the modernized systems

KPI 4.7 The level of integration of digital solutions and smart instrumentation in utility monitoring and control

KPI 4.8 The ability of the upgraded systems to support research, engineering, and nuclear operations without interruption

KPI 4.9. Strengthening RATEN's expertise in preparing technical documentation for authorization

Targeted results:

- R.4.1. Number of feasibility studies for refurbishment: *3*
- R.4.2. Number of funding applications: *3*
- R.4.3. Number of investment projects for the modernization and expansion of the utility system, developed: *3*
- R.4.4. Number of investment projects for the modernization and expansion of the utility system, promoted: *3*
- R.4.5. Number of external students/researchers within the ICERR frameworks: *at least 2/year (after refurbishment)*

SO5 – Developing human capital

Human resources represent a key asset of RATEN's capabilities and are essential to the fulfilment of its mission. RATEN recognizes the equal strategic importance of careers in research and development and technological engineering, as well as careers in nuclear operations. To this end, two professional career development paths will be established: the research, development, and technological engineering path, and the operations and execution path. Attracting new specialists is a strategic priority for RATEN, and in order to achieve this, internship and postdoctoral programs will be developed. Furthermore, efforts will be made to implement a human resources policy based on recognizing professional performance and encouraging creativity and engagement in RATEN's activities.

The strategic directions will focus on:

SD 5.1. Implementing a human resources policy focused on the two career paths
SD 5.2. Continuing professional development and human resource development for various fields of activity within RATEN
SD 5.3. Building high-performing teams and leadership
SD 5.4. Attracting, developing, and retaining specialists to offset the loss of expertise due to retirement and migration

Strategic measures:

SM 5.1. Establishing the administrative framework for implementing a new human resources policy
SM 5.2. Establishing an incentive mechanism for specialists
SM 5.3. Updating the human resources policy
SM 5.4. Defining a set of measures to encourage the formation of high-performing teams
SM 5.5. Developing a sustainable internal mentoring and professional development program

The expected impact is the creation of a competitive and motivating professional environment that ensures the sustainability of the national nuclear expertise necessary for the success of the ALFRED, CANDU, and SMR projects, as well as the maintenance of a critical balance between RATEN's capacity for disruptive innovation and the safe operation of its research infrastructure, thereby reducing the risk of losing vital knowledge.

Indicators:

KPI5.1 Human resources policy updated and implemented in accordance with the European Charter for Researchers
KPI5.2 The level of expertise and performance of internal teams in research, engineering, and operations.
KPI5.3 The degree of retention and attraction of specialists in RATEN's strategic fields.
KPI5.4 The degree to which teams and leadership are aligned to support strategic objectives.

Targeted results:

R.5.1. Updated human resources strategy: *1, by 2026*
R.5.2. Methodologies for professional career development along the two paths: *2 by 2027*
R.5.3. Number of participants in the mentoring program: *5 people/year, starting in 2028*

SO6 – Establishing a Center for Nuclear Energy Education (CEEN)

Aimed equally at training our own staff, master's and doctoral students, young researchers from Romania and abroad, as well as operational personnel in the nuclear sector, the Center will develop and offer a program of training, professional development, and certification that will focus primarily on priority areas.

The strategic directions addressed are as follows:

SD 6.1. Establishing a framework for training, professional development, and certification tailored to the needs of the nuclear sector
SD 6.2. Integration of the Center into the EAGLES training and professional development program
SD 6.3. Integrating the Center into national-level professional training, development, and certification activities

Strategic measures:

SM 6.1. Establishing the Center's bylaws, curriculum, and program for training, professional development, and certification
SM 6.2. Training and certifying a sustainable pool of trainers
SM 6.3. Accreditation of the Center by the National Qualifications Authority
SM 6.4. Implementation of a professional training program tailored to internal, national, and international requirements
SM 6.5. Heavily promoting the Center at national level

Impact: continuous improvement of knowledge and skills for RATEN staff, attracting talented young people, and new revenue opportunities from educational and training activities.

Indicators:

KPI 6.1. The relevance and timeliness of educational programs in relation to the needs of the nuclear sector
KPI 6.2. The quality of lecturers in relation to national and international standards
KPI 6.3. The extent to which CNEEN is integrated with the EAGLES projects and other international training programs
KPI 6.4. Impact on the skills and abilities of RATEN staff
KPI 6.5. The appeal of the Center to students, young researchers, and international professionals
KPI 6.6. The effectiveness of promotional programs and the visibility of CNEEN at the national and international levels

Targeted results:

R.6.1. Number of course modules: at least 2/year (starting in 2028)
R.6.2. Number of certified instructors: at least 5/year (starting in 2028)
R.6.3. Number of students: at least 25/year (starting in 2028)

SO7 – Strengthening cooperation at the national and international levels in the field of nuclear energy

RATEN aims to become a nationally and internationally recognized organization in the field of nuclear energy through sustained involvement in projects and strategic partnerships.

The strategic directions addressed are as follows:

SD 7.1. European integration through the EAGLES consortium
SD 7.2. Developing strategic partnerships to support national objectives in the nuclear field
SD 7.3. Strengthening RATEN's position as a technical support organization for Romania's nuclear sector
SD 7.4. Strengthening collaboration between education, research, and industry in the field of nuclear technologies (Generation IV, advanced fuels, digitalization, radioisotopes) through national and international projects initiated and/or coordinated by RATEN

Strategic measures:

SM 7.1. Active representation of Romania in international organizations

SM 7.2. Actively promoting RATEN's potential at the national and international levels through communication programs and active participation in relevant events
SM 7.3. Promoting legislation to recognize RATEN as a technical support organization for Romania's nuclear sector and establishing mechanisms to fund its technical support activities
SM 7.4. Positioning RATEN as the national contact point for LFR technologies
SM 7.5. Supporting the exchange of information and researcher mobility by exploring opportunities offered by EURATOM, IAEA, NEA/OECD, etc., as well as existing partnerships
SM 7.6. Developing partnerships with the nuclear industry for technology transfer and the commercialization of RATEN research results.

The expected impact of this objective includes strengthening RATEN's position and contribution within EAGLES and establishing its presence at the European level in the field of SMR LFR, integrating RATEN's research infrastructure into European and international networks, maintaining ICERR status, increasing participation in national and international projects and contracts, continuously raising competency standards and creating strong research teams in key areas.

Indicators:

KPI 7.1. The extent to which RATEN is involved in EAGLES projects and working groups
KPI 7.2. The relevance and applicability of RATEN's contributions to European standards and methodologies
KPI 7.3. The degree of interoperability between RATEN infrastructure and equipment and that of the consortium
KPI 7.4. RATEN's ability to effectively coordinate or participate in European multi-partner projects
KPI 7.5. RATEN's visibility and recognition within the European nuclear community
KPI 7.6. The impact of EAGLES collaborations on the internal development of research and engineering skills
KPI 7.7. The level of recognition of RATEN's expertise at the national and international levels
KPI 7.8. The impact of strategic partnerships on the development of advanced nuclear technologies
KPI 7.9. The extent to which RATEN infrastructure and results are integrated into international projects
KPI 7.10. The effectiveness of knowledge exchange and researcher mobility
KPI 7.11. RATEN's contribution to standards, methodologies, and best practices in the nuclear field at the European and global levels

Targeted results:

R.7.1. Approved legislation proposals: *at least 1*
R.7.2. Number of collaboration agreements: *at least 3*
R.7.3. Number of IAEA research contracts: *at least 3 active/year*
R.7.4. Number of participations in NEA/OECD expert groups: *at least 2/year*
R.7.5. Number of projects submitted through education–research–industry partnerships: *at least 1/year*

SO8 – Strengthening EU governance and compliance

RATEN will implement a modern governance and control system to ensure transparency, accountability, and compliance with national and European standards, as well as a clear separation of economic and non-economic activities. At the same time, the institution will promote its research findings and expertise at the national and international levels to strengthen Romania's position in the field of nuclear energy.

Strategic directions:

SD 8.1. Implementation of an integrated governance and management system (including ERP and digital control tools)

SD 8.2. Audit and periodic evaluation: financial (annual), technical and scientific (every 3 years)

SD 8.3. Promoting RATEN's results, its contribution to the security and progress of the national program, and Romania's position in the global nuclear energy arena at the political, governmental, and public levels

SD 8.4. Developing an internal professional communication system to strengthen public perception and the institution's visibility

SD 8.5. Ensuring a clear and transparent separation between economic and non-economic activities, to ensure legal compliance and operational efficiency

SD 8.6. Development of limited and sustainable economic activities, ensuring that they account for no more than 35% of total revenue per RATEN.

Strategic measures:

SM 8.1. Implementation of the ERP system for the integrated management of RATEN's resources and activities

SM 8.2. Annual financial audit

SM 8.3. Technical and scientific audit every 3 years

SM 8.4. Establishing and implementing accounting and operational procedures to ensure clear management of economic and non-economic activities, including control mechanisms and regular reporting

SM 8.5. Development of nuclear testing services and expertise

SM 8.6. Developing and implementing a professional communication plan focused on national and international target groups

SM 8.7. Establishing indicators and procedures for monitoring the share of economic revenue and governance performance

Indicators:

KPI 8.1. The degree of implementation of ERP and integrated governance procedures

KPI 8.2. The quality and effectiveness of financial and technical-scientific audits

KPI 8.3. The level of national and international recognition of RATEN's expertise

KPI 8.4. Public and professional perceptions of the institution's transparency and professionalism

KPI 8.5. The extent to which economic and non-economic activities are kept separate

KPI 8.6. The impact of communication on the visibility and promotion of RATEN at the national and international levels

12 Phased Implementation Plan

The implementation of the RATEN Strategy 2026–2035 is structured in three successive phases, aligned with the development of LFR, participation in the EAGLES consortium, assuming the role of technology support for CANDU and iPWR SMRs, and the modernization of the RATEN infrastructure.

Phase I - Institutional strengthening and technological training (2026–2028)	
Phase objectives/ Actions	**Strategic measures**
Leveraging RATEN's unique position and potential by participating in major nuclear energy projects in Romania and Europe	
Leveraging its position as the only nuclear research institution in Europe specializing in CANDU technology and its unique infrastructure (TRIGA Reactor, LEPI, TAR)	SM 2.1, SM 2.3, SM 2.4, SM 2.6, SM 3.1, SM 3.3, SM 3.4, SM 3.5, SM 7.1, SM 7.3
Leveraging the experience and expertise gained in the field of nuclear energy	SM 1.1, SM 2.2, SM 2.5, SM 2.7, SM 3.2, SM 3.4, SM 3.6
Leveraging experience in operating research infrastructure	SM 1.2, SM 1.4, SM 2.2, SM 2.3, SM 2.4, SM 2.5
Leveraging experience gained from participation in European consortia, particularly the EAGLES consortium	SM 1.8, SM 1.11, SM 2.7, SM 3.6
Active participation in EAGLES projects	SM 1.4, SM 1.1, SM 1.2, SM 1.3, SM 1.7, SM 1.8, SM 1.9, SM 1.10
Leveraging RATEN's expertise and research outcomes by developing economic activities that secure additional funding	
Expanding the range of services and products to capitalize on research results	SM 2.8, SM 3.7
RATEN's involvement in designing ALFRED	SM 1.9
Preparation of feasibility studies for the expansion and modernization of critical infrastructure	SM 4.1, SM 4.2, SM 4.3, SM 4.4, SM 4.5
Promoting, for the purpose of securing funding, projects to expand and modernize the RATEN infrastructure	SM 4.6, SM 4.7
Refurbishment of TAR	SM 4.6
Establishing an active dialogue with policymakers and promoting RATEN's potential within the nuclear industry both domestically and internationally	SM 7.1, SM 7.2, SM 7.3, SM 7.4, SM 7.5
Building strong research teams in key areas and securing the human resources and adequate funding needed to continue RATEN's R&D&I program	
Adoption of a new human resources strategy and definition of career development methodologies	SM 5.1, SM 5.2, SM 5.3
Launching a program to attract young researchers and a policy to retain talent	SM 5.2, SM 5.4, SM 7.5
Organizing mentoring and internal training programs	SM 5.5
Developing strategic partnerships	SM 7.1, SM 7.2, SM 7.4, SM 7.6
Establishing a Center for Nuclear Energy Education	SM 6.1, SM 6.2, SM 6.3, SM 6.4, SM 6.5

Phase II - Technological development and operational integration (2029–2032)	
Phase objectives/ Actions	**Strategic measures**
Strengthening RATEN's position as a supporting institution for Romania's nuclear energy program	
Providing effective technical support for CANDU and SMR	SM 2.2, SM 3.2, SM 3.4

Obtaining CNCAN authorization for the siting of ALFRED	
Completion of the design and pre-licensing of ALFRED	SM 1.5, SM 1.9, SM 1.10
Obtaining the site permit for ALFRED	SM 1.9
Strengthening RATEN's participation in the EAGLES consortium	SM 1.10, SM 1.11
Completion of the expansion and modernization of the RATEN infrastructure	
Obtaining a construction permit for the storage facility for waste and spent fuel generated by the operation of TRIGA	SM 4.5
Refurbishment of critical facilities	SM 4.5
Modernization and expansion of the utility system	SM 4.7

Phase III – Strategic maturity and experimental operations (2033–2036)	
Phase objectives/ Actions	**Strategic measures**
RATEN's transition into a center for disruptive innovation, with the aim of keeping Romania among the countries developing advanced nuclear technologies and positioning RATEN on the map of leading European nuclear research	
Obtaining a building permit for ALFRED	SM 1.8, SM 1.9
Promoting RATEN as a national center of excellence for nuclear safety and technology validation	SM 4.8, SM 1.5, SM 1.6, SM 7.1, SM 7.2, SM 7.4, SM 7.6

13 Performance Indicators and the Monitoring Mechanism

The implementation of the strategy will be monitored using performance indicators for:

- IP.1. ALFRED: completion of design, authorization, and commissioning by 2037
- IP.2. EAGLES/EAGLES-300: RATEN involvement in technology packages and secured European funding
- IP.3. CANDU: annual technology support projects
- IP.4. SMR: involvement in technology authorization and validation
- IP.5. TRIGA: completion of refurbishment by 2034
- IP.6. Human resources: increasing the number of certified experts and staff retention

14 Budgetary Implications and Sources of Funding

Funding sources include the state budget through the Ministry of Energy, European funds, and revenue generated from economic activities consistent with RATEN's status.

Funding for the Strategy will be provided through separate allocations of resources under the following lines:

1. ALFRED/EAGLES Program;
2. CANDU and iPWR SMR Support Program;
3. Infrastructure Modernization Program;
4. Professional Training Program;
5. National and International Collaboration Program.

15 Alignment with the Ministry of Energy's Policy

The objectives of the RATEN Strategy are aligned with the objectives of Romania's nuclear policy as set forth in the current national strategies.

16 Final Provisions

The strategy takes effect following approval by the RATEN Administrative Board and endorsement by the Ministry of Energy. The document is binding on all RATEN units and serves as the basis for investment programs, multi-year budgeting, and human resources policies.

RATEN is recognized in this strategy as a critical nuclear infrastructure of the Romanian state, responsible for providing technological support for the CANDU and iPWR SMR programs and for developing advanced nuclear technologies through ALFRED and EAGLES-300, as well as for maintaining the national research capacity in the field of nuclear energy.