ENVIRONMENTAL REPORT

NATIONAL STRATEGY FOR THE DEVELOPMENT OF THE NUCLEAR SECTOR IN ROMANIA FOR THE PERIOD 2026-2030, WITH A PERSPECTIVE TO 2050 AND THE NATIONAL NUCLEAR PROGRAMME

Beneficiary:

AGENȚIA NUCLEARĂ ȘI PENTRU DEȘEURI RADIOACTIVE

Prepared by:

SOCIETATEA DE CERCETARE A BIODIVER I
INGINERIA MEDIULUI AON SR

2026

- VOLUME I -

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2026

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LIST OF ABBREVIATIONS AND ACRONYMS

IAEA	International Atomic Energy Agency
ANDR	AGENȚIA NUCLEARĂ ȘI PENTRU DEȘEURI RADIOACTIVE
ALFRED	Advanced Lead Fast Reactor European Demonstrator
ANC	National Authority for Research
ANDR	AGENȚIA NUCLEARĂ ȘI PENTRU DEȘEURI RADIOACTIVE
ANPIC	Protected natural area of community interest
AR	Assessment Report
ATF	Accident-Tolerant Fuel
CANDU	CANada Deuterium Uranium
RDI	Research, Development and Innovation
R&D	Research and Development
CDMN	Danube-Black Sea Canal
CNCAN	National Commission for Nuclear Activities Control
NPP	Cernavodă Nuclear Power Plant
CTRF	Cernavodă Tritium Removal Facility
C-14	Carbon-14 radioactive isotope
CO_2	Carbon dioxide
COP26	26th Conference of the Parties to the UNFCCC (United Nations Framework Convention on Climate Change)
VOC	Volatile Organic Compounds
D_2O	Heavy water
DFDSMA	Final Repository for Short-Lived Low- and Intermediate-Level Radioactive Waste
DGA	Deep Geological Repository
DICA	Interim Spent Fuel Storage Facility
DIDSR	Interim Solid Radioactive Waste Storage Facility
DNDR	National Radioactive Waste Repository
DUPIC	Direct Use of Spent PWR Fuel in CANDU
EA	Appropriate Assessment
EDF	Électricité de France
ELI-NP	Extreme Light Infrastructure - Nuclear Physics
EURATOM	European Atomic Energy Community
FCN	Nuclear Fuel Plant
FEED	Front-End Engineering Design
FPCU	Uranium Concentrate Processing Plant
GHG	Greenhouse gases
GWP	Global Warming Potential
HVAC	Heating, Ventilation and Air Conditioning
HLW	High-Level Waste
INCDDD	National Institute for Research and Development of the Danube Delta
I&C	Instrumentation and Control
IFIN-HH	Horia Hulubei National Institute for Research and Development in Physics and Nuclear Engineering
INEGES	National Greenhouse Gas Emissions Inventory
LEPI	Post-Irradiation Examination Laboratory
LILW-SL	Short-Lived Low- and Intermediate-Level Waste
LILW-LL	Long-Lived Low- and Intermediate-Level Waste
LNRR	National Reference Laboratory for Radioactivity
LULUCF	Land Use, Land-Use Change and Forestry
MACSTOR	Modular Air-Cooled Storage

MMAP	Ministry of Environment, Waters and Forests
NOx	Nitrogen oxides
NRC	U.S. Nuclear Regulatory Commission
SDG	Sustainable Development Goals
OECD-NEA	OECD Nuclear Energy Agency
GEO	Government Emergency Ordinance
PIF	Commissioning
PM	Particulate matter
PNN	National Nuclear Programme
PNRR	National Recovery and Resilience Plan
PWR	Pressurised Water Reactor
RATEN ICN	Autonomous Administration for Nuclear Energy Technologies - Institute for Nuclear Research
PNRUNR	National Nuclear or Radiological Emergency Response Plan
RIF	Radioactive Ion Facility
RIM	Environmental Impact Assessment Report
RCP	Representative Concentration Pathways
RNSRM	National Environmental Radioactivity Monitoring Network
SCI	Site of Community Importance
SEA	Strategic Environmental Assessment
SEN	National Power System
SER	Romania's Energy Strategy
SMR	Small Modular Reactor
SPA	Special Protection Area
SNASC	National Climate Change Adaptation Strategy
SNN	Nuclearelectrica S.A.
SNDDN	National Strategy for the Development of the Nuclear Sector
SNMRI	National Flood Risk Management Strategy
SNPIC	National Strategy on Critical Infrastructure
SSP	Shared Socioeconomic Pathways - climate scenarios
SSRM	Environmental Radioactivity Monitoring Stations
STRD	Radioactive Waste Treatment Plant
TRIGA	Training, Research, Isotopes, General Atomics - research reactor
EU	European Union
VOC	Volatile Organic Compounds
WEI	Water Exploitation Index
Units of measurement	
Bq	Becquerel
dB	Decibel
Sv	Sievert

1. GENERAL INFORMATION

1.1. DOCUMENT IDENTIFICATION DETAILS

Name: NATIONAL STRATEGY FOR THE DEVELOPMENT OF THE NUCLEAR SECTOR IN ROMANIA FOR THE PERIOD 2026-2030, WITH A PERSPECTIVE TO 2050, AND THE NATIONAL NUCLEAR PROGRAMME

Beneficiary: AGENȚIA NUCLEARĂ ȘI PENTRU DEȘEURI RADIOACTIVE

1.2. CONSULTANT – LEGAL ENTITY

SOCIETATEA DE CERCETARE A BIODIVERSITĂȚII ȘI INGINERIA MEDIULUI AON SRL – a legal entity certified by the Romanian Association for the Environment to prepare the following types of environmental studies: RIM-1, RIM-2, RIM-3, RIM-4, RIM-7, RIM-11a, RIM-11b, RIM-11c, RIM-12, RIM-13b, RA-3, RA-6, RA-7, RA-11a, RA-11b, RM-3, RM-4, RM-11a, RM-11c, RM-12, RM-13b, RS-11b, BM-2, BM-3, BM-4, BM-7, BM-11b, BM-13b, EA, EGZA, EGSC, MB
Headquarters: Constanta, 131 I.C. Brătianu Blvd., Tax Code RO13758156
Unique Identification Code: RO13758156

Preparation team:

No.	Name Legal entity / individual	Certified to prepare the following types of environmental protection studies:
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1.3. INFORMATION SOURCES AND RESPONSIBILITIES OF THE PARTIES

THIS STUDY WAS PREPARED ON THE BASIS OF THE DOCUMENTS, TECHNICAL DATA, DOCUMENTATION AND INFORMATION PROVIDED BY THE BENEFICIARY, AS WELL AS DIRECT ON-SITE OBSERVATIONS BY THE CONSULTANT'S EXPERTS. RESPONSIBILITY FOR THE ACCURACY OF THE DOCUMENTS, TECHNICAL DATA, DOCUMENTATION AND INFORMATION PROVIDED TO THE CONSULTANT RESTS WITH THE BENEFICIARY.

THE SELECTION AND INTEGRATION INTO THE ENVIRONMENTAL REPORT OF THE INFORMATION PROVIDED BY THE BENEFICIARY, AS WELL AS THE ASSESSMENT METHODOLOGIES, ARE THE RESPONSIBILITY OF THE CONSULTANT.

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CERTIFICAT DE ATESTARE

Seria RGX nr. 365/11.09.2025

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Se atestă **SOCIETATEA DE CERCETARE A BIODIVERSITATII SI INGINERIA MEDIULUI AON SRL** cu sediul în Constanța, bd. I. C. Brătianu, nr. 131, jud. Constanța, CUI RO 13758156, ca **expert atestat - nivel principal** pentru elaborarea următoarelor studii de mediu în domeniile de atestare acordate de Comisia de atestare conform Procesului verbal nr. 75 din data de 11.09.2025: **RIM-1, RIM-2, RIM-3, RIM-4, RIM-7, RIM-11a, RIM-11b, RIM-11c, RIM-12, RIM-13b; RA-3, RA-6, RA-7, RA-11a, RA-11b; RM-3, RM-4, RM-11a, RM-11c, RM-12, RM-13b; RS-11b; BM-2, BM-3, BM-4, BM-7, BM-11b, BM-13b; EA; EGZA; EGSC; MB** ----------

PREȘEDINTE

prof. univ. dr. ing. Ioan BICA

TIPUL DE STUDII: (RIM) Raport privind impactul asupra mediului; **(RA)** Raport de amplasament; **(RM)** Raport de mediu; **(RS)** Raport de securitate; **(BM)** Bilanț de mediu; **(EA)** Studiu de evaluare adecvată; **(EGCA)** Evaluarea și gestionarea calității aerului; **(EGZA)** Evaluarea și gestionarea zgomotului ambiant; **(EGSC)** Evaluarea și gestionarea schimbărilor climatice; **(MB)** Monitorizarea biodiversității.

DOMENII DE ATESTARE: (1) Agricultură, silvicultură, piscicultură; **(2)** Industria extractivă; **(3)** Industria energetică; **(4)** Energie nucleară; **(5)** Producerea și prelucrarea metalelor; **(6)** Industria mineralelor și a materialelor de construcții; **(7)** Industria chimică; **(8)** Industria alimentară; **(9)** Industria textilă, a pielăriei, a lemnului și hârtiei; **(10)** Industria cauciucului: fabricarea și tratarea produselor pe bază de elastomeri; **(11-a)** Infrastructura de transport (aerian, rutier, feroviar, naval – inclusiv porturi); **(11-b)** Infrastructura de gestionare a deșeurilor; **(11-c)** Infrastructura de gospodărire a apelor; **(12)** Turism și agrement; **(13-a)** Alte domenii – telecomunicații; **(13-b)** Alte domenii în care se dezvoltă proiectele enumerate la pct. 11 din anexa nr. 2 la Legea nr. 292/2018.

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CERTIFICAT DE ATESTARE

Seria RGX nr. 347/28.08.2025

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Se atestă domnul **Traian PETRESCU** cu domiciliul în Constanța, str. Lyon, nr. 32, jud. Constanța, CNP 1520505131326, ca **expert atestat - nivel principal** pentru elaborarea următoarelor studii de mediu în domeniile de atestare acordate de Comisia de atestare conform Procesului verbal nr. 74 din data de 28.08.2025: **RIM-1, RIM-2, RIM-3, RIM-4, RIM-7, RIM-11a, RIM-11b, RIM-11c, RIM-12, RIM-13b; RA-3, RA-6, RA-7, RA-11a, RA-11b; RM-4, RM-11c, RM-13b; RS-11b; BM-2, BM-3, BM-4, BM-7, BM-11b, BM-13b; EA; EGZA; EGSC; MB** ----------

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ASOCIAȚIA DE MEDIU ARM 1998

TIPUL DE STUDII: (RIM) Raport privind impactul asupra mediului; **(RA)** Raport de amplasament; **(RM)** Raport de mediu; **(RS)** Raport de securitate; **(BM)** Bilanț de mediu; **(EA)** Studiu de evaluare adecvată; **(EGCA)** Evaluarea și gestionarea calității aerului; **(EGZA)** Evaluarea și gestionarea zgomotului ambiant; **(EGSC)** Evaluarea și gestionarea schimbărilor climatice; **(MB)** Monitorizarea biodiversității.

DOMENII DE ATESTARE: (1) Agricultură, silvicultură, piscicultură; **(2)** Industria extractivă; **(3)** Industria energetică; **(4)** Energie nucleară; **(5)** Producerea și prelucrarea metalelor; **(6)** Industria mineralelor și a materialelor de construcții; **(7)** Industria chimică; **(8)** Industria alimentară; **(9)** Industria textilă, a pielăriei, a lemnului și hârtiei; **(10)** Industria cauciucului: fabricarea și tratarea produselor pe bază de elastomeri; **(11-a)** Infrastructura de transport (aerian, rutier, feroviar, naval – inclusiv porturi); **(11-b)** Infrastructura de gestionare a deșeurilor; **(11-c)** Infrastructura de gospodărire a apelor; **(12)** Turism și agrement; **(13-a)** Alte domenii – telecomunicații; **(13-b)** Alte domenii – domeniile în care se dezvoltă proiectele enumerate la pct. 11 din anexa nr. 2 la Legea nr. 292/2018.

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Se atestă domnul **Traian Răzvan PETRESCU** cu domiciliul în Constanța, str. Lyon, nr. 32, jud. Constanța, CNP 1850825133923, ca **expert atestat - nivel principal** pentru elaborarea următoarelor studii de mediu în domeniile de atestare acordate de Comisia de atestare conform Procesului verbal nr. 63 din data de 17.04.2025: **RIM-1, RIM-2, RIM-3, RIM-7, RIM-11a, RIM-11b, RIM-11c, RIM-12; RA-11b; RM-3, RM-4, RM-11a, RM-12; BM-2, BM-3, BM-7, BM-11b; EA; MB** ---------

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DOMENII DE ATESTARE: (1) Agricultură, silvicultură, piscicultură; **(2)** Industria extractivă; **(3)** Industria energetică; **(4)** Energie nucleară; **(5)** Producerea și prelucrarea metalelor; **(6)** Industria mineralelor și a materialelor de construcții; **(7)** Industria chimică; **(8)** Industria alimentară; **(9)** Industria textilă, a pielăriei, a lemnului și hârtiei; **(10)** Industria cauciucului: fabricarea și tratarea produselor pe bază de elastomeri; **(11-a)** Infrastructura de transport (aerian, rutier, feroviar, naval – inclusiv porturi); **(11-b)** Infrastructura de gestionare a deșeurilor; **(11-c)** Infrastructura de gospodărire a apelor; **(12)** Turism și agrement; **(13-a)** Alte domenii – telecomunicații; **(13-b)** Alte domenii în care se dezvoltă proiectele enumerate la pct. 11 din anexa nr. 2 la Legea nr. 292/2018.

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Comisia de atestare a persoanelor fizice și juridice care elaborează studii de mediu

Certificat ISO 14001 nr. 205340/A/0001/UK/Ro

CERTIFICAT DE ATESTARE

Seria RGX nr. 343/28.08.2025

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Se atestă doamna **Daniela VASILE** cu domiciliul în Slobozia, str. Tudor Vladimirescu, nr. 2, bl. 13, sc. A, et. 4, ap. 14, jud. Ialomița, CNP 2851122211195, ca **expert atestat - nivel principal** pentru elaborarea următoarelor studii de mediu în domeniile de atestare acordate de Comisia de atestare conform Procesului verbal nr. 74 din data de 28.08.2025: **EA; MB** ----------

PREȘEDINTE

conf. univ. dr. Brîndușa SLUȘER

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TIPUL DE STUDII: (RIM) Raport privind impactul asupra mediului; **(RA)** Raport de amplasament; **(RM)** Raport de mediu; **(RS)** Raport de securitate; **(BM)** Bilanț de mediu; **(EA)** Studiu de evaluare adecvată; **(EGCA)** Evaluarea și gestionarea calității aerului; **(EGZA)** Evaluarea și gestionarea zgomotului ambiant; **(EGSC)** Evaluarea și gestionarea schimbărilor climatice; **(MB)** Monitorizarea biodiversității.

DOMENII DE ATESTARE: (1) Agricultură, silvicultură, piscicultură; **(2)** Industria extractivă; **(3)** Industria energetică; **(4)** Energie nucleară; **(5)** Producerea și prelucrarea metalelor; **(6)** Industria mineralelor și a materialelor de construcții; **(7)** Industria chimică; **(8)** Industria alimentară; **(9)** Industria textilă, a pielăriei, a lemnului și hârtiei; **(10)** Industria cauciucului: fabricarea și tratarea produselor pe bază de elastomeri; **(11-a)** Infrastructura de transport (aerian, rutier, feroviar, naval – inclusiv porturi); **(11-b)** Infrastructura de gestionare a deșeurilor; **(11-c)** Infrastructura de gospodărire a apelor; **(12)** Turism și agrement; **(13-a)** Alte domenii – telecomunicații; **(13-b)** Alte domenii – domeniile în care se dezvoltă proiectele enumerate la pct. 11 din anexa nr. 2 la Legea nr. 292/2018.

2. OVERVIEW OF THE CONTENT AND MAIN OBJECTIVES OF THE SNDDN AND ITS RELATIONSHIP WITH OTHER RELEVANT PLANS AND PROGRAMMES

2.1. General information on the content and main objectives of the Strategy

This Environmental Report for the National Strategy for the Development of the Nuclear Sector in Romania (SNDDN) and the National Nuclear Programme (PNN) was prepared within the environmental procedure, according to the *Decision of the screening stage no. 1/12.02.2024 i*ssued by the Ministry of Environment, Waters and Forests.

The environmental assessment for the National Strategy for the Development of the Nuclear Sector in Romania (SNDDN) and the National Nuclear Programme (PNN) analyses the significant environmental effects determined by their implementation according to the requirements of Government Decision No. 1076/2004 (updated) on establishing the procedure for carrying out the environmental assessment for plans and programmes which transposed into national legislation Directive 2001/42/EC of the European Parliament and of the Council and which refers to the assessment of the effects of certain plans and programmes on the environment (the "SEA Directive").

The Environmental Report is an important tool for integrating environmental considerations into the preparation and adoption of plans and programmes because it ensures the identification, description, assessment and consideration in this process of potential significant effects on the environment. The preparation of the Environmental Report and the integration of environmental considerations into the preparation of strategies, plans and programmes is an iterative process that must contribute to sustainable decision-making. Thus, this environmental report was prepared at the Strategy level, with the environmental procedures related to each plan/project in the National Strategy for the Development of the Nuclear Sector in Romania (SNDDN) and the National Nuclear Programme (PNN) being carried out or in progress.

The National Strategy for the Development of the Nuclear Sector, hereinafter referred to as the SNDDN, is the principal policy document underpinning the sustainable development of the nuclear sector in Romania.

The SNDDN establishes the premises for a sustainable consolidation of the general organisational and legal framework for the safe and secure conduct of exclusively peaceful energy and non-power applications in the nuclear sector, ensuring the protection of professionally exposed personnel, the environment, the population and property.

The SNDDN sets out the policy for the future of nuclear applications in Romania and the medium- and long-term priority directions against which decisions and priorities may be assessed in a coordinated manner, so that plans and actions in the nuclear sector are developed in accordance with the principle of sustainable development. Activities in the nuclear sector are carried out over long periods, applying the principle of using the best technologies and techniques, supported by adequate financial and human resources, so as to avoid placing unjustified burdens on future generations.

The SNDDN is updated periodically by the AGENȚIA NUCLEARĂ ȘI PENTRU

DEȘEURI RADIOACTIVE (ANDR), the national authority responsible for the promotion, development and monitoring of nuclear activities, based on the progress of scientific research in recent years, the evolution of techniques and technologies in the nuclear sector and taking into account good practices and lessons learned from national and international practice.

Preparation of the current SNDDN was carried out in accordance with Article 8 of *Government Ordinance No 7/2003 on the promotion, development and monitoring of nuclear activities, republished*, as subsequently amended and supplemented, in conjunction with Article 3(1)(a) and Article 4(2)(a) of Annex 1 to *Government Decision No 1437/2009 approving the Regulation on the organisation and operation and the organisational structure of the AGENȚIA NUCLEARĂ ȘI PENTRU DEȘEURI RADIOACTIVE*, as subsequently amended and supplemented, after consultation with the main institutional stakeholders in the sector - ministries, public-administration institutions and authorities, relevant organisations, economic operators and professional associations - taking into account the projects/plans proposed in the two strategic documents (particularly information on environmental procedures completed or under way and aspects concerning the environmental impacts of the proposed projects/plans).

Within the time horizon projected by this National Strategy, Romania will become one of the important factors at regional and international level, both in terms of ensuring energy security from sustainable sources and with minimal impact on the environment and the population, and in terms of achieving excellence in the use of peaceful applications of nuclear energy in all fields of activity, at the highest performance standards.

By developing the nuclear sector, Romania strengthens the resilience of its national energy system, contributing to long-term stability and the ability to adapt to climatic, technological and geopolitical challenges.

In accordance with Romania's Energy Strategy 2025-2035, with a perspective to 2050, approved by Government Decision No. 1491/2024, Romania envisages developing the energy sector through investment in low-GHG-emission generation capacity, including the maintenance and expansion of nuclear capacity, alongside the development of renewable energy sources and the use of natural gas as a transition fuel. In this context, completion of Units 3 and 4 at Cernavodă NPP, refurbishment of the existing units and development of new nuclear projects contribute to energy security, diversification of the energy mix and reduction of emissions from the energy sector.

The strategic objectives, directions of action, as well as the specific/individual activities included in this National Strategy cannot be achieved without a permanent reference to the following fundamental principles:

- The principle of sustainable development: Activities in the nuclear sector are carried out taking into account sustainable development, meaning meeting the needs of the present without endangering the environment and without compromising the ability of future generations to meet their own needs;
- The principle of the prevalence of benefits of using nuclear applications: The use of nuclear energy must provide benefits that exceed the level of costs and associated risks;
- The principle of legality and predictability of regulations: Activities in the nuclear sector are carried out within a coherent, predictable and perfectly aligned legislative

and organisational framework with international regulations in the field, which ensures the implementation of a safe and controlled nuclear energy programme;

- The principle of long-term commitment: Nuclear activities must be carried out in a predictable climate, based on long-term commitments at the political and institutional level;
- The principle of assuming responsibility of all institutional factors and operators active in the nuclear sector: Activities in the nuclear sector are carried out in compliance with the "polluter pays" principle and with the assumption of responsibility of all factors in the field, according to the regulations in force;
- The non-proliferation principle: Activities in the nuclear sector are carried out for exclusively peaceful purposes, taking into account the risks posed by the proliferation of nuclear weapons;
- The principle of ensuring the protection of professionally exposed personnel, of the population, property and the environment: Activities in the nuclear sector must be carried out under maximum safety conditions, so that the population and the environment are protected in accordance with national and international standards and regulations in the field;
- Principle of protecting current and future generations: The population and the environment, both now and in the future, must be protected against radiation-related risks, and radioactive waste must be managed so as to avoid placing undesirable burdens on future generations;
- The principle of continuous improvement: The educational system and the continuous development of personnel skills, as well as the support of research-development-innovation activities in the nuclear sector, must be calibrated to meet the needs of the national nuclear programme;
- Principle of transparency of the decision-making process: Decisions regarding the use of peaceful applications of nuclear energy must be adopted in a transparent manner, thus facilitating the active involvement of all stakeholders;
- The principle of using the best existing techniques and technologies without incurring unjustified costs for future generations and taking into account possible transboundary effects.

Scope

This Strategy applies to the planning, implementation, monitoring and continuous improvement of nuclear power and non-power activities carried out exclusively for the peaceful and sustainable development of society and within the time horizon covered by the Strategy, including:

- Activities regarding the development of nuclear energy projects (such as nuclear research reactors, SMRs, Gen IV reactors);
- Activities relating to the refurbishment and/or construction of new nuclear reactors using CANDU technology;
- Research-development-innovation activities in the nuclear sector;
- Activities relating to the safe management of radioactive waste generated by the operation, refurbishment and decommissioning of nuclear power facilities, research

reactors and radiological facilities, as well as the management of spent nuclear fuel;
- Nuclear facility closure and decommissioning activities;
- Activities regarding the conservation of the quality and quantity of heavy water, in the medium and long term, for CANDU nuclear reactors;
- Activities relating to the management of radioactive waste generated by industries other than the nuclear industry;
- Activities supporting strategic objectives in other national policy areas that interface with the nuclear sector, including mining and energy mineral resources (radioactive ores, consisting of accumulations of uranium and thorium in the form of naturally occurring chemical compounds), and hydrogen production, etc.;
- Activities in industrial, medical and research applications that use radioactive sources.

With regard to the extraction and processing of nuclear raw materials, the National Strategy for the Development of the Nuclear Sector is aligned with the applicable sectoral strategic documents, including the National Strategy for Non-Energy Mineral Resources 2025-2035, approved by Government Decision No. 1464/2024, and Romania's Energy Strategy 2025-2035, with a perspective to 2050, approved by Government Decision No. 1491/2024. These activities are governed by the applicable specific legislative and procedural framework, and the Strategy addresses them at the level of policy coordination insofar as they are relevant to securing the nuclear fuel cycle and security of supply.

Strategy objectives

The SNDDN has fundamental strategic objectives that structure the entire analysis and planning process for the medium term (2030) and with the time horizon of 2050. Achieving the objectives requires a sustainable development of the nuclear sector based on the use of energy and non-power applications for exclusively peaceful purposes, provided that security, protection of the population and the environment are ensured.

The strategic objectives will be achieved simultaneously through a set of operational measures that sum up priority actions/projects/investments staggered over time, with a short, medium and long-term implementation schedule (Detailed in Annex 1 of the PNN), and taking into account the continuous improvement of nuclear and radiological safety and security, and the protection of professionally exposed personnel, the population and the environment against the harmful effects of ionising radiation.

Strategic objectives regarding the development of nuclear energy and non-power activities in Romania in the medium and long term:

- SO 1 - Maintaining a high level of performance and increasing the number of nuclear units using CANDU technology;
- SO 2 - Construction of new types of nuclear power plants through a phased approach over time and by reactor technology (small modular reactors - SMRs and innovative Generation IV reactors);
- SO 3 - Development of an integrated fuel cycle to ensure the sustainability and efficiency of nuclear energy;
- SO 4 - Safe management of spent nuclear fuel and radioactive waste, including the closure and institutional control of final radioactive waste disposal facilities;

- SO 5 - Strengthening technical and scientific support capacity and increasing the role of research and innovation in the nuclear sector;
- SO 6 - Ensuring the highly qualified human resources required to achieve the proposed objectives successfully;
- SO 7 - Harnessing the benefits of non-power applications in medicine, industry, agriculture, space applications, hydrogen production, etc.

The development of the nuclear sector, as defined by the strategic objectives of the SNDDN, is carried out in accordance with the National Strategy for Sustainable Development of Romania 2030 and contributes to the achievement of relevant Sustainable Development Goals.

The expansion of low-carbon nuclear capacity, including through the maintenance and expansion of existing units and the introduction of SMR and Generation IV technologies, contributes to SDG 7 - Affordable Clean Energy and SDG 13 - Climate Action, by reducing greenhouse gas emissions and strengthening energy security.

Strengthening the research, development and innovation component of the nuclear sector, together with associated technological infrastructures, supports SDG 9 - Industry, innovation and infrastructure, by promoting advanced technologies and strengthening national research capacity.

At the same time, the expansion of non-power applications of nuclear energy in medicine, industry and agriculture contributes to SDG 3 - Health and well-being, in safe conditions and with respect for the protection of the population and the environment. The strategy also promotes non-power applications of nuclear technologies for environmental protection, including the monitoring of emerging pollutants and the assessment of the quality of environmental components, with indirect positive effects on environmental knowledge and protection.

In accordance with the vision and strategic objectives of the SNDDN, the development of the nuclear sector is ensured by carrying out strategic projects of national interest, which are identified within the PNN - an integral part of the SNDDN, namely:

1) Completion of Units 3 and 4 at Cernavodă NPP;
2) Refurbishment of Unit 1 and Refurbishment of Unit 2 at Cernavodă NPP;
3) Building the DFDSMA;
4) Building the DGA;
5) Construction works of the Cernavodă Tritium Removal Facility (CTRF), on the Cernavodă NPP platform;
6) Construction of a new nuclear power plant based on SMR modules;
7) Construction of experimental support facilities for the ALFRED demonstrator;
8) Construction of the ALFRED demonstrator, intended to demonstrate the viability of LFR technology;
9) Construction of a research infrastructure for the production of radioactive beams and radioisotopes of medical interest;
10) Development of technologies for fundamental and applied nuclear physics research with the high-power laser system at ELI-NP.

Nuclear energy, a low-carbon energy source, has a significant share in the total national electricity production - about 18% - and is a basic component of the energy mix in

Romania. Nuclear energy in Romania is supported by domestic resources and infrastructure covering the entire open nuclear fuel cycle; in practice, Romania has a high degree of independence in nuclear energy production.

Analyses regarding the need to meet environmental and energy security objectives and targets, security of supply and diversification of sources for a balanced energy mix, which would ensure an affordable energy price for consumers, reveal that the Project of Units 3 and 4 at Cernavodă NPP represents one of the optimal solutions for covering the electricity production capacity deficit forecast for the future as a result of reaching the operating life limit of several existing capacities.

The completion of the Cernavodă NPP Units 3 and 4 Project, a priority strategic investment project of national interest, envisages the recovery of existing assets of a high value, in the public domain - heavy water and uranium octoxide - and, respectively, in the domain of SNN - land, buildings, equipment, etc. - and of EnergoNuclear (EN) - intangible assets, etc., under the terms of the law. At the same time, in order to ensure the CANDU nuclear fuel necessary for the operation of Cernavodă NPP Units 3 and 4, SNN envisages the expansion of production capacity at the Nuclear Fuel Factory (FCN Pitești).

Increasing the production capacity of Cernavodă NPP is also an investment measure supported by Romania's energy security objective. Achieving the investment objective Units 3 and 4 at Cernavodă NPP will ensure an additional energy input into the energy system of approximately 11 TWh, respectively an increase in installed power by 1,448 MWe, in the medium and long term, taking into account 2 operating cycles following the refurbishment for each nuclear unit of Cernavodă NPP.

Taking into account the operating characteristics of the NPP, this power will have a high degree of availability and will allow ensuring the coverage of the base of the energy production and consumption curves in the national electricity system (SEN). The systemic effects that will be recorded after the construction of these two groups will be the following:

- increasing the production capacity of the National Power System (NPS) with positive effects on energy security by ensuring Romania's energy supply to regional markets;
- installation of new highly efficient and reliable groups, which will raise the overall efficiency and reliability indicators of the production system;
- the surplus of power and energy in the system will allow the temporary withdrawal from operation of other capacities for modernisations and refurbishment or the closure of those capacities where they are not justified;
- the transition to an energy sector with low greenhouse gas emissions;
- maintaining production capacities on the national territory of profitable activities in the field of uranium reserves exploitation, nuclear raw material processing and nuclear fuel production;
- recovery of investments made in the constructions related to Units 3 and 4 at Cernavodă NPP;
- using the heavy-water reserve determined in previous years for the operation of Cernavodă NPP;
- ensuring a visible participation of the horizontal nuclear industry in Romania (engineering, design, equipment manufacturing, etc.) and increasing the number of jobs;

- supporting the collaboration of the nuclear (power and non-power) industry with education and training institutions, which would lead to the provision of highly qualified personnel necessary for the operation of nuclear and radiological facilities.

In line with the evolution of the process of formalising energy objectives at global and regional levels, as well as considerations regarding a new national energy security policy, it is estimated that by 2050, a production sector based entirely on low-carbon technologies will rely on an electricity mix with a significant contribution from nuclear energy, which will ensure:

- electricity production delivered in base load mode;
- stability of the energy system and security of supply, with the reduction of energy dependence or the increase of the sector's resistance to the impact of external factors. Ensuring a margin of safety against current uncertainties (related to the success/failure of various technologies or to political and economic developments at the international level, which have a pronounced dynamic). Convenient coverage of the refurbishment periods with the minimisation of imports;
- expanding the use of nuclear technologies for non-power applications (cogeneration, hydrogen production, industrial processes, medicine, desalination, etc.);
- prospects for export and contributions to ensuring energy security in the region (as a pole of stability).

Also, to achieve strategic objectives and support projects and activities in the nuclear sector, a series of general measures must be taken into account:

- ensuring a robust and relevant legal and regulatory framework;
- ensuring a sustained investment programme;
- ensuring adequate financial and human resources;
- increasing the capacity of domestic industry;
- increasing investment in research and innovation in order to ensure high-performance and active scientific and technical support, connected to the European and global scientific community;
- stimulating international cooperation and partnerships;
- leveraging development potential through international cooperation projects;
- maintaining a high level of national competence in the field of Romanian nuclear research and increasing its involvement in the development of nuclear energy.

Lines of action to achieve strategic objectives

In order to implement the strategic objectives defined above, the main directions of action for the field of nuclear energy and non-power activities in Romania have been identified:

SO 1: Maintaining a high level of performance, extending the operating life of existing units and increasing the number of nuclear units using CANDU technology, through:

- Completing the construction and commissioning of Units 3 and 4 at Cernavodă NPP;
- Refurbishment of operational units at Cernavodă NPP;
- Maintaining design and research capability for the CANDU technology, in the areas of:

- safety analyses;
- the study of structural materials and advanced nuclear fuels;
- instrumentation and control, equipment and process analysis;
- radioactive waste management and radiological protection;
- ensuring a high degree of operating performance through the use of appropriately qualified equipment and personnel, while meeting the requirements related to the continuous increase in the level of nuclear safety for normal and/or accident situations.

- Studying fuel scenarios and strategies, such as:
  - Accident-tolerant fuel;
  - Advanced CANDU fuel;
  - The possible use of other types of fuel in compliance with international treaties and conventions to which Romania is a party and taking into account the types of nuclear reactors commissioned;
- Ensuring the preparation of material and human resources for the nuclear energy programme, through correlation with education systems, specific training within research and design institutes and through international collaboration.

SO 2: Construction of new types of nuclear power plants through a phased approach over time and by reactor technology (small modular reactors - SMRs and innovative Generation IV reactors), through:

- Construction of plants based on small modular reactor (SMR) technology, through technology transfer and development of national resources to support manufacturing and operation;
- Construction of the experimental support infrastructure for demonstrating the technical and economic viability of Generation IV lead-cooled fast reactors;
- Continuing research and completing the ALFRED demonstration reactor;
- Establishing a regional hub to promote know-how in the field of operation and production of small modular reactors.

SO 3: Development of an integrated fuel cycle to ensure the sustainability and efficiency of nuclear energy, through:

- Ensuring nuclear fuel in integrated systems at national level, taking into account the types of nuclear reactors put into operation;
- Integrating the fuel cycles of CANDU power plants with those of the new generation;
- Management of radioactive waste, including spent fuel, by ensuring interim storage on the plant site, in the short and medium term;
- Defining, finalising and implementing solutions for final disposal of radioactive waste and spent fuel in the medium and long term;
- Providing solutions for the treatment and conditioning of radioactive waste and the conditioning of spent nuclear fuel to meet the acceptance requirements of final disposal facilities;
- Implementation of applications that increase the efficiency of the plant and its utility

in the economy (manufacture of various isotopes that can be used in the medical industry and for various medical treatments, such as Cobalt, Molybdenum, Lutetium, etc.);

- Analysis of documented alternative scenarios that consider the possibility of implementing a DUPIC (Direct Use of Spent PWR Fuel in CANDU) cycle in Romania that would be used both within the SMRs implementation project and for future CANDU units. The possibility of using spent fuel from CANDU reactors within the ALFRED project should also be analysed;
- Active international participation in maintaining the sustainability of CANDU technology, implementing new reactor technologies and managing an integrated fuel cycle at national level.

SO 4: Safe management of spent nuclear fuel and radioactive waste commensurate with the development of nuclear energy, including the closure and institutional control of final radioactive waste disposal facilities

The fundamental objective of the National Medium and Long-Term Strategy on the Safe Management of Spent Nuclear Fuel and Radioactive Waste is the continuous improvement of the process of responsible and safe management of spent nuclear fuel and radioactive waste, without unjustified transfer of responsibility to future generations. In this direction, the periodic updating of this strategy provided for by the legislation will support the achievement of the strategic objectives of the SNDDN, by:

- Updating the National Programme for the Management of Spent Nuclear Fuel and Radioactive Waste, to include, in an appropriate, gradual and documented manner, plans and technical solutions for the management from generation to final disposal of spent nuclear fuel and radioactive waste resulting from the development of future nuclear activities provided for in the SNDDN;
- Defining, finalising and implementing solutions for the final disposal of radioactive waste and spent fuel in the medium and long term;
- Development of pre-storage management and storage solutions for waste resulting from non-nuclear energy activities.

SO 5 - Strengthening technical and scientific support capacity and increasing the role of research and innovation in the nuclear sector

- Development of an R&D programme correlated with the nuclear energy projects of SNDDN;
- Supporting the research-development-innovation programme in support of the national nuclear programme and related infrastructure;
- Increasing allocations for nuclear R&D in the public and private sectors;
- Development of technologies for fundamental and applied nuclear physics research with the high-power laser system at ELI-NP;
- Development and creation of new research and development infrastructures in the field of terrestrial and space mineral resources - DECENEU;
- Strengthening excellence-level research;
- Maintaining and continuously developing nuclear expertise and competence within

the community;

- Encouraging the development of new potential energy sources for electricity production;
- Development of research and development programmes/projects concerning hydrogen production that would make use of the electricity and heat generated in nuclear reactors (in coordination with the action directions, measures, etc. of the hydrogen strategy);
- Exploiting results in the field of research, development and innovation, especially for mobilising private investment and developing specific policies in the field;
- Strengthening international cooperation.

SO 6: Ensuring the highly qualified human resources required to achieve the proposed objectives successfully, through:

- Ensuring the necessary human resources for the commissioning of new nuclear facilities and the maintenance of existing ones;
- Revitalising the national education system;
- Maintaining and continuously developing nuclear expertise and competence within the community;
- Supporting the complementarity of educational and training programme providers and facilitating their collaboration;
- Establishing a national and international personnel training centre using specialised platforms for SMR reactors, etc.;
- Supporting the creation of national platforms that ensure the provision of training programmes for different occupational categories in the field (both power and non-power);
- Supporting those involved in the university and postgraduate educational process and students and researchers in the field (diploma, master's, doctoral theses, scientific papers, etc.).

SO 7: Harnessing the benefits of non-power applications in medicine, industry, agriculture, research and hydrogen production, through:

- Development of ionising radiation metrology;
- Developing applications of technological irradiation in high-value-added industries such as medical device manufacturing, pharmaceuticals and cosmetics, as well as in agriculture or cultural heritage preservation;
- Initiating steps related to the development of hydrogen production capacities that will use electrical and thermal energy produced in nuclear reactors (in correlation with directions of action, measures, etc. from the hydrogen strategy);
- Developing revolutionary medical applications;
- Developing nuclear forensics with the aim of reducing threats to nuclear security, benefiting from advances in analytical instrumentation and data evaluation techniques;
- Developing research in the fields of smart specialisation at the national level: research to obtain new materials, methods, techniques, technologies and advanced equipment that stimulate economic growth;

- Assessing the impact of ionising radiation on the environment and biological systems in order to ensure radiation protection and radiological safety in nuclear practices;
- Development and implementation of new irradiation technologies for the production and extraction of radioisotopes and the preparation of radiopharmaceutical compounds.

To achieve the strategic objectives and expected results, the action directions will be supported by measures to leverage international cooperation in promoting nuclear projects and to inform the public with a view to increasing public acceptance.

- ***Leveraging development potential through international cooperation projects***
  - ✓ Continuing to implement technical-assistance projects carried out by Romania under the IAEA technical cooperation programme and financed from the IAEA budget; identifying common areas of interest at international and regional level; and leveraging the potential for international cooperation in the sector;
  - ✓ Carrying out assistance projects in third countries, in order to support its own development objectives (for example: in the field of regulation, decommissioning of research reactors, nuclear forensics, etc.);
  - ✓ Providing specialised expertise, concluding partnerships and collaboration protocols in the field;
  - ✓ Implementing new initiatives, in the form of pilot projects, to encourage the introduction of innovative technologies and techniques;
  - ✓ Developing projects in the field of education and vocational training, by providing scholarships and training internships abroad.

- ***Promoting nuclear projects and informing the public in order to increase public acceptance***
  - ✓ Informing and ensuring public participation, under the law, regarding the conduct of nuclear activities and the development process of nuclear projects, taking due account of the legal provisions regarding classified information;
  - ✓ Informing and preparing the public in the area surrounding the potential locations of new projects, in order to accept their location;
  - ✓ Proposing social programmes for local communities hosting new facilities;
  - ✓ Harmonisation of public information policies regarding the development of activities in the nuclear energy and non-energy fields;
  - ✓ Increasing the visibility of nuclear activities through dissemination at national, regional and international levels.

In order to carry out the necessary steps for the successful development and implementation of the objectives proposed by the Strategy, a series of directions and measures were identified to facilitate their achievement.

Thus, within the Action Plan for achieving medium and long-term strategic objectives, the proposed objectives can be monitored through performance indicators, in order to assess the progress made towards their achievement, in a manner relevant to all parties involved, to examine the essential aspects and to measure the results of the Strategy implementation (Annex

1 to this document).

Expected results

The expected results from the implementation of the strategy are the following:

- **The institutional and legislativ**e framework updated and aligned with international requirements and standards, IAEA documents and global best practices;
- **Clearly defining and assigning roles, responsibilities**, authority and accountability in ensuring nuclear safety and security, for all entities involved;
- **Maintaining the necessary nuclear energ**y capacities in the medium and long term to contribute to ensuring security of electricity supply, reducing energy dependence, and sustainable energy and economic development with low-carbon emissions in Romania;
- **Developing the nuclear programme by building new-type power plants by** consolidating the national energy sector, based on the principle of sustainable development;
- **Ensuring the management of spent nuclear fuel and radioactive waste in co**nditions of nuclear safety and security, in the long term, while protecting present and future generations;
- **Advanced national research, development and innovation capabilities,** appropriate for the nuclear sector;
- **Ensuring** a sufficient number **of qualified and motivated p**ersonnel and adequate financial resources for high-tech activities in entities directly involved in the nuclear sector;
- **Effective use of the international cooperation framework and mechanism**s;
- **Correct and coherent information to the p**ublic regarding the conduct of nuclear activities;
- **Increasing the level of public trust in s**tate institutions with duties and responsibilities in the nuclear sector;
- **Increasing the visibility of national expert**ise regarding services provided in the nuclear sector (e.g. ALFRED infrastructure, TRIGA reactor, RATEN ICN laboratories, NFL-RO laboratory, radioisotopes and radiopharmaceuticals with applications in research, medicine, industry, agriculture, education, advanced detectors used in major national and international research centres, INCDMRR, ICPMRR Bucharest Laboratories);
- **Supporting and strengthening nuclear research and development** capacity at national, regional and international levels.

2.2. RELATIONSHIP WITH OTHER RELEVANT PLANS / PROGRAMMES / STRATEGIES

The SNDDN synthesises and integrates the main directions and objectives established in the other relevant programmatic documents in the nuclear sector, namely:

a) National Nuclear Safety and Security Strategy of 23 July 2014;
b) National Strategy on the Safe Management of Spent Nuclear Fuel and

Radioactive Waste, approved by Government Decision No. 102 of 19 January 2022;

c) Romania's Energy Strategy 2025-2035, with a perspective to 2050, approved by Government Decision No. 1491 of 21 November 2024.

When preparing the SNDDN, harmonisation and coordination were undertaken with existing or emerging strategies and programmes and with integrated national plans approved at national or EU level that are directly related to the scope of this Strategy and to Romania's responsibilities. With regard to non-power nuclear applications for environmental protection, the SNDDN is aligned with the objectives of the European Green Deal, the EU Circular Economy Action Plan and European pollution-reduction policies, as well as with relevant IAEA programmes concerning the use of nuclear techniques for environmental monitoring.

The SNDDN also took into account relevant strategic documents, programmes and plans in force or under revision and at various stages of adoption at national and sectoral level, which define the current framework for sustainable development, energy, climate, the economy, research, security and regulation, as well as specific documents prepared by the organisations involved in implementing the National Nuclear Programme.

These documents include:

- The Integrated National Plan for Energy and Climate Change 2021-2030, approved by Government Decision No. 1076/2021;
- The Integrated National Energy and Climate Change Plan (PNIESC), updated in October 2024;
- National Investment and Economic Recovery Plan 2021-2027;
- National Roadmap of Research Infrastructures in Romania 2017 approved by the EC;
- National Strategy for Research, Innovation and Smart Specialisation 2022 – 2027, approved by Government Decision 933 of July 20, 2022;
- Romania's long-term strategy for reducing greenhouse gas emissions - Romania Neutral in 2050, approved by Government Decision No. 1215 of November 29, 2023;
- National Strategy on Adaptation to Climate Change for 2024-2030, with a perspective to 2050, approved by Government Decision No. 1010 of 14 August 2024; National Strategy for Non-Energy Mineral Resources 2025-2035, approved by Government Decision No. 1464 of 21 November 2024;
- National Strategy for Sustainable Development of Romania 2030, adopted by Government Decision No. 877/9 November 2018, published in the Official Gazette no. 985/21 November 2018;
- National Strategy on Critical Infrastructures, Government Decision No. 718 of July 13, 2011;
- Strategy for the Refurbishment Project of Unit 1 of Cernavodă NPP, AGM Decision of 28.09.2017;
- Investment strategy of the National Company Nuclearelectrica S.A. for the period July 1, 2020 - July 1, 2025, approved by the Decision of the Ordinary General Meeting of Shareholders of 12.06.2020;

- Continuation Strategy of the Cernavodă NPP Units 3 and 4 Project, approved by the AGM Decision of 05.04.2021;
- The strategy for diversifying the sources of supply of raw materials necessary for the production of nuclear fuel, approved by the AGM Decision of 25.04.2018;
- SNN Memorandum of Understanding with NuScale Power to exchange technical and economic information regarding innovative nuclear technology developed by NuScale, signed on March 19, 2019;
- Agreement between the Government of Romania and the Government of the United States of America on cooperation in connection with the nuclear energy projects at Cernavodă and in the civil nuclear energy sector in Romania signed on September 21, 2020 and ratified by Law No. 200/16.07.2021;
- Agreement signed at COP26 between SNN and NuScale Power to advance the implementation of NuScale's small modular reactor technology in Romania, signed on November 4, 2021;
- RATEN Development Strategy for the period 2015-2025, Revision I, February 2021;
- Memorandum on the construction of the lead-cooled demonstration reactor, ALFRED, in Romania, approved in the Government meetings of February 9, 2011 and January 7, 2014, respectively;
- Memorandum of Cooperation between ANSALDO Nucleare and ENEA from Italy and the Pitești Nuclear Research Institute, RATEN ICN, for the implementation of the construction of the ALFRED project, from 2013, renewed in 2021;
- National Nuclear or Radiological Emergency Response Plan, CNCAN, 2023.

The SNDDN will be reviewed and updated periodically, depending on the evolution of nuclear strategies, namely:

- ✓ National Nuclear Safety and Security Strategy;
- ✓ National Strategy on the Safe Management of Nuclear Fuel and Radioactive Waste;
- ✓ National Strategy on Critical Infrastructures;
- ✓ The National Radon Action Plan and, last but not least, the provisions of Romania's Energy Strategy 2025-2035, with a perspective to 2050.

The action directions and supporting actions established in the SNDDN are implemented through the major projects, investments, measures and actions of the National Nuclear Programme, which forms an integral part of the SNDDN and is planned and implemented through:

- ➢ national and sectoral programmes/plans (e.g. programmes/plans endorsed and/or approved by the Government of Romania, the Ministry of Energy, the Ministry of Education and Research, CNCAN, ANDR, etc.);
- ➢ national and sectoral research-development-innovation programmes/plans (own research-innovation/development/investment/social and environmental/corporate strategies/programmes/plans, etc.) of organisations that have direct responsibility for projects and activities in the nuclear sector provided for in the SNDDN and PNN.

TABLE 1- RELATIONSHIP OF THE NATIONAL STRATEGY WITH OTHER RELEVANT STRATEGIES

No.	Strategy	Time horizon	Brief description of the document	Relationship with the National Strategy
1	ROMANIA'S ENERGY STRATEGY 2025-2035, WITH A PERSPECTIVE TO 2050	2025-2035 with a perspective to 2050	The vision of Romania's Energy Strategy is to develop the energy sector under conditions of security, accessibility and sustainability, ensuring economic competitiveness and a central place for the consumer, taking into account the EU's climate targets for the years 2030, 2040 and 2050. The objectives of the Energy Strategy are: 1. Energy security 2. Low-carbon energy 3. Energy efficiency 4. Physical access to energy for all consumers and financial affordability and economic competitiveness of energy 5. Efficient energy markets 6. Digitalisation, development of smart grids and cybersecurity.	Defines the central role of nuclear energy in the energy mix. The RES envisages the expansion of the national nuclear sector, with the construction of new large-scale units and small modular reactors that will significantly contribute to increasing low-carbon electricity production, as well as to ensuring new energy supply solutions in new industrial applications. Romania is among the 14 EU member states that maintain their option to use nuclear energy. (https://www.ceeol.com, THE EFF*ECTS OF ELECTRICITY FROM RENEWABLE ENERGY FOR THE ENERGY SECURITY OF ROMANIA*) Currently, nuclear energy covers approximately 20% of the country's electricity production through the two units at Cernavodă, with the percentage set to reach approximately 33-35% in 2035 through the expansion of existing large-scale capacities and the construction of small modular reactors.

				Romania's Energy Strategy 2025-2035, with a perspective to 2050, aims to consolidate the current nuclear fuel cycle, as well as to secure and streamline the supply of raw materials necessary for the manufacture of nuclear fuel at FCN Pitești. To this end, SNDDN has taken over and is considering the processing of nuclear raw materials by establishing the subsidiary Factory for Processing Uranium Concentrates-Feldioara SRL (FPCU Feldioara). Planned investments: development of units 3 and 4 at the Cernavodă Nuclear Power Plant and small modular reactors. Extending the life of existing nuclear power plants and assessing operational safety. To ensure the CANDU nuclear fuel necessary for the operation of Units 3 and 4 at Cernavodă NPP, SNDDN is considering expanding production capacity at the Nuclear Fuel Factory (FCN Pitești).
2	NATIONAL NUCLEAR SAFETY AND SECURITY STRATEGY	Permanent	The strategy aims to achieve the general framework necessary for a unified and coherent approach to the objective of improving security and	The relationship between the two strategies is achieved at the level of the objectives of the strategies, aiming in both strategies at the continuous

			safety in the nuclear sector, as well as combining the efforts of authorities and institutions with relevant duties and responsibilities.	improvement of nuclear safety and security, and the protection of professionally employed personnel, the population and the environment against the harmful effects of ionising radiation.
3.	NATIONAL STRATEGY FOR RESEARCH, INNOVATION AND SMART SPECIALISATION 2022-2027	2022-2027	Its vision recognises that research, including fundamental research, remains the basis for innovation and for ensuring technology transfer.	Innovation in the nuclear sector. The nuclear sector is included in the content of the Strategic Research Agenda.
4.	NATIONAL STRATEGY FOR SUSTAINABLE DEVELOPMENT OF ROMANIA 2030	2030	Through this strategy, Romania establishes its national framework for supporting the 2030 Agenda and implementing the set of 17 SDGs. The strategy supports Romania's development on three main pillars, namely economic, social and environmental. Goal 7 refers to: ensuring access to affordable, secure, sustainable and modern energy for all through energy infrastructure, energy security, access to energy and renewable energy, energy efficiency	Building resilient infrastructures - promoting sustainable industrialisation and encouraging innovation. Large investments in major infrastructures, included in international scientific networks, specific to cutting-edge, emerging technologies, within major projects at European level: including the ongoing R&D Programme for Generation IV ALFRED reactors, ELI-NP Extreme Light Infrastructure Project – Nuclear Physics, with a high-power laser system and a high-intensity gamma beam system
5.	MEDIUM AND LONG-TERM NATIONAL STRATEGY ON THE SAFE MANAGEMENT OF		The specific objectives of the National Strategy are: a) Establishing appropriate national measures for the responsible	This strategy applies to the planning, implementation, monitoring and continuous improvement of activities in the nuclear power and non-power

	SPENT NUCLEAR FUEL AND RADIOACTIVE WASTE		management of spent nuclear fuel and radioactive waste, in compliance with the nuclear and radiological safety requirements established by the legislative and regulatory framework for the nuclear sector; b) Improving the information process and ensuring the necessary public participation regarding the management of spent nuclear fuel and radioactive waste, in compliance with the legal regulations in force regarding classified information and the principle of confidentiality.	field: - Activities for the safe management of radioactive waste and spent nuclear fuel resulting from the operation of nuclear facilities (for energy production and/or research reactors) and radiological facilities, resulting from their operation, refurbishment and decommissioning (refurbishment and closure of DNDR Baita); Nuclear facility closure and decommissioning activities; - Radioactive waste management activities from industries other than the nuclear industry. - Medium and long-term National Strategy on the safe management of spent nuclear fuel and radioactive waste, a deep geological repository (Deep Geological Repository – DGA) is planned to be put into operation around 2055 to accommodate the spent nuclear fuel generated by the Cernavodă nuclear power plant. It is envisaged that the National Deep Geological Repository will also ensure the co-location of LILW radioactive waste with long-lived isotopes. LILW radioactive waste with short-lived isotopes will be stored in a surface

				repository (DFDSMA), the selected location of which is located in the exclusion zone of the Cernavodă nuclear power plant and which is planned to be put into operation by 2028. - The SNDDN will be reviewed and updated periodically, depending on the evolution of nuclear strategies. In future updates of the National Strategy for the medium and long term on the safe management of spent nuclear fuel and radioactive waste, depending on the available data, concepts or plans and technical solutions for spent nuclear fuel and radioactive waste generated by future nuclear energy capacities will be analysed and considered.
6.	NATIONAL STRATEGY ON ADAPTATION TO CLIMATE CHANGE FOR THE PERIOD 2024-2030, WITH A PERSPECTIVE TO 2050	2024-2050	The SNASC aims to improve the adaptive capacity of Romania's socio-economic and ecological systems in order to reduce the impacts of climate change on the population and the environment. The Strategy provides a coherent and sustainable framework enabling society and the national economy to	Adapting the energy sector to climate change: - establishing critical infrastructure in energy systems and implementing measures to cope with the impacts of extreme events; - the development of the nuclear sector supports the climate change mitigation efforts promoted by SNASC;

			adapt effectively to climate-related challenges, while supporting sustainable development and protecting citizens.	- SNASC provides a framework for the adaptation of the energy sector to climate change, promoting measures to ensure infrastructure resilience and security of energy supply in variable climate conditions
7.	National Integrated Energy and Climate Change Plan (PNIESC)	2021-2030	The PNIESC is a strategic document that presents the vision and measures for the transition to a decarbonised and energy-sustainable economy and includes objectives, strategies and concrete measures in the following 5 essential areas: - decarbonisation - energy efficiency - energy security - internal energy market - research, innovation and competitiveness	The construction of new nuclear power generation capacities is planned. It is envisaged to ensure energy security through the development of nuclear energy: nuclear energy development projects, such as the refurbishment of Unit 1 at Cernavodă NPP, the construction of two new nuclear units at Cernavodă NPP (U3 and U4), the project regarding the development of small modular nuclear reactors (Small Modular Reactor – SMR) and the decarbonisation of the energy sector, because the technology for producing electricity from nuclear sources has zero GHG emissions. Increased use of nuclear energy is expected. The Integrated National Plan for Energy and Climate Change 2021-2030 (PNIESC) provides for the development of a support mechanism to stimulate investments, with the aim

				of facilitating the development of new low-carbon electricity production capacities, thus ensuring the diversification of energy sources and the flexibility of the national system.
8.	ROMANIA'S MINING STRATEGY	2017-2035	The strategic mining objectives are: 1. Repositioning the mining sector in the perspective of ensuring the mineral resources necessary for the sustainable development of the country, with priority from domestic production; 2. Harmonising the national interest in increasing mining sector activities with the requirements of sustainable development; 3. Sustainable use of the country 's mineral resources in harmony with the environment, protecting natural and cultural objectives in the European context; 4. Responsible participation of communities in areas with mining potential in decisions and actions carried out throughout the entire life cycle of mining projects, under transparent conditions.	The Ministry of Economy, through the mine closure and environmental restoration component, has carried out projects with funding from the World Bank, promoting a series of norms and regulations regarding extractive activities, mine closure and ecological reconstruction, and community consultation. Scope of the activity regarding the support of strategic objectives in other national strategic areas and which are located at the interface with the nuclear sector, including: mining, hydrogen production, etc. The SNDDN also took into account relevant information from approved strategies and programmes/plans prepared by the main organisations involved in implementing the National Nuclear Programme. These documents include Romania's Mining Strategy 2017-2035.
9.	NUCLEARELECTRICA S.A. (SNN)	2015-2025	The SNN objectives represent the subjective, anticipatory vision of the	Nuclearelectrica S.A. is involved at national level in nuclear-sector activities

	DEVELOPMENT STRATEGY		company's management in the context of the analysis of inherent risks, pursuing the following objectives: -Security of energy supply and ensuring economic and social development, in the context of a growing energy demand; -Ensuring economic competitiveness by maintaining an affordable price for end consumers; -Protecting the environment by limiting the effects of climate change.	carried out under the SNDDN. The main field of activity of SNN is the production, transmission and distribution of electricity, and the main object of activity is the production of electricity. SNN also carries out other complementary activities to support its core activities.
10.	NATIONAL MEDIUM- AND LONG-TERM FLOOD RISK MANAGEMENT STRATEGY (SNMRI), 2009-2035;	2023-2035	The strategy aims to ensure the general framework for reducing flood risk for the population, economy, environment and cultural heritage, while contributing to improving/maintaining the state of water bodies and biodiversity, through the synergy of prevention, protection, preparedness, emergency management and post-event measures (reconstruction/recovery). The strategy aims to ensure the general framework for reducing flood risk for the population, economy, environment and cultural heritage, while contributing to	The Nuclear Strategy and the SNMRI do not directly overlap, but are complementary in terms of nuclear site security, climate change resilience and the protection of critical infrastructure against natural hazards. Integrating flood risk assessment into nuclear project planning is essential for sustainable and safe development.

			improving/maintaining the state of water bodies and biodiversity, through the synergy of prevention, protection, preparedness, emergency management and post-event measures (reconstruction/recovery).	
11.	NATIONAL RECOVERY AND RESILIENCE PLAN PNRR 2021	2021-2026	The National Recovery and Resilience Plan (PNRR) of Romania pursues the general objectives of the Recovery and Resilience Mechanism (RRM), a mechanism created at the European Union (EU) level as a temporary financial instrument to support the recovery from the crisis caused by the COVID-19 pandemic. The National Recovery and Resilience Plan (PNRR) in Romania includes a package of reforms and public investments that must be implemented by 2026. The overall objective of Romania's PNRR is to develop Romania by implementing essential programmes and projects that support resilience, crisis preparedness, adaptive capacity and growth potential, through major reforms and key investments with funds from the Recovery and Resilience Mechanism.	Romania's PNRR is structured on 15 components that cover all 6 pillars provided for by the Regulation, point I Green Transition being C6. Energy. Component C6 proposes: -Reform the electricity market, by replacing coal from the energy mix and supporting a stimulating legislative and regulatory framework for private investments in electricity production from renewable sources; -Improving corporate governance of state-owned enterprises in the energy sector.

12.	NATIONAL INVESTMENT AND ECONOMIC RECOVERY PLAN 2021-2027		The National Investment and Economic Recovery Plan provides that the European Green Deal will become the main economic growth strategy at the European Union level in the long term. In the field of public investments in Romania's physical infrastructure, the short-term priority is to increase the pace of completion of ongoing works and prepare major medium- and long-term infrastructure projects in the fields of transport, energy, communications, agriculture, health, sports and education. In the medium and long term, the Government's objective is to launch and implement a large-scale public investment programme with a budgetary allocation of European and national funds, reimbursable and non-reimbursable, of approximately 100 billion euros between 2020 and 2030.	The plan foresees that nuclear energy has a significant contribution to low-carbon generation, with SNN's main investments being to increase nuclear-based capacity through the construction of Units 3 and 4 ~~–a~~nd to extend the operating life of Unit 1 by another 30 years. The investment volume is estimated at 2.25 billion lei in the first 5 years. Ensuring the necessary conditions for the continuation and completion of major research projects, with national and pan-European funding and participation. In the field of scientific research, the plan provides for development of the ALFRED (Advanced Lead Fast Reactor European Demonstrator) research infrastructure. The budget allocated to the project is RON 12 million, and the contractor is the Autonomous Administration for Nuclear Energy Technologies (RATEN).
13.	NATIONAL ROADMAP OF RESEARCH INFRASTRUCTURES IN	2017-2027	The National Roadmap of Research Infrastructures, which has the role of: - a strategic planning tool and	The National Roadmap of Research Infrastructures (e.g. 2021–2027) is a strategic planning document that

	ROMANIA 2017 APPROVED BY THE EC		reference document for decision-making regarding the construction, operation and decommissioning of research infrastructures; - a tool for monitoring and evaluating the progress recorded by research infrastructures in Romania with national, European and international relevance; - identifying and prioritising public investments in research infrastructures, which must be implemented in the current financial programming cycle.	identifies and prioritises research infrastructures essential for Romania's scientific and economic competitiveness. Promotes investments in nuclear research infrastructures (e.g. the TRIGA research reactor at IFIN-HH Măgurele, the ELI-NP platform) as key elements for scientific progress and innovation. Supports Romania's participation in European infrastructure networks (e.g. ESFRI – European Strategy Forum on Research Infrastructures)
14.	NATIONAL STRATEGY ON CRITICAL INFRASTRUCTURES, GD NO. 718 OF 13 JULY 2011		The strategy establishes the national framework for the identification, designation and protection of critical infrastructures, including those in the nuclear sector, and is essential for understanding Romania's security and resilience policies.	Nuclear infrastructure (e.g. nuclear power plants, research facilities, radioactive waste repositories) is explicitly mentioned as critical infrastructure in the field of Energy and National Security. SNPIC provides the general framework for the identification, risk assessment, protection and continuity of operation of critical infrastructures, including nuclear ones.
15.	INVESTMENT STRATEGY 2025-2030, WITH A PERSPECTIVE TO 2035. DEVELOPMENT,	2025-2030	SNN's mission is to produce nuclear energy in complete safety, in accordance with the most demanding international standards, contributing to energy sustainability and	The development of the nuclear sector will require substantial investments, estimated at over 100 billion dollars annually in the next decade, aimed at both the development of new capacities

	INNOVATION AND SUSTAINABILITY		environmental protection.	and the modernisation of existing infrastructure and the integration of efficient use of nuclear energy in the future energy system: ▪ Development of units 3 and 4 of Cernavodă NPP ▪ Development of small modular reactors (SMRs) ▪ Refurbishment of Unit 1 Cernavodă ▪ Development of the Interim Spent Fuel Storage Facility (DICA) ▪ Development of the Emergency Centre ▪ Modernisation and development of the nuclear fuel plant ▪ Modernisation, refurbishment and development of the Uranium Concentrate Processing Plant ▪ Digital transformation and resilience ▪ Other significant investments planned ▪ Implementation of the Cernavodă Tritium Removal Facility ▪ Diversifying the product portfolio through the production of medical radioisotopes
16.	MEMORANDUM OF UNDERSTANDING SNN WITH NUSCALE POWER		Based on the Agreement, Nuclearelectrica S.A. signed an agreement with the US company	In accordance with the vision and strategic objectives of the SNDDN, the development of the nuclear sector is

	FOR THE EXCHANGE OF TECHNICAL AND ECONOMIC INFORMATION REGARDING THE INNOVATIVE NUCLEAR TECHNOLOGY DEVELOPED BY NUSCALE, SIGNED ON MARCH 19, 2019		NuScale at COP26 (2021) for the development of small modular reactors (SMRs). Under the agreement, NuScale supports Nuclearelectrica in assessing this technology and developing a six-module SMR power plant with a total capacity of 462 MWe.	ensured by implementing strategic projects of national interest, which are identified within the PNN - an integral part of the SNDDN, namely: the construction of a nuclear power plant based on SMR modules.
17.	AGREEMENT BETWEEN THE GOVERNMENT OF ROMANIA AND THE GOVERNMENT OF THE UNITED STATES OF AMERICA ON COOPERATION IN CONNECTION WITH THE NUCLEAR ENERGY PROJECTS AT CERNAVODA AND IN THE CIVIL NUCLEAR ENERGY SECTOR IN ROMANIA SIGNED ON SEPTEMBER 21, 2020 AND RATIFIED BY Law No. 200/16.07.2021		For Romania, nuclear energy represents a strategic option, being a basic component of the national energy mix, this option being supported by the existence of an infrastructure that allows the development of electricity production in safe and economically efficient conditions, nuclear energy constituting for Romania an optimal solution to cover the deficit in electricity production capacity due to the need to replace energy capacities based on fossil fuels with capacities based on low-carbon technologies.	The SNDDN took into account relevant information from approved strategies and programmes/plans prepared by the main organisations involved in implementing the National Nuclear Programme. This agreement is one of the documents considered.
18.	AGREEMENT SIGNED IN THE FRAMEWORK OF COP26 BETWEEN SNN AND NUSCALE POWER TO		Through the agreement with NuScale Power, Romania has the potential to develop plants based on small	This agreement ensures one of the objectives of the SNDDN, namely energy security and even the role of

	ADVANCE THE IMPLEMENTATION OF NUSCALE'S SMALL MODULAR REACTOR TECHNOLOGY IN ROMANIA, SIGNED ON NOVEMBER 4, 2021		modular reactors in Europe	supplier in the region. The partnership between Nuclearelectrica and NuScale comes at an important time, as key decision-makers around the world discuss the urgency of accelerating the transition to clean energy. SMR technology can support international goals to minimise the negative impact of climate change and strengthen global prosperity.
19.	MEMORANDUM ON THE CONSTRUCTION OF THE ALFRED LEAD-COOLED DEMONSTRATION REACTOR IN ROMANIA, APPROVED IN THE GOVERNMENT MEETINGS OF FEBRUARY 9, 2011 AND JANUARY 7, 2014 RESPECTIVELY		The Romanian Government has approved two essential memoranda for the development of the ALFRED (Advanced Lead Fast Reactor European Demonstrator) demonstration reactor, a European reference project in the field of Generation IV nuclear technology.	The Memorandum on the construction of the ALFRED lead-cooled demonstration reactor in Romania is closely linked to Romania's Nuclear Strategy, as it reflects the country's long-term vision to actively engage in the development of Generation IV nuclear technologies, with the aim of ensuring energy independence, decarbonisation and technological innovation. Main connections: - Implementation of the Strategy for the Development of Advanced Nuclear Technologies; - Affirming Romania as a European hub for nuclear research; - Consolidation of the national nuclear infrastructure

				(Romania invests in the Mioveni ICN Pitești platform); - ALFRED is aligned with the climate targets in the national and European CO_2 emission reduction strategy.
20.	MEMORANDUM OF COOPERATION BETWEEN ANSALDO NUCLEARE AND ENEA FROM ITALY AND THE INSTITUTE OF NUCLEAR RESEARCH PITEȘTI, RATEN ICN, FOR THE IMPLEMENTATION OF THE CONSTRUCTION OF THE ALFRED PROJECT, SINCE 2013, RENEWED IN 2021		The memorandum aims to collaborate on the implementation of the ALFRED (Advanced Lead-cooled Fast Reactor European Demonstrator) project. The objective is to build in Romania, in Mioveni, the first European demonstration reactor with lead-cooled fast neutrons – ALFRED, part of the European initiatives for generation IV reactors.	The Memorandum of Cooperation on the ALFRED project is directly linked to the National Strategy for the Development of the Nuclear Sector in Romania for the period 2020–2030, with a perspective to 2050, through the following key points: - Romania's involvement in the development and testing of generation IV reactors; - strengthening the national nuclear research infrastructure; - positioning Romania as a regional centre of nuclear excellence
21.	NATIONAL NUCLEAR OR RADIOLOGICAL EMERGENCY RESPONSE PLAN, CNCAN, 2023		The National Nuclear or Radiological Emergency Response Plan (PNRUNR) provides the basis for effectively integrating the local, national and international response in the event of a nuclear accident or radiological emergency. The document covers the national response to nuclear emergencies in Emergency Preparedness Categories	The Strategy defines the increase in nuclear capacities (e.g. expansion of Cernavodă NPP, SMR modular reactors), and the Response Plan ensures that these activities are carried out with effective protective measures in case of emergency. - In Strategy, CNCAN is involved in the regulation and supervision of nuclear technological development.

			(EPC) I, II and V.	In accordance with the provisions of the National Nuclear or Radiological Emergency Response Plan, the National Commission for the Control of Nuclear Activities (CNCAN) is the responsible authority with the main role in preparing for and responding to a nuclear or radiological emergency. At the same time, according to Government Decision No. 557/2016 on the management of risk types, CNCAN is designated as the responsible authority with the main role for managing nuclear or radiological risk. - The plan is an essential component of implementing the strategy, to ensure that nuclear development is carried out with responsibility and adequate public protection.

2.3. OBJECTIVES PROPOSED IN ACCORDANCE WITH THE VISION AND STRATEGIC OBJECTIVES OF THE SNDDN

The development of the nuclear sector is ensured by implementing strategic projects of national interest, which are identified within the PNN - an integral part of the SNDDN.

Action plan to achieve medium- and long-term strategic objectives

Within the Action Plan for achieving the medium- and long-term strategic objectives, it is necessary to monitor the objectives assumed through appropriate performance indicators. The use of these indicators allows for the periodic assessment of the progress made, as well as the relevance and significance of the results for each of the stakeholders involved.

TABLE 2 - SO 1: MAINTAINING A HIGH LEVEL OF PERFORMANCE AND INCREASING THE NUMBER OF NUCLEAR UNITS USING CANDU TECHNOLOGY

Directions of action/ Project	Key measures for implementing the action lines / Project development stages	Responsible entity/entities	Completion date	Performance indicator
(Project) Completion of construction and commissioning of Units 3 and 4 at Cernavodă NPP	Stage 1 - Preparatory Stage - Preliminary Notice to Proceed (Pre-LNTP)	SNN Ministry of Energy	12-18 months	✓Reactivation of the EN project company ✓Studies and pre-project activities required to review the technical requirements for EPC contracting. ✓Undertaking actions to support project financing ✓Implementation of the strategy for reactivating the project company and developing the project
	Stage 2 - Preliminary Works (Limited Notice to Proceed - LNTP) - Phase 1 of the EPC (Engineering, Procurement and Construction) Contract	SNN Ministry of Energy	18-24 months	✓Development of the critical engineering part of the Project, nuclear safety documentation and analyses of the local market of equipment and service providers necessary for the implementation of construction works ✓Project Notification to the European Commission under Article 41 of the EURATOM Treaty ✓Re-analysing the Project feasibility based on the new technical-economic indicators and making the Final Investment Decision, which will allow the Project to move to Stage 3

	Stage 3 - Construction (Issue of the Final Notice to Proceed - FNTP) - Phase 2 of the EPC (Engineering, Procurement and Construction) Contract.	SNN Ministry of Energy	68-78 months	✓ Effective start of construction, assembly and commissioning works (Estimated deadlines: U3-2031; U4-2032).
(Project) Refurbishment of operational units at Cernavodă NPP. Refurbishment of U1 at Cernavodă NPP	Phase 1 – Preliminary studies	SNN Ministry of Energy	2018-2022	✓ Demonstrating the capability of the current components of the Unit 1 reactor to operate for over 210,000 hours at nominal power, until at least the end of 2026. ✓ Defining the scope of the Refurbishment Project works, as well as demonstrating the feasibility of the Refurbishment Project. ✓ Feasibility Study Approval. *Note:* SNN shareholders approved on 23.02.2022 the investment decision in the Cernavodă NPP Unit 1 Refurbishment project, based on the Feasibility Study. The project has entered phase 2.
	Phase 2 – Implementation Preparation	SNN Ministry of Energy	2022-2026	✓ Development of engineering packages related to project changes. ✓ Procurement of equipment and components with long manufacturing cycles. ✓ Award of the engineering, procurement and construction (EPC) contract.
	Phase 3 – Unit shutdown and actual implementation of the Refurbishment Project	SNN Ministry of Energy	2027-2030	✓ Shutdown of the unit and effective implementation of the refurbishment project of Unit 1 of Cernavodă NPP. ✓ Return to operation of Unit 1 of Cernavodă NPP: 2030. *Note:* The Agreement between the Government of Romania and the Government of the United States of America on cooperation in relation to nuclear energy projects at Cernavodă and in the civil nuclear energy sector in Romania ("IGA") ratified by Law No. 200/16.07.2021 takes into account the Unit 1 refurbishment project.
(Project) Refurbishment of operational units at Cernavodă NPP.	Similar scenario for planning the phases and activities of preparation and implementation of the project, a scenario in which good practices and lessons	SNN Ministry of Energy	2037- 2039	✓ Performance indicators similar to those implemented for the U1 Refurbishment project are considered.

Refurbishment of U2 at Cernavodă NPP	learned in the U1 Refurbishment project will be taken into account.			
(Project) Construction works of the Cernavodă Tritium Removal Facility, on the Cernavodă NPP platform	Stage 1 including the completion of investment preparations	SNN Ministry of Energy	2022-2023	✓ Award of the Engineering, Procurement and Construction (EPC) contract ✓ Establishing funding ✓ Obtaining the required authorisations and endorsements, including the decision to issue the Environmental Agreement, which form the basis for construction approval
	Stage 2 - which includes construction activities - assembly, technological tests/commissioning • Start of construction and installation works • Commissioning of the facility	SNN Ministry of Energy	2023-2027	✓ Obtaining the construction authorisation for the project and the commissioning authorisation ✓ Carrying out construction and installation works ✓ Commissioning the installation
Maintaining and increasing the acquired national design and research capability for the CANDU technology	Ensuring continuity of expertise in conducting safety analyses	SNN RATEN Ministry of Energy CNCAN	Permanent	✓ Obtaining and maintaining nuclear safety authorisations at Cernavodă NPP ✓ Safety analyses carried out by nationally recognised organisations for R&D, design and engineering activities relating to nuclear power units
	Study of structural materials and advanced nuclear fuels	SNN RATEN Ministry of Energy Ministry of Economy CNCAN	Permanent	✓ Experimental results, data and information, credited as support for the safety analyses that underlie the supporting documents describing the performance of structural materials and the decision-making process for the development of advanced fuel solutions
	Study of possibilities for improving the performance of design, testing, operation, maintenance, authorisation and modernisation of instrumentation and control systems and the performance of equipment and process analyses	SNN RATEN Ministry of Energy	Permanent	✓ Development of capabilities to consolidate knowledge and expertise for improving the performance of instrumentation and control systems and the quality of equipment and process analyses ✓ Contributions to improving the performance of the entire nuclear power plant and consequently, contributions to the economics and safety of present and future nuclear power plants

	Continuous development and improvement of radioactive waste management and radiological protection	SNN ANDR RATEN IFIN-HH CNCAN Ministry of Education Ministry of Energy; MC	Permanent	✓ Identification and demonstration of authorisable and economically feasible technical and technological solutions for the management of certain categories of radioactive waste from generation to final disposal ("cradle to grave"), within the framework of sectoral and national R&D programmes ✓ Maintaining competencies and incorporating lessons learned from applying ALARA to reduce doses to personnel and the public ✓ Long-term planning of preventive measures to maintain and appropriately develop radiological-protection knowledge and competencies, aligned with the need to ensure the safety levels required for future nuclear projects
	Ensuring a high degree of operating performance through the use of appropriately qualified equipment and personnel, while meeting the requirements related to the continuous increase in the level of nuclear safety for normal and accident situations.	SNN Ministry of Energy CNCAN	Permanent	✓ Preventive and corrective maintenance programmes, inspections, mandatory testing during planned shutdowns, implementation of design changes. ✓ Recruitment and retention programmes for competent personnel to meet increased nuclear safety requirements, appropriate for new generations of specialists
Studying fuel scenarios and strategies	Study of accident-tolerant fuel (correlated with the similar measure under SO 3)	SNN RATEN Ministry of Energy Ministry of Research CNCAN	2025-2030	✓ Technological feasibility study ✓ Making a decision on the implementation of an ATF fuel solution applicable to CANDU technology that could be manufactured at FCN Pitești and used at Cernavodă NPP ✓ Contributions to meeting the supporting conditions required to obtain financing agreements from investors and companies that apply taxonomy criteria for demonstrating environmental and social sustainability
	Studies on Advanced CANDU Fuel	RATEN SNN Ministry of Energy CNCAN ANDR	2035	✓ Studies/reports on the feasibility of implementing alternative advanced CANDU fuel solutions, taking into account the most recent evolution of international experience in the field

	Investigating the possibility of using other types of fuel in compliance with international treaties and conventions to which Romania is a party and taking into account the types of nuclear reactors put into operation	SNN RATEN Ministry of Energy CNCAN ANDR	2025-2035	✓ Studies/reports on the analysis and documentation of strategic approach processes regarding the possibility of using other types of nuclear fuel, based on the types of nuclear reactors put into operation
Ensuring material resources for the nuclear energy programme	Analysis of the possibilities to meet material resource needs taking into account future projects	SNN; RATEN Ministry of Energy Authorities and organisations operating within the scope and responsibilities of the Ministry of Economy, ANRM, the Ministry of Research, the Romanian Academy, etc.	Permanent	✓ Own investment programmes and/or sectoral or national programmes
	Use of the heavy-water reserve established in previous years for the operation of Cernavodă NPP, including meeting the estimated annual technological make-up requirements, operating Units 3 and 4 throughout their service lives and restarting heavy-water production.	CNMAG Ministry of Energy Authorities and organisations with responsibilities for heavy-water management: General Secretariat of the Government, ANRSPS, CNCAN RATEN, SNN, etc.	Permanent	✓ Ensuring the planning and implementation of activities that allow the conservation of the quality and quantity of heavy water, in the medium and long term, for CANDU nuclear reactors ✓ Feasibility analysis of the project to restart operation of the Heavy Water Plant

	Correlating national education systems with the needs of the nuclear programme Specific training within research and design institutes, within SNN and through international collaboration	SNN; RATEN Ministry of Energy Authorities and organisations operating within the scope and responsibilities of the Ministry of Economy, the Ministry of Education, the Ministry of Research, the Romanian Academy, etc.	Permanent	✓ Social responsibility programmes in the fields of education, health and the environment ✓ Succession plans and attracting highly qualified personnel

TABLE 3 SO 2: CONSTRUCTION OF NEW TYPES OF NUCLEAR POWER PLANTS THROUGH A PHASED APPROACH OVER TIME AND BY REACTOR TECHNOLOGY (SMALL MODULAR REACTORS - SMRs AND INNOVATIVE GENERATION IV REACTORS)

Action directions / Projects	Development stages in projects/ Key measures in developing directions of action	Responsible entity/entities	Completion date	Performance indicator
(Project) Construction of a new type of nuclear power plant based on SMR modules	Preliminary activities	SNN Ministry of Energy	2021-2022	✓ Technical support studies to identify possible locations for SMRs ✓ Choosing the preferred candidate location ✓ Establishing a project company
	Site selection and initiation of pre-project activities necessary for making the Final Investment Decision		2022-2028	✓ Initiation of the procedure for obtaining the Environmental Agreement ✓ Initiation of the procedure for obtaining the siting authorisation ✓ Identification of financial sources ✓ Feasibility Study Completion
	Start of engineering, procurement and construction activities		2026-2029	✓ Obtaining the Environmental Agreement ✓ Obtaining the siting authorisation ✓ Obtaining the building permit ✓ Placement of orders and manufacture of long-lead equipment
	Module installation and commissioning		2029-2034	✓ Installation, testing and commissioning; ✓ Obtaining the operating authorisation
Establishing a regional hub to promote know-how in the field of operation and production of small modular reactors	Exchange of experience in promoting and implementing small modular reactor projects Improving knowledge transfer from developer to operator	SNN, RATEN, Ministry of Energy, CNCAN, Authorities and organisations with responsibilities in education and training Ministry of Economy; Ministry of Education; Ministry of Research;	2027-2030	✓ Development of capabilities to bring together expertise and training resources in the operation and production of small modular reactors ✓ Social responsibility programmes in the field of education appropriate to the expansion of new reactor types in the nuclear energy programme

		IFIN-HH; Romanian Academy; etc.		
(Project) Construction of experimental support facilities for the ALFRED demonstrator	Completion of the ATHENA and CHEMLAB facilities Construction of the HELENA2 and ELF facilities Construction of the MELTIN POT facility Construction of the HANDS-ON facility Construction of the HUB and Lead School	Ministry of Energy, ANC, RATEN	2025 – 2030	✓ Experimental data for testing, demonstration and qualification of materials, components and sub-assemblies of the ALFRED reactor for its authorisation ✓ Verification and validation of the standards and calculation codes used in the design of the ALFRED reactor for the authorisation of the demonstrator ✓ Training the human resources necessary for the construction and operation of the ALFRED demonstrator ✓ Involvement of the domestic nuclear industry in the supply chain specific to LFR technology
(Project) Construction of the ALFRED demonstrator	Preliminary activities regarding pre-authorisation Facility authorisation activities Facility construction activities Operation and commercial deployment of the developed LFR-SMR technology	Ministry of Energy ANC RATEN CNCAN	2025 – 2045	✓ Obtaining approval of the ALFRED reactor conceptual design ✓ Obtaining the siting authorisation ✓ Obtaining the construction authorisation ✓ Demonstrating the viability of LFR technology

TABLE 4 - SO 3: DEVELOPMENT OF AN INTEGRATED FUEL CYCLE TO ENSURE THE SUSTAINABILITY AND EFFICIENCY OF NUCLEAR POWER

Action directions / Projects	**Key measures in the development of action directions/ Development stages in projects**	**Responsible entity/entities**	**Completion date**	**Performance indicator**
Development of accident-tolerant fuel (ATF)	Development of technical concepts for an ATF fuel bundle compatible with the CANDU 6 reactor; Testing ATF fuel performance outside the reactor Fabrication of experimental elements for demonstration irradiation Development of technologies and facilities for the manufacture of an ATF fuel bundle prototype	Ministry of Energy, RATEN Other authorities involved	2022- 2032	✓ Fabrication of an experimental ATF fuel element ✓ Demonstration of ATF fuel performance under irradiation ✓ ATF fuel bundle ✓ Obtaining ATF fuel concept authorisation

	Qualification-authorisation of the new type of fuel bundle			
Ensuring nuclear fuel in integrated systems at national level, taking into account the types of nuclear reactors put into operation	Diversification of the sources of raw materials required for nuclear-fuel production and SNN's further development of the front end of the nuclear fuel cycle Maintaining economically viable domestic capacities for uranium mining, nuclear-fuel processing and nuclear-fuel production Key measures in the development of this action line in conjunction with measures presented under the Action Line "Studying fuel scenarios and strategies"	SNN Ministry of Energy Authorities and organisations operating within the scope and responsibilities of the mining sector and associated activities (Ministry of Economy, ANRM, etc.)	2026-2035	✓ Development of feasible scenarios for securing nuclear fuel in an integrated system at national level ✓ Sustainable development of the front end of the nuclear fuel cycle, also taking into account strategic options for the back end of the nuclear fuel cycle ✓ Modernisation and expansion, as appropriate, of uranium ore preparation, nuclear raw material processing and CANDU nuclear fuel production capacities
Integrating the fuel cycles of CANDU power plants with those of the new generation	Analysis of possibilities for integrating the fuel cycles used in existing and future NPPs. Analysis and documentation of the possibility of recycling spent nuclear fuel. Analysing documented alternative scenarios that consider the possibility of implementing a DUPIC cycle (Direct Use of Spent PWR Fuel in CANDU) in Romania Analysis of the possibility of using spent fuel from CANDU reactors within the ALFRED project	Ministry of Energy SNN RATEN CNCAN	2023-2030	✓ Studies on feasible economic solutions for the integration of CANDU and new generation fuel cycles ✓ Defining strategic options on how to approach the alternative of recycling spent nuclear fuel ✓ Studies on the conditions for implementing the DUPIC cycle in Romania, taking into account the latest national and international experience and the technical maturity of R&D results concerning the use of advanced CANDU fuel ✓ Studies on closing the fuel cycle by implementing LFR technology

Management of radioactive waste, including spent fuel, by ensuring interim storage on the plant site, in the short and medium term	Promoting radioactive waste management facilities that ensure the safe pre-storage management (including interim storage) of all radioactive waste generated by the operation of the nuclear power units at Cernavodă NPP	SNN, ANDR, CNCAN Authorities and organisations operating within the scope and responsibilities of the Ministry of Economy, the Ministry of Environment, Waters and Forests, the Ministry of Health, etc.	2022-2032	✓Strategy/plan for managing radioactive waste generated at Cernavodă NPP, in accordance with the DFDSMA and DGA programmes ✓Investment programmes for future projects ✓Proper compliance with the conditions of permits for radioactive waste management activities at nuclear and radiological facilities ✓Strategic approach to technical solutions for radioactive waste management on the Cernavodă NPP platform in synergy for Units 1 and 2 and Units 3 and 4
Providing solutions for the treatment and conditioning of radioactive waste and for conditioning spent nuclear fuel to meet the acceptance requirements of final disposal facilities	Establishing and implementing an integrated concept of technological solutions for treating and conditioning radioactive waste generated at Cernavodă NPP and ensuring its acceptance at the DFDSMA Identification and demonstration of technical and technological solutions for treating and conditioning LL-LILW for final disposal Study of the spent nuclear fuel encapsulation concept, taking into account the selected deep geological disposal concept for the DGA Study of radioactive waste management from the decommissioning of nuclear power units	SNN, RATEN, ANDR, CNCAN, Ministry of Energy, IFIN-HH Authorities and organisations with relevant responsibilities: Ministry of Economy; ANRM; Ministry of Research; Romanian Academy, etc.		✓R&D study on an integrated concept of economically feasible technical and technological treatment and conditioning solutions suitable for final disposal at the DFDSMA of radioactive waste from Cernavodă NPP ✓Decision and implementation plan for a radioactive-waste treatment facility for waste intended for disposal at the DFDSMA in Saligny ✓Implementation of an integrated technological solution for the deep geological disposal concept, covering transport and disposal containers and the spent nuclear fuel encapsulation facility ✓Updating studies/reports of decommissioning plans and estimating associated costs, with the integration of the results of studies describing economically feasible technological solutions for the disposal of all waste categories (VLLW, SL-LILW and LL-LILW)
Implementing applications that increase the plant's efficiency and utility in the economy	Study of the production of various isotopes that can be used in medicine and medical treatments, such as cobalt, molybdenum and lutetium.	SNN Ministry of Energy, ANC CNCAN	2027-2030	✓Studies on the production of radioisotopes in nuclear reactors and, where appropriate, substantiation of the decision-making process for implementing economically feasible solutions, taking into account their potential use at national and international level

TABLE 5 - SO 4: SAFE MANAGEMENT OF SPENT NUCLEAR FUEL AND RADIOACTIVE WASTE, CONSISTENT WITH THE DEVELOPMENT OF NUCLEAR POWER, INCLUDING CLOSURE AND INSTITUTIONAL CONTROL OF FINAL RADIOACTIVE WASTE REPOSITORIES

Action directions / Projects	Key measures for implementing the action lines / Project development stages	Responsible entity/entities	Completion date	Performance indicator
Updating the National Programme for the Management of Spent Nuclear Fuel and Radioactive Waste (correlated with the action lines and indicators presented under SO 3)	Integration into the National Programme of flow diagrams covering the management, from generation to disposal, of spent nuclear fuel and radioactive waste arising from future nuclear activities provided for in the SNDDN	ANDR The main generators of waste Interinstitutional Working Group	2025-2028	✓Updated National Programme for the Management of Spent Nuclear Fuel and Radioactive Waste ✓Studies on estimating the inventory of radioactive waste and spent fuel for new nuclear energy projects ✓Generators' own strategies for the pre-storage management of radioactive waste and spent nuclear fuel
Defining, finalising and implementing solutions for the final disposal of radioactive waste and spent fuel in the medium and long term	Promoting the final disposal of very low-level radioactive waste (VLLW) Study of the geological disposal of LL-LILW, including alternative solutions involving the spent nuclear fuel repository	ANDR, SNN, RATEN, CNCAN, Ministry of Energy, IFIN-HH Authorities and organisations with relevant responsibilities: Ministry of Economy; Ministry of Education; Ministry of Research; Romanian Academy, etc.	2026-2030	✓Studies to develop conceptual solutions for the final disposal of VLLW, including assessment of the feasibility and appropriateness of a disposal solution for this waste category ✓Development plan for an operational concept for geological disposal of LL-LILW ✓Studies to define and develop conceptual solutions for the final disposal of all categories of radioactive waste and spent fuel produced from CANDU and SMR reactors, in the medium and long term
	Establishing appropriate national measures for the responsible management of spent nuclear fuel and radioactive waste, including waste arising from potential emergencies, bankruptcy or judicial	ANDR - Interinstitutional Working Group SNN, Ministry of Energy CNCAN, RATEN	Permanent	✓The plan for the management of radioactive waste arising from radiological or potentially radioactive emergencies, including the identification, segregation and minimisation of waste that also presents other non-radiological hazardous characteristics, such as toxicity and biological properties; the plan will also address issues related to human and animal remains.

	liquidation and/or falling under State responsibility, in compliance with the nuclear and radiological safety and security requirements established by the legislative and regulatory framework and ensuring protection of the public and the environment	IFIN-HH Authorities and organisations operating within the scope and responsibilities relevant to the sector: Ministry of Economy; National Institute of Public Health; Ministry of Health; Ministry of Education and Research; Ministry of Environment; MAPN, IGSU, MAI, etc.		✓ Solutions regarding the integrated management at national level of radioactive waste resulting from potential emergency situations, bankruptcy or judicial liquidation situations and/or under the responsibility of the State ✓ Solutions for integrated national management of materials contaminated with radioactive substances and potentially classifiable as radioactive waste, arising from activities that are not registered or authorised by CNCAN
Development of pre-storage management and disposal solutions for waste arising from non-power applications	Development of pre-storage management solutions for long-lived radioactive waste and spent nuclear fuel arising from non-power applications	RATEN, IFIN-HH ANDR, Ministry of Energy, Ministry of Education and Research, INCDMRR	2023-2035	✓ Ensuring dry interim storage capacity at the RATEN ICN site for spent fuel generated by operation of the TRIGA reactor ✓ Ensuring interim storage capacity at the RATEN ICN and IFIN-HH sites for long-lived radioactive waste intended for final disposal in the DGA
	Supporting research and innovation activities under national research programmes that provide efficient and accessible solutions and technologies for the treatment, conditioning and interim storage of radioactive waste prior to disposal in final disposal facilities being developed in Romania, and for	Ministry of Energy, Ministry of Education and Research, RATEN, IFIN-HH, ANDR	Permanent	✓ Identification and demonstration of technical and technological solutions for treating and conditioning LL-LILW for final disposal in the DGA ✓ Analysis of the impact of the operation of GEN IV and SMR nuclear power plants on the disposal of radioactive waste ✓ Development of treatment and conditioning technologies for radioactive waste considered problematic, generated from VVR-S decommissioning, TRIGA operation/decommissioning, ALFRED operation/decommissioning (irradiated graphite, aluminium,

	decommissioning nuclear and radiological facilities;			beryllium, boron carbide, lead waste, etc.) and other research and development activities.
	Promoting the optimisation of radioactive waste management in a manner that ensures the reuse and recycling of radioactive materials and sources, in the context of the transition to a circular economy	ANDR, Ministry of Energy, CNCAN, SNN, RATEN	Permanent	✓Optimisation of design solutions for final disposal, in correlation with the reuse and recycling activities promoted in the pre-disposal stages ✓Analyses of solutions for minimising the volume of radioactive waste and spent nuclear fuel intended for final disposal (correlated with the indicators presented under SO 3)
Building the DFDSMA	Preparatory activities for obtaining the siting and design authorisations	ANDR, Ministry of Energy, CNCAN	2025-2028	✓Steps required to procure engineering services for obtaining the siting authorisation ✓PUZ endorsement, Environmental Agreement and DFDSMA siting authorisation (under the engineering services contract for obtaining the siting and design authorisations for the DFDSMA final disposal facility - Final Repository for Short-Lived Low- and Intermediate-Level Radioactive Waste)
	Preparatory activities for obtaining the construction authorisation (first eight cells)	ANDR, Ministry of Energy CNCAN	2028-2031	✓Preparation of procurement documentation for contracting the services required to obtain the construction authorisation and construct the DFDSMA repository ✓Construction of the first 8 cells of the DFDSMA repository
	Activities for obtaining the operating authorisation (first eight cells)	ANDR, Ministry of Energy CNCAN	2030-2032	✓Selection by ANDR of a DFDSMA operator according to the legislation in force ✓Obtaining DFDSMA operating authorisation
Authorisation, construction and commissioning of the DGA	Establishing the site selection strategy and geological repository concept	ANDR, Ministry of Energy, CNCAN	2022-2025	✓Action Plan for implementing a geological repository in Romania for spent nuclear fuel, high-level radioactive waste and long-lived low- and intermediate-level radioactive waste.

				✓ Studies to identify potentially suitable host rocks and establish criteria for selecting potential sites, etc.
	R&D support plan for the implementation of the geological repository	ANDR, Ministry of Energy, CNCAN, RATEN	2025-2028	✓ Preparation of at least two R&D studies supporting the site-selection process and characterisation methods
	Host-rock selection activities	ANDR, RATEN, Ministry of Energy, CNCAN	2028 - 2030	✓ Preparation of a study on selecting the host rock for potential Deep Geological Repository sites, based on the selection criteria established by CNCAN and in accordance with IAEA recommendations
	Activities required for site investigation and characterisation	ANDR, RATEN, Ministry of Energy, CNCAN	2030	✓ Conducting studies to establish potential locations for the Deep Geological Repository
	Activities required to obtain the repository construction authorisation	ANDR, CNCAN	2045	✓ Obtaining the Environmental Agreement and other endorsements and approvals ✓ Obtaining the siting and construction authorisations
	Activities for construction and operation of the geological repository	ANDR, Ministry of Energy, CNCAN	2045-2055	✓ Steps required to contract the repository construction works ✓ Obtaining the operating authorisation

TABLE 6- SO 5: STRENGTHENING TECHNICAL AND SCIENTIFIC SUPPORT CAPACITY AND INCREASING THE ROLE OF RESEARCH AND INNOVATION IN THE NUCLEAR SECTOR

Action directions / Projects	Key measures for implementing the action lines / Project development stages	Responsible entity/entities	Completion date	Performance indicator
Supporting the research-development-innovation programme in support of the national nuclear programme and related infrastructure	Supporting research centres directly involved in the development of innovative solutions Ensuring a high-performance infrastructure Securing the necessary funding	Ministry of Energy, Ministry of Education and Research, RATEN	Permanent	✓Research programmes adapted to the stage of project implementation and strategic objectives ✓Proposed and funded research and infrastructure projects ✓Appropriate financing mechanisms
Increasing allocations for nuclear R&D in the public and private sectors	Gradual increase in the percentage of GDP allocated to research, development and innovation spending	ANC, RATEN	Permanent	✓No. of funded R&D programmes/projects in the nuclear sector ✓Supporting nuclear R&D programmes by allocating appropriate budgets ✓Gradual achievement of 1% of GDP by 2030
	Engaging the private sector in financing nuclear research	ANC	Permanent	✓Promoting fiscal approaches that encourage the private sector by granting fiscal incentives for investments in research, innovation and demonstration
Developing excellence in RDI in the nuclear sector	Improving nuclear research management capacity Improving the qualification of personnel in the nuclear sector Support for maintaining highly qualified human resources and for promoting specialists and their teams Harnessing talent and promoting access to research excellence	ANC, Research organisations	Permanent	✓Continuous staff training projects ✓Measures to stimulate top specialists and their teams
	Supporting researcher mobility	ANC, Research organisations	Permanent	✓Grants for training and mobility awarded to early-stage, consolidating and established researchers
	World-class, integrated and interconnected research infrastructures	ANC Research organisations	Permanent	✓Participation in the formation of new international research infrastructures ✓Synergy grants

Development of research and development programmes/projects concerning hydrogen production that would make use of the electricity and heat generated in nuclear reactors (in coordination with the action directions, measures, etc. of the hydrogen strategy)	Gradual increase in allocations for research, development and innovation in this area	ANC, Research organisations, CNHPC	Permanent	✓ Number of R&D projects that ensure the achievement of technical maturity of research and development solutions ✓ Pilot/demonstration installations
Exploiting results in the field of research, development and innovation, in particular for mobilising private investment and developing specific policies in the field	Creating synergies between research and innovation policy and industrial policy	Research organisations; ANC; Ministry of Energy, Ministry of Economy		✓ Stimulating innovation ecosystems, innovation clusters
	Creating a framework for knowledge valorisation and the uptake of research results Improvement of competencies and intellectual-asset management	Research organisations; ANC; Ministry of Energy, Ministry of Economy		✓ Stimulating innovation ecosystems ✓ Stimulating innovation and technology transfer activity ✓ Addressing EU policy priorities and global challenges through R&D&I ✓ Supporting national and EU policies on the continuous improvement of nuclear safety, safeguards and security
Strengthening international cooperation	Continuing and intensifying international collaboration in the field of research and development and technological engineering	ANC, Ministry of Energy, ANDR, RATEN, IFIN-HH, Research organisations	Permanent	✓ Research and technical assistance programmes with international organisations ✓ Bilateral and intersectoral collaboration programmes
	Improving participation in regional, European, NEA/OECD collaboration on nuclear research and development	Authorities and organisations operating in the sphere of action and responsibilities	Permanent	✓ Creating the national and legislative framework that allows access to and participation in collaboration at regional, European and international levels ✓ Legislative changes ✓ Accessing and participating in partnerships/consortia, programmes, projects, initiative groups, working groups,

		related to the nuclear sector		training networks, etc., at regional, European and international level, in accordance with the projects and actions in the PNN
	Collectively addressing global societal challenges	ANC		✓Broader opportunities for collaboration ✓Access to the best talent, expertise, knowledge and resources ✓Increasing supply and demand for innovative solutions

TABLE 7- SO 6: ENSURING HIGHLY QUALIFIED HUMAN RESOURCES REQUIRED FOR THE SUCCESSFUL ACHIEVEMENT OF THE PROPOSED OBJECTIVES

Action directions / Projects	**Key measures for implementing the action lines / Project development stages**	**Responsible entity/entities**	**Completion date**	**Performance indicator**
Ensuring the necessary human resources for the commissioning of new nuclear facilities and the maintenance of existing ones	Attracting new generations to the nuclear sector through actions adapted to new generations and taking into account their particularities	SNN, ANDR, RATEN, IFIN-HH, CNCAN Authorities and organisations operating in the sphere of action and responsibilities related to ensuring highly qualified human resources for the nuclear sector, the Ministry of Energy, the Ministry of Education and Research, the National Research Authority, etc.	Permanent	✓National Human Resources Strategy in the nuclear sector ✓Increasing the number of students and graduates of faculties with a nuclear energy profile ✓Increasing the number of graduates employed in the nuclear sector
Revitalising the national education system to address the need to provide qualified human resources for the nuclear sector	Stimulating cooperation between research-industry-universities Adapting the educational programme to the requirements of nuclear energy in Romania	SNN, RATEN, IFIN-HH, ANDR, CNCAN, ANDR Authorities and organisations operating in the sphere of action and responsibilities related to ensuring highly qualified	Permanent	✓Collaborations and partnerships between interested entities in the nuclear sector ✓Setting educational requirements at the national level ✓Periodic updating of university educational programmes for the fields and specialties necessary for nuclear energy ✓Plan of measures to raise standards in education (equipment, scholarships, etc.)

	Increasing the performance of the education system	human resources for the nuclear sector (Ministry of Education and Research, Ministry of Energy, ANC, etc.)		
Maintaining and continuously developing nuclear expertise and competence within the community	Attractive careers for researchers and facilitating the connection with higher education	IFIN-HH, SNN, RATEN, ANDR, CNCAN Authorities and organisations operating in the sphere of action and responsibilities related to ensuring highly qualified human resources for the nuclear sector (Ministry of Education and Research, Ministry of Energy, ANC, etc.)	Permanent	✓Supporting traditional faculties specialising in the nuclear sector ✓Developing an internal research market that provides improved framework conditions for research careers, both in and outside academia.
	Developing training capacities in the nuclear sector		Permanent	✓Establishing a regional training centre in Romania ✓Specialisation of personnel in the field of nuclear sciences and technologies ✓Qualification and certification of specialised personnel
Supporting the complementarity of educational and training programme providers and facilitating their collaboration	Creating a national network for nuclear education and communities of practice		Permanent	✓Creating national hubs to facilitate nuclear-specific education
Establishment of a national and international personnel training centre using specialised platforms for NuScale SMR reactors	Creation of an E2 Centre (NuScale Energy Exploration Centre)	NUSCALE-UPB Partnership	2022-2023	✓The Energy Exploration Centre (E2 Centre) was installed in 2023 at the Politehnica University of Bucharest, with funding provided by the US Department of State, under the FIRST (Foundational Infrastructure for Responsible Use of Small Modular Reactor Technology) programme.
ENEN2plus	UPB participates in the creation of education and training programmes funded by the European Union/EURATOM as well as in a personnel mobility programme for their preparation and training.	ENEN partnership - 52 partner organisations (including UPB)	2022-2026	✓Analysis of the human resource needs of the European nuclear industry complemented by human resource needs in research centres ✓Development of a HUB that can serve as a single public access point for information on available courses, internships, thesis projects, jobs and other opportunities in the nuclear industry, healthcare, research and government institutions

				✓Organising at least 3 career events to attract young people to nuclear ✓Awards for outstanding work in the nuclear sector (provided for: undergraduate, master's and doctoral students based on the final thesis); ✓Programmes dedicated to teachers for outstanding achievements in promoting nuclear science, STEM and nuclear topics within STEM, including nuclear communication ✓Creating a European online network for teachers: 3 summer schools, 2 nuclear science camps and 2 youth workshops ✓2 interdisciplinary "science dating" events. ✓Strengthening nuclear skills, analysis and comparative evaluation of current university S&T programmes ✓Educational materials (new technologies in medical physics; radiation protection - including space; Decontamination and decommissioning; nuclear systems), webinars for specialists on news from the nuclear industry ✓6 summer schools on various classic nuclear topics ✓2 workshops for doctoral students ✓1 winter school for master's students ✓Regular doctoral competitions ✓Expanding the mentoring network ✓Developing the EU strategy for nuclear higher education ✓Creating a VET learning community ✓Implementing a VET platform with dedicated courses ✓Creating a generous mobility programme with over EUR 2.5 million to attract, retain and develop ✓New and existing human resources in the nuclear sector. ✓International cooperation ✓Developing and implementing E&T actions together with international organisations such as the JRC, ✓OECD/NEA and partners from the US, China, Canada, Korea and Japan

TABLE 8 - SO 7: HARNESSING THE BENEFITS OF NON-POWER APPLICATIONS IN MEDICINE, INDUSTRY, AGRICULTURE, THE SPACE SECTOR, HYDROGEN PRODUCTION, ETC.

Action directions / Projects	Key measures for implementing the action lines / Project development stages	Responsible entity/entities	Completion date	Performance indicator
Development ionising radiation metrology	Developing radon (222Rn) metrology to offer new services to beneficiaries in Romania	ANC, IFIN-HH	2022 - 2027	✓Calibration of equipment that measures the concentration of radon activity in air, water and soil, and calibration with provision of radon standard sources
	Calibration in activity of new radionuclides with applications in medicine, industry and other fields	ANC, IFIN-HH	2022 - 2027	✓Primary activity standards
	Improving and expanding the performance of calibration services	ANC, IFIN-HH	Permanent	✓Ensuring metrological traceability for dose measurements ✓Participation in new international comparisons or proficiency testing
	Extension of dose rate measurement ranges	ANC IFIN-HH	Permanent	✓Ensuring metrological traceability for dosimetry applied in the radiation protection of personnel professionally exposed to ionising radiation
Development of technological irradiation applications in high value-added industries	Installation of new 60Co sources up to 1,000,000 Ci	ANC IFIN-HH	2022-2035	✓A 300% increase in IRASM irradiation capacity
	Installation of an electron accelerator for the development of new applications and meeting industry requirements	ANC IFIN-HH	2022-2030	✓Irradiation technologies with applications in plastic waste recycling ✓Improving sterilisation methods for medical and pharmaceutical products ✓Biotechnologies based on technological irradiation
	Maintaining and increasing Romania's participation in IAEA regional and inter-regional projects in the field of technological irradiation	IFIN-HH	Permanent	✓IAEA regional and interregional projects

Initiation of steps related to the development of hydrogen production capacities that will use electrical and thermal energy produced in nuclear reactors (in correlation with directions of actions, measures, etc. from the hydrogen strategy)	Technical-economic analyses and business plan regarding the potential for application of technological research and development solutions regarding hydrogen production capacities	CNHPC, ANC, Ministry of Energy, RATEN	In correlation with the investment decision-making process in the national energy sector	✓Harnessing research, development and innovation results through technology transfer in order to achieve climate-neutrality performance targets
Developing revolutionary medical applications	Development and implementation of new irradiation technologies for the production and extraction of radioisotopes and the preparation of radiopharmaceutical compounds	RATEN, Ministry of Energy IFIN-HH, ANC	2022 - 2030	✓Production and extraction of radioisotopes and preparation of radiopharmaceutical compounds ✓Methods of treatment of some conditions, especially oncological ones.
	Development of diagnostic and therapeutic techniques	ANC, IFIN-HH Other medical institutions	2022-2035	✓Early diagnostic imaging techniques ✓Radiation therapy protocols
	Developing innovative solutions to combat cancer: early detection, treatment and care	ANC, IFIN-HH Other medical institutions	2022-2035	✓Widely accessible cancer hadronotherapy ✓Phase-contrast X-ray imaging for early tumor detection
Developing nuclear forensics to reduce threats to nuclear security	Implementation of traditional forensic methods in the NNFL-RO laboratory	IFIN-HH, CNCAN	2022-2027	✓Methods for analysing samples contaminated with radionuclides under safe conditions
	Digitisation of nuclear safeguards data	IFIN-HH, CNCAN	2022 – 2030	✓Implementation of a digital nuclear forensics library as an accounting and control system for materials of interest for nuclear safeguards
	Developing on-site intervention capabilities according to the criminal procedure code	IFIN-HH, CNCAN	2022 – 2028	✓Procedures in accordance with the criminal legislation in force developed within the SMC implemented in the laboratory

	Strengthening the nuclear safeguards system for the WRMA balance area	IFIN-HH, CNCAN	2022 – 2030	✓Updating of working procedures on nuclear safeguards according to Euratom Regulation 302, Additional Protocol and NGN-01
Assessment of the impact of ionising radiation on the environment and biological systems in order to ensure radiation protection and radiological safety in nuclear practices	Estimation of the radiological risk of radionuclides, especially tritium and carbon-14 in the environment	ANC, IFIN-HH, RATEN	Permanent	✓Prospective and retrospective mathematical models ✓IT products ✓Preventive measures
	Development of advanced dynamic models for the transfer of tritium and carbon-14 in the atmosphere-soil-plants-animals-human; human dosimetry of tritium (exposed personnel and population), aquatic food chain;	ANC, IFIN-HH	Permanent	✓Prospective and retrospective mathematical models ✓IT products ✓Corrective/preventive measures
	Development and implementation of nuclear methods and technologies for complex environmental determinations and monitoring	RATEN, IFIN-HH, CNCAN, ANPM	2022 - 2030	✓Corrective measures
	Assessment of the ecological and radiological impact of nuclear activities, response to nuclear accidents and radiological emergencies	IFIN-HH, CNCAN, ANPM	Permanent	✓IT products ✓Corrective measures
Developing research in smart-specialisation areas at national level: research to obtain new materials, methods, techniques, technologies and advanced equipment that stimulate	Development of advanced detection and data acquisition systems	ANC, IFIN-HH, RATEN	2022 - 2030	✓Development of small specialised detectors ✓Development of a new generation of detectors, front-end electronics, data processing and acquisition ✓Development of fast, high-granularity, and radiation-hardened detectors for electron measurement and hadron identification
	The development of quantum technologies in Romania	ANC IFIN-HH	Permanent	✓Building a secure quantum communications infrastructure

economic growth				✓Protecting sensitive data and critical infrastructures by integrating quantum systems into existing communications infrastructures, providing an additional level of security based on quantum communications
	Development of major industrial applications and critical security applications	ANC IFIN-HH	2022 - 2040	✓Development of compact and efficient particle accelerators with extreme particle density up to TeV energies ✓Equipment for remote detection of sensitive nuclear materials ✓Development of ultrafast non-destructive testing using gamma rays and neutrons
	Development of methods for measuring low activities in ultra-low background radiation	ANC, IFIN-HH	2022 - 2030	✓New techniques and methods for the most precise measurement of specific radioactivity for the protection and preservation of the environment in the current and future context
	Obtaining, characterising and/or modifying the properties of materials	ANC, IFIN-HH	2022 - 2030	✓Production of new materials of technological interest, with uses in biology, geology, archaeology, etc. ✓Production of radioactive tracers with applicability in medicine, industry, agriculture, environment, research
	Creation of facilities, instrumentation and procedures dedicated to performing elemental analyses based on nuclear methods	RATEN	2022 – 2035	-
	Development of methods and instruments for measuring and monitoring radioactive effluents released from nuclear activities	RATEN	2022 – 2030	-
Development and implementation of new irradiation technologies for the production and extraction	Assimilation of fission-produced Mo-99 technology Cyclotron production of Mo99	RATEN, IFIN-HH	2022 - 2030	✓Fission-produced Mo-99 technology

of radioisotopes and the preparation of radiopharmaceutical compounds	Production of radioisotopes for therapy			

The following table presents information on environmental procedures completed or under way for the plans/projects proposed under the National Strategy for the Development of the Nuclear Sector (SNDDN).

TABLE 9 - ENVIRONMENTAL PROCEDURES COMPLETED OR UNDER WAY FOR THE PLANS/PROJECTS PROPOSED UNDER THE NATIONAL STRATEGY FOR THE DEVELOPMENT OF THE NUCLEAR SECTOR (SNDDN)

SNDDN/PNN project under ANDR responsibility	**Aspects that demonstrate that the projects ensure the protection of the population and the environment**
Completion of Units 3 and 4 at Cernavodă NPP	• For this project, the environmental impact assessment procedure was carried out and was completed in 2012, with the decision of the Ministry of Environment, Waters and Forests to issue the Environmental Agreement for the project "Continuation of construction and completion works of Units 3 and 4 at Cernavodă NPP", an environmental agreement issued by adopting Government Decision No. 737/2013.
Refurbishment of Unit 1 and Refurbishment Unit 2 of Cernavodă NPP	The environmental impact assessment procedure was carried out under Law No. 292/2018 and was completed in July 2025. Government Decision No. 586 of 14 July 2025 issued the Environmental Agreement for the project "Refurbishment of Cernavodă NPP Unit 1 and Expansion of the Interim Spent Fuel Storage Facility with MACSTOR 400 Modules", proposed by Nuclearelectrica S.A. • The project will not be implemented in any area of Community interest and will not use resources from those areas located in the vicinity of the Cernavodă NPP. • The project does not require the appropriate assessment stage, studies showing that its implementation will not have a potential negative impact on the integrity of protected areas of Community interest in the vicinity of the Cernavodă NPP. Also, the project will not have a direct influence through air emissions, noise, vibrations, radiation, products during the construction, operation or decommissioning phases and will not affect the biological diversity of protected natural areas. It is estimated that the Cernavodă NPP Unit 2 Refurbishment Project will undergo an environmental impact assessment procedure similar to that for the Unit 1 Refurbishment Project.
Construction works of the Cernavodă Tritium Removal Facility (CTRF), on the Cernavodă NPP platform	The environmental impact assessment procedure for the project "Construction of the Cernavodă Tritium Removal Facility at Cernavodă NPP" was carried out under Law No. 292/2018 and was completed with the issuance by MMAP of Environmental Agreement No. 1 of 30 January 2023. • The project will not be implemented in any protected natural areas, will not have a direct influence through air emissions, noise, vibrations, radiation, products during the construction or operation phases, and will not affect the biological diversity in protected natural areas.

	• The project did not require the appropriate assessment procedure, with studies showing that the implementation of this project does not have a potentially negative impact on the integrity of protected areas of Community interest. • The project did not require an assessment of the impact on water bodies.
Construction of a new type of nuclear power plant based on SMR technology	• In 2021, an agreement was signed between SNN and NuScale Power at COP26 to advance the implementation of NuScale's Small Modular Reactor (SMR) technology in Romania. The international interest in developing SMRs is directly proportional to the interest of countries in ensuring energy security and achieving decarbonisation goals. • NuScale's SMR technology is the first and only SMR project to receive approval from the U.S. Nuclear Regulatory Commission (NRC). NRC certification means that the project meets applicable NRC safety requirements. • The project is based on pressurised water reactor (PWR) technology and comprises six modules, each with an installed capacity of 77 MWe. PWR technology is proven worldwide, and the reactor design relies on natural processes that require neither operator intervention nor an active power source (the so-called "passive processes") in its operating and safety systems. • The design submitted for NRC certification considered the parameters for a reasonable number of different locations. At the same time, the supporting assessments for obtaining NRC certification show that this design is robust and ensures through its current intrinsic characteristics that the probability and consequences of severe accidents are minimised, being an environmentally friendly design that ensures the protection of personnel and the population. • In 2019, SNN received a USTDA grant to assess potential sites. A preliminary phase of engineering and design studies is under way to provide essential data for developing the first small modular reactor power plant in Romania. • The project is proposed to be located on the site of the former Doicești Thermal Power Plant, Dâmbovița County, Romania. This candidate site, with an area of approximately 48 ha, is under evaluation. • Currently, most of the site decommissioning and cleanup activities have been completed. • After obtaining the appropriate permits, the project will be carried out in stages that include: construction, commissioning and operation. The proposed implementation period begins with the conceptual design (FEED – Front-end Engineering Design) and ends with the commissioning of the reactors.

Construction of a research infrastructure for the production of radioactive beams of medical interest	The proposal to develop the RIF@IFIN (Radioactive Ion Facility at IFIN-HH) research infrastructure is currently at the design-brief stage for preparation of the Documentation for Approval of Intervention Works (DALI), which also includes obtaining the administrative act issued by the competent environmental authority. Environmental objectives were established in the design brief in accordance with the regulations in force for both the construction and operation phases. The project includes improving the energy efficiency of the existing building in which the research infrastructure will be installed, including the installation of photovoltaic panels. During operation, radioactive releases will be monitored and will remain within the limits applicable to the IFIN-HH site, as established by the CNCAN authorisations to be obtained. Radioactive waste, expected to be generated in relatively small quantities, will be managed by the IFIN-HH Radioactive Waste Management Department (DMDR), whose radioactive-waste pre-storage management and storage activities are authorised by CNCAN and covered by the Environmental Permit. The risks of other forms of environmental pollution during operation are practically insignificant.
Developing technologies for fundamental and applied nuclear physics research with the high-power laser system at ELI-NP	The environmental impact of the ELI-NP research infrastructure was assessed, and Environmental Endorsement No. 1/06.05.2011 was issued by the environmental authorities for the Zonal Urban Plan (PUZ). During the authorisation of the ELI-NP construction works, the environmental authority also issued Screening Decision No. 150/12.09.2011, valid until completion of project implementation. The IFIN-HH and ELI-NP activities at 30 Reactorului Street, Măgurele, Ilfov County, are covered by Environmental Permit No. 151/15.10.2018, valid for five years. For radiological-impact purposes, the ELI-NP research infrastructure obtained CNCAN Construction Authorisation No. RP 1686/2021. CNCAN commissioning authorisations were obtained for the ELI-NP facilities with a radiological impact, to be followed by trial-operation authorisations. Radioactive waste generated at the site is managed by the IFIN-HH Radioactive Waste Management Department (DMDR-IFIN-HH), whose pre-storage and storage activities are authorised by CNCAN and covered by the Environmental Permit.
Construction of experimental support facilities for the ALFRED demonstrator	• The project was notified to the Ministry of Environment, Waters and Forests • By the Screening Decision, the MMAP communicates that the notified project is not subject to environmental impact assessment, is not subject to appropriate assessment and is not subject to impact assessment on water bodies,

Construction of the ALFRED demonstrator, intended to demonstrate the viability of LFR technology	The project is in the preparation and design phase.
Building the DFDSMA;	• Project included in the medium and long-term National Strategy on the management of spent nuclear fuel and radioactive waste • The programmatic document was notified to the Ministry of Environment and went through the SEA procedure in accordance with Government Decision No. 1076/2004 • For this Strategy, Environmental Endorsement No. 55/29.06.2021 was issued • The National Strategy was adopted by Government Decision No. 102/2022 • For implementation of the DFDSMA project, ANDR obtained Urban Planning Certificate No. 132/07.12.2020, under which the issuing authority (Constanța County Council) requires the preparation and approval of a Zonal Urban Plan (PUZ) for the area, including the corresponding Environmental Endorsement. • ANDR started the implementation of the PUZ in March 2021 • The first version of the PUZ was notified to the APM Constanța in October 2021 in order to initiate the SEA procedure. • Following the completion of the SEA environmental procedure for PUZ DFDSMA Saligny, Environmental Endorsement No. 2/29.07.2022 was issued • ANDR concluded the engineering services contract for the purpose of obtaining the location and design authorisation for the DFDSMA final disposal facility, within which the environmental impact assessment procedure of the aforementioned project will be carried out, in order to obtain the Environmental Agreement.
Building the DGA	• Project included in the medium and long-term National Strategy on the management of spent nuclear fuel and radioactive waste • The programmatic document was notified to the Ministry of Environment and went through the SEA procedure in accordance with Government Decision No. 1076/2004 • For this Strategy, Environmental Endorsement No. 55/29.06.2021 was issued • The National Strategy was adopted by Government Decision 102/2022.

2.3.1. Geographic and administrative location, map presentation and GIS coordinates, including the coordinate reference system used

Strategy site location

Cernavodă NPP platform

The Cernavodă NPP site is located in Constanța County, approx. 2 km SE of the city of Cernavodă and approx. 1.5 km NE of the first lock of the Danube-Black Sea navigable canal (CDMN), being bordered to the northeast by the Cișmelei Valley, and to the southwest by DJ 223 and the secondary railway line, providing access to the industrial and port area of the city of Cernavodă. The platform was initially designed to host 5 CANDU 600 reactors, each of them estimated at a gross installed capacity of over 700 MW. Construction was started simultaneously on the 5 units, a strategy that was changed in the early 1990s. Units 1 and 2 entered commercial operation, as follows: Unit 1 in 1996 and Unit 2 in 2007, the other nuclear units remaining in conservation at that time. Units 3 and 4 are 52% and 30% complete, respectively, and are planned in the SNDDN and PNN for completion. For unit 5, there is a decision to change the destination and inside the envelope of this unit, technological spaces are to be arranged that will contribute to ensuring the operation of Units 1 and 2 and, subsequently, Units 3 and 4, in conditions of nuclear safety and security, and the Intermediate Radioactive Waste Repository at Unit 5 (DIDR-U5).

This repository will provide additional intermediate capacity to the existing one at Cernavodă NPP, namely the Intermediate Solid Radioactive Waste Repository. DIDR-U 5 provides interim storage capacity for radioactive waste produced in the Cernavodă NPP Unit 1 Refurbishment project, planned in the SNDDN and PNN.

The SNDDN and PNN also provide for the Cernavodă Tritium Removal Facility (CTRF) and the expansion of the Interim Spent Fuel Storage Facility (DICA) on the Cernavodă NPP platform.

FIGURE 1 - CERNAVODĂ NPP SITE

DFDSMA location

The DFDSMA site is located outside the built-up area of Saligny commune, Constanța county and is included in the exclusion zone of the Cernavodă NPP (which has a radius of 1 km from Reactor 1, Cernavodă NPP slope – DN22 C – Valea Cișmelei), at approx. 350 m from the boundary of the NPP premises and, respectively, at approx. 750 m from the Bucharest - Constanța railway loop.

FIGURE 2 - DFDSMA SITE

Mioveni Platform

The Mioveni platform is located in the Subcarpathian area in Argeș County, about 32 km northeast of the city of Pitești and 1.7 km from the city of Mioveni. The site borders the DACIA-RENAULT Car Plant to the west – 2.5 km, on a wooded plateau that continues towards the neighbouring communes. The general elevation of the plateau is 420÷450 m above the Black Sea level and about 150 m above the Doamnei River bed.

FIGURE 3 - MIOVENI PLATFORM SITE

The Măgurele Platform

The Măgurele Platform is located within the built-up area of the city of Măgurele, Ilfov County, southwest of Bucharest (3.5 km from its border and 10 km from the centre) and 1.3 km from the Ciorogârla River. A ring forest with a radius of approximately 800 m constitutes the sanitary protection zone for the nuclear activities carried out on the site, based on the authorisations issued by the regulatory authority - the National Commission for the Control of Nuclear Activities.

The current land use is forestry and construction yards. On the Măgurele platform site, the buildings related to the ELI-NP project in the field of high-power lasers and gamma beams, implemented by the National Institute of Nuclear Physics and Engineering – Horia Hulubei, are already built. The ELI-NP facility covers an area of approximately 3^3,000 m 2 of high-quality and energy-efficient buildings, most of which are allocated to the high-power laser system, the high-intensity gamma system and the experimental instrumentation.

FIGURE 4 - MĂGURELE PLATFORM SITE

Doicești Platform

The Doicești platform, which is located on the site of the former Doicești power plant, located in Dâmbovița County, on the administrative territory of Doicești commune, in the central-southern area of Romania, is a candidate site under evaluation. There are also concerns related to the evaluation of other sites for the implementation of other SMR technologies in the long term.

The site is located on the banks of the Ialomița River, approximately 10km north of the municipality of Târgoviște, in an area characterised by a low piedmont plain relief, with low altitudes and flat lands, used mostly for agriculture.

FIGURE 5 - DOICEȘTI SMR PLATFORM SITE

Location of the Deep Geological Repository

In order to implement the final waste disposal objective, Romania is analysing the possibility of creating a deep geological repository. At the time of the study, the exact location of the deep geological site has not been established, the project being in the early stages of site selection.

Studies supporting selection of a DGA site have inventoried several geological formations that are potential candidates for hosting the disposal system. The analysis began by excluding formations that do not meet the minimum requirements for depth, surface area, thickness, degree of tectonic disturbance and fracturing, degree of alteration, mineralogical and petrographic homogeneity and permeability. The remaining geological formations were then ranked according to the importance of the criteria proposed by the IAEA. The analysis identified six geological formations offering possible DGA siting options, in the following order: green schists, granites, basalts, clays, rock salt and Dej volcanic tuff.

In the preliminary data, the locations of the sites are not georeferenced, the perimeters are approximated in accordance with the most favourable geological conditions offered by the respective area. The only more clearly delimited perimeter is that in Central Dobrogea attributed to green shales, inscribed in a quadrangle between the localities of Hârșova – Rahman – Casimcea – Vulturi. At the level of granites, only the granite bodies as a whole are mentioned (e.g. Tismana, Vf. Pietrii, Muntele Mic), without referring to any possible location for the site.

The re-evaluation of the candidate formations confirms the hierarchy established in the preliminary analysis of the candidate geological formations, in which the green shales from Central Dobrogea meet the most favourable characteristics defined at the level of the first two selection criteria: the effectiveness of the geological barrier (E), and the long-term stability of the geological barrier (S), closely followed by granites. The other geological formations analysed (basalts, clays, rock salt and volcanic tuffs) constitute a potential or possible reserve, acceptable in certain conjunctural situations or in the context of the development of more advanced technologies.

TABLE 10 - TABULAR PRESENTATION OF THE STRATEGY OBJECTIVES AND DISTANCES FROM PROTECTED NATURAL AREAS

Strategy objectives	Location	Distance from the nearest ANPIC	Other additional information
Completion of units 3 and 4 at Cernavodă NPP	Cernavodă NPP	2.4 km from ROSPA0039 Dunăre-Ostroave 3.1 km from ROSCI0022 Canaralele Dunării 3.5 km from Cernavodă Fossil Site Natural Monument	Outside protected natural areas
Refurbishment of Units 1 and 2 at Cernavodă NPP	Cernavodă NPP	2.9 km from ROSCI0022 Canaralele Dunării 2.3 km from ROSPA0039 Dunăre-Ostroave 3.2 km from Cernavodă Fossil Site Natural Monument	Outside protected natural areas
Building the DFDSMA	The outskirts of the commune of Saligny Cernavodă NPP exclusion zone	2.03 km from ROSPA0039 Dunăre-Ostroave 3.00 km from ROSCI0022 Canaralele Dunării 3.74 km from Cernavodă Fossil Site Natural Monument	Outside protected natural areas
Construction works of the Cernavodă Tritium Removal Facility (CTRF), on the Cernavodă NPP platform	Cernavodă NPP	<2 km from ROSPA0039 Dunăre-Ostroave <3 km from ROSCI0022 Canaralele Dunării	Outside protected natural areas
Construction of experimental support facilities for the ALFRED demonstrator	Mioveni Platform	11.5 km from ROSPA0062 Lacurile de acumulare Argeș 9.5 km from ROSCI0326 Muscelele Argeșului 10 km from ROSCI0316 Lunca Râul Doamnei. 3.7 km from Lacul lui Bârcă Nature Reserve	Outside protected natural areas
Construction of the ALFRED demonstrator, intended to demonstrate the viability of LFR technology	Mioveni Platform	11.5 km from ROSPA0062 Lacurile de acumulare Argeș 9.5 km from ROSCI0326 Muscelele Argeșului 10 km from ROSCI0316 Lunca Râul Doamnei. 3.7 km from Lacul lui Bârcă Nature Reserve	Outside protected natural areas
Construction of a research infrastructure for the production of radioactive beams and radioisotopes of medical interest	The Măgurele Platform	7.7 km from RONPA0954 Parcul Natural Văcărești 15.2 km from the common boundary of the Comana Natural Park with ROSCI0043 Comana and ROSPA0022 Comana	Outside protected natural areas

Strategy objectives	Location	Distance from the nearest ANPIC	Other additional information
		20.9 km from ROSCI0138 Pădurea Bolintin	
Developing technologies for fundamental and applied nuclear physics research with the high-power laser system at ELI-NP	The Măgurele Platform	7.7 km from RONPA0954 Parcul Natural Văcărești 15.2 km from the common boundary of the Comana Natural Park with ROSCI0043 Comana and ROSPA0022 Comana 20.9 km from ROSCI0138 Pădurea Bolintin	Outside protected natural areas
Building the DGA	The site has not yet been determined. The host rock has not yet been selected.	The distance from protected areas is unknown. The location of the DGA will take into account environmental protection provisions, so it will be located outside protected natural areas.	-
Construction of a new type of nuclear power plant based on SMR modules	Doicești Platform	- Approx. 12 km from ROSAC0344 Forests of the Southern Piedmont of Cândești - Approx. 15 km from ROSPA0124 Lakes of the Ilfov Valley - Approx. 21 km from ROSAC0014 Bucșani	Outside of any ANPIC – approximate measurement taking into account the location of the Doicești thermal power plant

Activities generated as a result of strategy implementation

The nuclear development strategy aims to consolidate and expand nuclear uses in Romania, both in the energy sector (energy security, NES stability, decarbonisation) and in the non-energy sector (research, health, industry, agriculture and environment), while respecting nuclear safety and environmental protection requirements.

The ancillary services generated by implementation of the National Strategy for the Development of the Nuclear Sector (SNDDN) form an integral part of the Strategy and are essential to the coherent and safe functioning of the entire nuclear sector. These services include decommissioning activities, rerouting of pipelines and other supporting works that directly contribute to the Strategy objectives. Their development supports operational efficiency, nuclear and radiological safety and compliance with environmental protection requirements, while strengthening national infrastructure and institutional capacity for sustainable management of the nuclear sector.

Nuclear energy activities (energy production)

Nuclear energy activities, generated by the implementation of the SNDDN, constitute pillars of Romania's energy independence and of achieving the decarbonisation targets assumed by Romania as an EU Member State:

- extending the life of existing units with CANDU technology;
- completion and commissioning of Units 3 and 4 at Cernavodă NPP (CANDU);
- development of small modular reactors (SMRs), beginning with the Doicești project as a flexible and incrementally deployable solution developed in partnership with NuScale Power (USA).

Implementation of these projects is expected to increase the share of nuclear energy to approximately 36% of national electricity generation and approximately 66% of carbon-free electricity generation, while producing socio-economic benefits through the development of the domestic supply chain and related industries.

The National Strategy for the Development of the Nuclear Sector aims to ensure electricity generation from nuclear sources through two complementary reactor technologies: CANDU reactors for existing and planned large-scale capacity, and small modular reactors (SMRs) for new, flexible and incrementally deployable capacity, implemented in compliance with nuclear safety and environmental protection requirements.

With regard to the extraction and processing of nuclear raw materials, the National Strategy for the Development of the Nuclear Sector is aligned with the applicable sectoral strategic documents, including the National Strategy for Non-Energy Mineral Resources 2025-2035, approved by Government Decision No. 1464/2024, and Romania's Energy Strategy 2025-2035, with a perspective to 2050, approved by Government Decision No. 1491/2024. These activities are governed by the applicable specific legislative and procedural framework, and the Strategy addresses them at the level of policy coordination insofar as they are relevant to securing the nuclear fuel cycle and security of supply.

At the same time, to ensure the CANDU nuclear fuel necessary for the operation of Units 3 and 4 at Cernavodă NPP, SNN is considering expanding production capacity at the Nuclear Fuel Factory (FCN Pitești).

*Energy Strategy 2025-2035, with a perspective to 2050, aims to c*onsolidate the current nuclear fuel cycle, as well as to secure and streamline the supply of raw materials necessary for the manufacture of nuclear fuel at FCN Pitești. To this end, SNN has taken over and is considering the nuclear raw materials processing activities by establishing the Uranium Concentrate Processing Factory-Feldioara SRL (FPCU Feldioara).

The new nuclear systems are designed to be flexible based on the concepts of Small Modular Reactors (SMR) and which can also be used in the cogeneration option (production of electricity and heat for various industrial processes).

The option to increase energy capacity based on nuclear technology through the development of small modular reactors is part of the Intergovernmental Agreement between Romania and the United States of America for the development of Romania's civil nuclear programme and is a decisive element in achieving energy objectives for the development of new nuclear technologies that support the achievement of decarbonisation and energy security objectives.

In 2021, SNN and NuScale Power signed a Teaming Agreement – roadmap for the implementation of NuScale small modular reactors (SMRs) in Romania, with the aim of developing a preliminary plan and roadmap for a project.

In this context, SNN is carrying out a series of preparatory activities regarding the development of a nuclear power plant based on SMR technology at the national level this decade.

There may also be concerns regarding the long-term location and implementation of SMR technologies. This option for SMR technology will be implemented by SNN, in the context in which the Action Plan for achieving the medium and long-term strategic objectives of the SNDDN in the PNN promotes collaboration at regional, European and international levels on research and development, demonstration and innovation in the nuclear sector, in this particular case, this collaboration consisting of involvement in international activities regarding the promotion of innovative nuclear technologies of the SMR type. In this regard, SNN envisages continuing involvement in the SMR Industrial Alliance launched by the European Commission in 2023 and which aims to accelerate the implementation of Small and Advanced Modular Reactors at the European Union level.

On the other hand, the strategy also emphasises **non-energy nuclear activities (research activities), w**hich significantly contribute to social and scientific progre**ss: research activities in the field of high-power lasers and LFR technology**

Research activities in the field of high-power lasers

The Extreme Light Infrastructure – Nuclear Physics (ELI-NP), part of the pan-European ELI project, has entered the operational phase, becoming an International Centre of Excellence in Laser and Nuclear Physics, in Măgurele, Romania (http://www.eli-np.ro/). ELI-NP is one of the most advanced research infrastructures in the world focused on studies and applications in the field of photonuclear physics, at the frontiers of science and technology: from fundamental sciences – in the fields of laser and nuclear physics, astrophysics and related topics – to important discoveries in the field of applications of major interest to society, in life sciences, nuclear materials management and other fields.

Extreme Light Infrastructure – Nuclear Physics (ELI-NP) is the world's most advanced research infrastructure in the field of high-power lasers. ELI-NP has two high-power lasers, each capable of delivering 10 PW pulses to experiments, as well as lower power levels of 100 TW and 1 PW. These features make the ELI-NP laser system unique in the world, both in terms of the power level generated and in terms of the possibility of performing combined experiments with two high-power lasers in the same experiment.

The second defining component of the ELI-NP centre is an advanced high-intensity monochromatic gamma-beam system, with parameters far exceeding the most advanced gamma-beam systems operational today worldwide. ELI-NP includes, in addition to the high-intensity beam systems, 9 experimental areas for high-power laser experiments, monochromatic gamma-beams and combined experiments with the two systems. The unique performances of the ELINP extreme light systems offer opportunities to carry out innovative studies, at the limit of current knowledge, in the field of light-matter interaction, mainly targeting nuclear physics problems with high-power lasers.

ELI-NP's main research directions

1. Production of ionising radiation beams useful in cancer therapy, using high-power lasers from ELI-NP, with a focus on: optimising the characteristics of accelerated ion beams obtained through laser-matter interaction (especially protons and carbon ions) for medical applications, targeting energies of up to 200 MeV/n and dose rates of the order of ~10^{12} Gy/s; optimisation of biological cell exposure protocols and methods for characterising cellular response in irradiation experiments at very high dose rates; in vivo studies for preclinical testing of irradiation conditions at very high dose rates (≈ 10^{12} Gy/s).

2. Research on the biological effects of ELI-NP radiation sources (ionising beams generated using high-power lasers and the gamma source): detection and exploitation of the differences between the biological effects produced by radiation at very high dose rates and those of classically generated radiation, through in vitro studies, including the identification of specific biomarkers; irradiation with short radiation pulses in imaging-guided sequences, applied to ex vivo samples and biological tissue models; evaluation of the effects of irradiations combined with radiation of different qualities (particles and/or photons); testing of adjuvant pharmaceutical compounds for radiotherapy and/or with a radioprotective effect on healthy tissue, in the context of ELI-NP specific pulsed radiation.

3. Phase-contrast medical imaging using coherent laser-generated X-ray sources: implementation of a reference laboratory for phase-contrast X-ray imaging; development of coherent X-ray sources generated by laser-matter interactions; construction of a mammography station based on phase-contrast X-ray imaging (area E4); conducting preclinical studies (animal models) and clinical studies (volunteers/patients) for phase-contrast mammography and computed tomography (CT).

4. Research on producing radioisotopes for medical applications using ELI-NP radiation sources (ionising-radiation beams generated using high-power lasers and the gamma source): optimisation of secondary-radiation production using high-power lasers and assessment of its use to trigger nuclear reactions for obtaining radioisotopes of medical interest; study of effective cross-sections for nuclear reactions leading to the production of medically useful isomers; development of radioisotope-production schemes for medical applications;

development of technological schemes for producing radioisotopes intended for medical applications; studies on medical applications of electron and gamma beams from the GBS (energy-resolved radiotherapy, microdosimetry and medical imaging).

Research activities in the field of LFR technology

Providing clean, sustainable, affordable and secure energy is a major global challenge. Europe has adopted extremely ambitious objectives and policies. In this context, nuclear energy will play an important role in the energy mix, provided that it demonstrates its ability to meet energy-market requirements. Driven by research and innovation, Generation IV (Gen IV) nuclear energy systems offer a robust, competitive and mature response. For this reason, Romania shares the EU's view that the Lead-cooled Fast Reactor (LFR) is one of the most promising Gen IV technologies and supports the ALFRED project as a necessary step in its development.

The ALFRED project represents a unique research infrastructure of pan-European interest, supported by academia, research and industry, intended to demonstrate the technical and economic viability, as well as the safety and sustainability of the technology of lead-cooled fast reactors of the new generation of nuclear systems, including in the form of Small Modular Reactors (SMR) concepts. The ALFRED project includes a demonstration reactor and a core of supporting experimental facilities, complemented by the HUB and the Lead School Centre of Excellence (CoE). The supporting research facilities are dedicated to the testing and qualification of materials, technologies and components that will be used in the realisation of the ALFRED demonstrator, as well as the validation and verification of the codes and calculation models used in the assessment of nuclear safety.

This complex research infrastructure will serve a triple purpose: to demonstrate the achievable performances of LFR technology, as a foundation for the implementation of the new generation of nuclear energy systems; to provide the largest and most relevant experimental environment, accessible to European researchers and technicians, for fundamental research and technological development in the nuclear energy field (assuming the role of a prototype for a commercial lead-cooled fast neutron SMR reactor), and to support, in the medium and long term, innovation for safe and sustainable operation.

Other non-energy nuclear applications

- **Applications of heavy water**

Heavy water is mainly used as a moderator for pressurised heavy water reactors, including CANDU reactors. Other uses of heavy water include: neutrino detection, tritium production, nuclear magnetic resonance spectroscopy, infrared spectroscopy, in organic chemistry for the preparation and labeling of certain isotopes, in physiology and biology for testing metabolic rate, in the semiconductor industry, optical cables and OLED displays, in medicine for routine and in-depth testing, in pharmacology for the creation of drugs with fewer adverse effects, by using deuterated components.

In this context, SNN is taking action to analyse the feasibility of reoperating the Drobeta Turnu-Severin Heavy Water Plant.

- **Technological irradiations**

IFIN-HH has developed a wide range of applications, such as: sterilisation/decontamination of medical and pharmaceutical products, for human and veterinary use, raw materials for cosmetics and food supplements, materials for biotechnology, radioresistance studies of microorganisms or materials and devices. A special application, to the development of which Romania has an important contribution at the international level, is the disinfection treatment for the preservation of cultural heritage.

IFIN-HH aims to maintain and strengthen the existing technological irradiation capacity (γ-ray irradiation) and to develop new applications specific to electron accelerators.

- **Ionising Radiation Metrology**

Metrology, as a field closely linked to most industrial sectors, requires progress towards digitalisation to adapt to new requirements; in this context, the concept of Digital Calibration Certificate (DCC) needs to be developed, validated and implemented.

- **Nuclear Forensics**

The NFL-RO Laboratory within the National Research and Development Institute for Nuclear Physics and Engineering "Horia Hulubei" (IFIN-HH) focuses on efficiency in supporting judicial authorities in criminal investigations, on the sustainability of the laboratory and human resources, as well as a fair approach to the cost-effectiveness ratio in terms of the analytical services offered.

- **Pilot Experimental Facility for Tritium and Deuterium Separation (PESTD)**

The experimental pilot (PESTD) is one of the few experimental facilities for the separation of tritium and deuterium in the world, and is unique in Europe at the semi-industrial pilot level, and the cryogenic distillation system, an integral part of this pilot, is a high-power refrigeration facility. This experimental facility allows the development of representative experiments for the recovery of tritium from liquid and gaseous effluents specific to both CANDU fission reactors and fusion reactors (ITER project), creating the premises for investigating the recovery and storage processes in the Tritium Cycle system.

- **National Centre for Hydrogen and Fuel Cells**

The aim is to promote applied and technological research, generating human and technological capabilities and new knowledge in strategic areas for Romania: (i) isotopic support technologies for nuclear energy; (ii) hydrogen energy and energy storage technologies; (iii) waste recovery; (iv) advanced investigation of anthropogenic impact on the environment and quality of life, including through the development and implementation of advanced analytical methods and appropriate markers.

- **Applications in medicine**

Nuclear techniques provide precise diagnostic information relevant to the detection and treatment of infectious and non-communicable diseases (including cancer). Radiopharmaceuticals are used for treatment and diagnostic imaging, and radiotherapy uses focused beams of radiation, essential in the treatment of some conditions.

- **Applications in agriculture and food**

Use of ionising radiation for preservation and/or phytosanitary treatments, where applicable.

- **environment**

Nuclear science plays a valuable role in helping us understand the history of our environment, how environmental systems function and interact, the parameters that can modify the spatiotemporal distribution of the water balance, as well as the impact that humans have on the environment.

IFIN-HH focuses on the robustness or fitness for purpose of application and use of environmental tracers in addressing problems and opportunities scientifically, to promote their widespread use and to address the underlying issues of vulnerability, sustainability and uncertainty in water (surface and groundwater), resource systems and their management. Technologies for neutralising pollutants from flue gases, wastewater or municipal sludge are being experimented with, and irradiation is currently used as a technological step in the manufacture of car tires and for other industrial crosslinking and chemical grafting processes.

- **Conservation of heritage assets**

The use of ionising radiation treatment for the preservation of cultural heritage for biocide control, under regulated conditions.

In order to exploit the full potential of technological irradiation, within IFIN-HH there are concerns for creating new accelerated electron irradiation capacities, promoting the development of new technological irradiation applications and developing feasibility studies for emerging technological irradiation applications, including through the installation of electron accelerators.

- **Applications in classical industry**

A wide range of industries, from agriculture to manufacturing, use radionuclides to evaluate materials, products, and processes.

- **Gamma radiography**

Similar to medical radiography, industrial X-ray or gamma-ray examination can provide detailed images of internal defects (e.g. cracks in castings, welds, etc.).

- **Industrial measurements and analysis**

Radioisotopes are frequently used in industrial processes to measure viscosity, density, and thickness, to calculate the efficiency of industrial mixing processes, to assess the wear of furnace walls, to detect leaks and other defects in cooling towers and heat exchangers at power plants, to quantify mineral deposits, to map geological contours using test wells and mining boreholes, and to determine the presence of hydrocarbons.

- **Miniaturised power sources**

Radioisotopes have found wide use in applications that require autonomous energy sources, such as: weather stations and balloons, navigation equipment (lighthouses, buoys, etc.), cardiac pacemakers, etc.

- **Manufacturing of Ir192 sources for non-destructive testing in industry**

The analysis of the structural integrity of industrial components manufactured by casting, forging or welding requires closed radiation sources to detect possible manufacturing defects using gamma radiography, Ir192 being one of the most commonly used isotopes in industrial non-destructive testing.

Activities for the safe management of radioactive waste and spent nuclear fuel resulting from the operation of nuclear facilities (for energy production and/or research reactors), their refurbishment and decommissioning

The management of radioactive waste and spent nuclear fuel resulting from the operation of nuclear facilities (including refurbishment and decommissioning activities) is carried out based on the dedicated national strategy for the safe management of these flows.

Romania applies the open nuclear fuel cycle, treating spent fuel as high-level waste for final disposal in a Deep Geological Repository (DGA), based on natural and engineered barriers. The national DGA programme is at an early stage; there are preliminary studies (1994–2013) that have indicated potentially suitable rock types, without selecting a preferred host rock. The siting process usually includes the following stages: conceptual planning, preliminary research, detailed site investigations and site confirmation.

Description of the technological processes carried out through the implementation of the strategy

Nuclear technological processes for energy production

Technological processes involved in the production of electricity using classic nuclear reactors - CANDU type

The main technological processes used in the nuclear power units on the Cernavodă NPP platform are:

- the conversion of fission energy into thermal energy in the nuclear reactor;
- transformation of thermal energy into mechanical energy in the turbine;
- the conversion of mechanical energy into electrical energy in the electric generator.

Heat production through nuclear fuel fission

The PHWR Candu 600 reactor at the Cernavodă NPP uses natural uranium as fuel to generate thermal energy through the nuclear fission process of the natural isotope U-235. The fission neutrons are thermalised using heavy water as a moderator in the reactor calandria vessel. The fission reaction is controlled by using reactivity control mechanisms. The reactor is composed of a number of 380 fuel channels connected in two independent cooling loops, each with two inlets and two outlets from the reactor. Each loop has two electric circulation pumps and two steam generators.

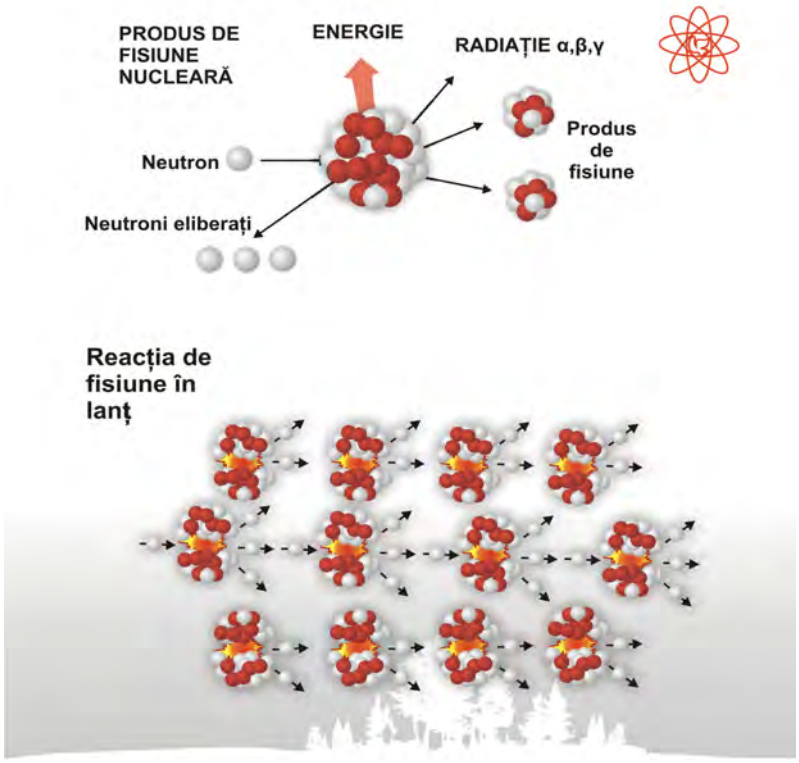


FIGURE 6 - FISSION REACTION (NUCLEARELECTRICA.RO)

The fission process takes place inside fuel bundles. These bundles are manufactured at the Nuclear Fuel Factory in Pitești.

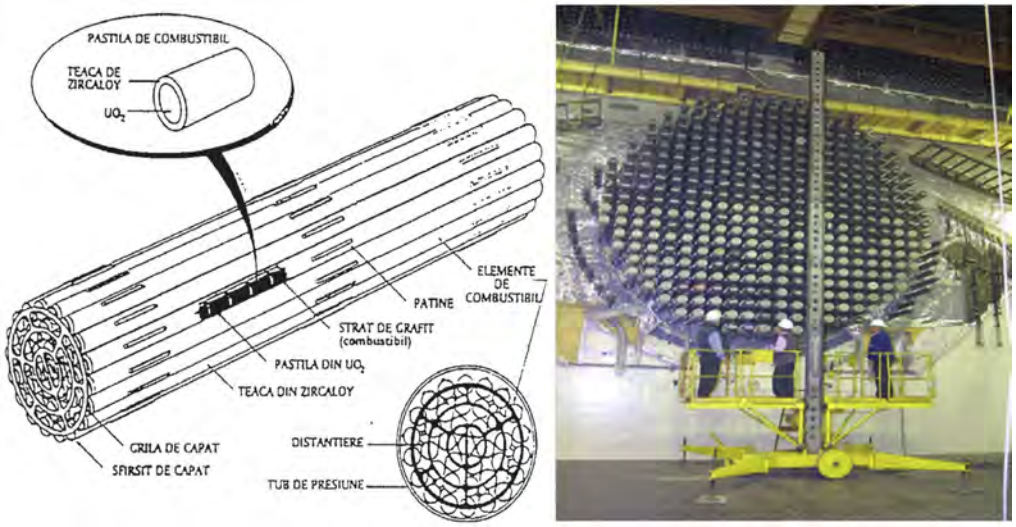


FIGURE 7 - NUCLEAR FUEL BUNDLE IN THE CANDU 6 REACTOR CORE (NUCLEAR SAFETY REPORT FOR CERNAVODĂ NPP UNIT 1)

Heat uptake by the primary coolant

In the operation of the CANDU 600 nuclear reactor at the Cernavodă NPP, thermal energy is generated by the fission of nuclear fuel in the core. This energy must be extracted, transferred and utilised in the thermo-energy cycle to produce electricity. To this end, the reactor uses a primary coolant (thermal agent) that takes the heat from the fuel and transports

it to the heat transfer systems; in the case of the CANDU 600, the primary coolant is heavy water.

The process begins at the fuel bundle level, where fission reactions take place and thermal energy is generated. The heat produced is taken up by the coolant in the primary heavy water (D_2O) circuit and transferred to downstream systems. The primary circuit is a closed circuit, in which continuous circulation of heavy water is ensured by primary pumps, to evacuate heat from the core.

The heavy water in the primary circuit becomes radioactive as a result of neutron activation and contact with components in the reactor area. It carries heat to the steam generators, where thermal energy is transferred to the demineralised water in the secondary circuit. Steam is produced in the secondary circuit and is used to drive the turbine and thereby generate electricity.

The operation of the plant is based on the existence of distinct circuits: one with radioactive heavy water (the primary circuit) and one with demineralised water and steam (the secondary circuit). The separation of the two circuits is essential to prevent the transfer of radioactive contamination to the downstream systems of the plant and to the facilities related to conventional operation.

Heat absorption by the secondary coolant and conversion of this heat into electrical energy

After taking over the heat generated by the fission of the nuclear fuel, the primary coolant (heavy water) is directed to the steam generators, where the transfer of thermal energy to the demineralised water in the secondary circuit takes place, resulting in saturated steam.

The steam is directed to the main turbine, where, through expansion, the thermal energy is transformed into mechanical energy, driving the turbine rotor. The rotor is coupled to the electric generator, which converts the mechanical energy into electrical energy.

After expansion, the exhausted steam enters the condenser, where it is cooled and condensed back into light water (condensate). This light water is taken up and recirculated in the system by means of condensate pumps, passing through low-pressure preheaters and degasser. It is then sucked in by feed pumps, passing through high-pressure preheaters and reintroduced into the steam generators to resume the cycle. This closed thermodynamic cycle ensures the continuous and efficient conversion of the thermal energy produced in the reactor into electrical energy, contributing to the stability and availability of electricity production.

Waste heat removal

The residual heat of the steam discharged to the condenser is taken up and discharged through the circulating water system, which operates in an open circuit. The system ensures the circulation of cooling water (raw water), taken up by pumping from the distribution basin, and its discharge, after heating, into the Danube River or, in special situations, into the second branch of the CDMN, through the siphon basins, the switch valve chambers and the hot water discharge spouts. The minimum temperature of the water at the entrance to the power plant is 5–7°C, and the temperature increase when passing through the condenser is 7.5–10.5°C. In winter, to maintain the minimum temperature required at the entrance to the power plant, a

recirculation circuit is provided, by injecting a fraction of the hot water flow discharged from the power plant into the distribution basin.

Heat evacuation from the equipment during normal operation of the plant, as well as during transient regimes, is carried out through two systems: the closed intermediate system and the technical service water system (raw water from the Danube River).

The intermediate cooling circuit uses chemically conditioned demineralised water, in a closed circuit, obtained at the chemical water treatment plant. The intermediate cooling system recirculates the demineralised water in the classical and nuclear parts, evacuating the heat received to the technical water system, both during normal plant operation and during transient regimes.

Part of the thermal energy produced is taken over and used in the district heating system. The electrical energy produced by the generator is mainly discharged into the National Energy System, through the 400 kV station (owned by Transelectrica), located outside the Cernavodă NPP site, and part is used to cover the plant's own consumption.

This type of reactor uses heavy water (D_2O) as both a moderator and a coolant, in two distinct systems. The coolant (D_2O) circulates through the reactor's fuel channels at high pressure, while the heavy water in the moderator zone is at low pressure.

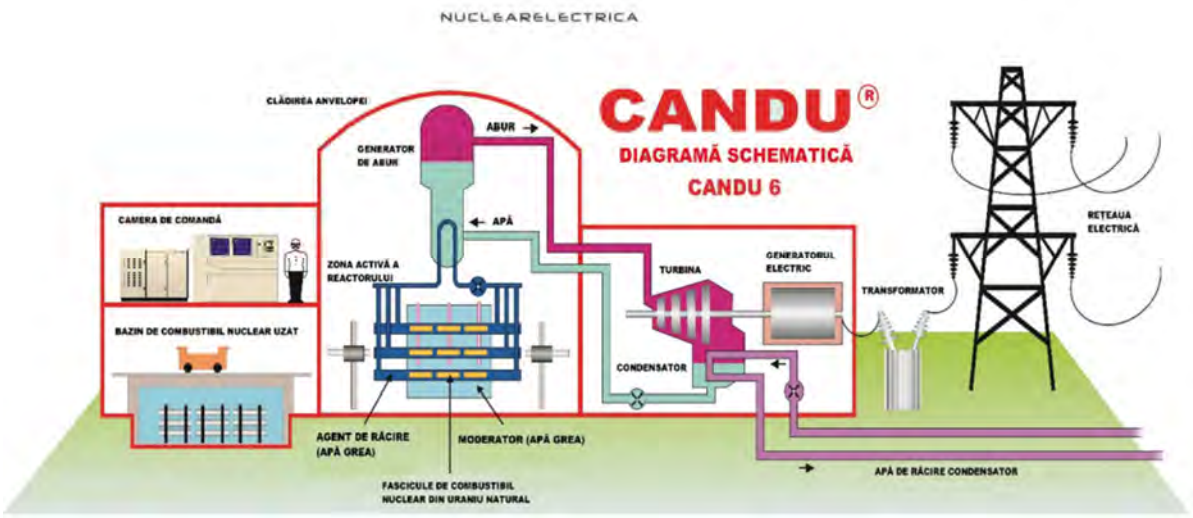


FIGURE 8 - SIMPLIFIED PROCESS FLOW DIAGRAM OF A CANDU 6 NUCLEAR POWER PLANT (NUCLEAR SAFETY REPORT FOR CERNAVODĂ NPP UNIT 1)

The fuel is natural uranium, in the form of sintered ceramic pellets of uranium dioxide (UO_2), coated in Zircaloy and assembled into fuel bundles, each bundle containing 37 fuel elements. The loading and unloading of the fuel is carried out during the operation of the nuclear unit.

The primary heat transfer system is a closed circuit, with two independent loops, which takes the heat generated in the fuel following the controlled fission chain reaction and transfers it, via four steam generators, to the secondary circuit. In the steam generators, the heat is transferred from the heavy water in the primary circuit to the light water in the secondary circuit, resulting in steam. The electrical energy is produced by the turbogenerator, the saturated steam expanding in the turbine, driving its rotor, after which it is condensed with the help of

cooling water taken through an open supply channel from the branch no. 1 of the Danube–Black Sea Canal.

Technological processes involved in the production of electricity using small modular reactors - SMR

Small modular reactors are an innovative nuclear-energy technology designed to combine a high level of safety, operational efficiency and flexibility of deployment at various sites. Each unit is a fully functional, compact reactor using conventional pressurised water reactor (PWR) light-water technology in a modular, integrated configuration. The reactor core contains enriched-uranium fuel in the form of uranium-dioxide (UO_2) ceramic pellets enclosed in metal tubes and arranged in fuel assemblies.

The basic process of energy production is still nuclear fission, as in the case of classical reactors. When a neutron hits a uranium-235 nucleus, the nucleus splits into two lighter fragments, releasing a significant amount of energy in the form of heat, along with other neutrons that continue the chain reaction. This heat is absorbed by the water in the primary loop, which circulates through the reactor core. Unlike conventional reactors, the entire primary system – including the core, steam generators and pumps – is contained in a single pressure vessel, which reduces operational complexity and increases safety.

The water in the primary loop, maintained at high pressure to prevent boiling, transfers heat to the steam generator. Here, the thermal energy is transferred to the water in the secondary loop, which vaporises and produces steam. The steam is directed to the steam turbine, where, by expansion, it transforms its thermal energy into mechanical energy; this drives the electric generator, which converts the mechanical energy into electrical energy.

Technological processes involved in heavy water detritiation on the Cernavodă NPP platform

The tritium removal facility (CTRF – Cernavodă Tritium Removal Facility) at the Cernavodă NPP will be built to reduce the tritium concentration in Units 1 and 2 of the Cernavodă NPP.

The principle of the project's detritiation method consists of removing tritium from tritiated heavy water (DTO) by using a combination of liquid phase catalytic isotope exchange (LPCE) and cryogenic distillation (CD) followed by safe storage of the tritium (metal hydride).

Schematically, the main processes taking place within the CTRF to reduce the tritium content in heavy water and separate it for tritium storage (T2) are:

Before being transferred to the tritium removal facility, the tritiated heavy water coming from the nuclear systems of the Cernavodă NPP – Unit 1 and Unit 2, respectively – is purified, in order to achieve the quality parameters necessary to feed the Catalysed Isotope Exchange (CLSE) columns, by eliminating mechanical impurities and retaining radionuclides, other than tritium, in a purification unit.

• The gaseous flow of tritiated deuterium (DT) / deuterium (D_2) / deuterated hydrogen (HD), resulting from the Catalysed Isotope Exchange (LPCE) process – in which tritiated heavy water circulated countercurrently with a gaseous flow of deuterium (D_2) – is passed through a purification-drying system, where traces of heavy water vapour (DTO) and trace

gases (nitrogen and oxygen) are retained, after which it is transferred to a cascade of columns in the Cryogenic Distillation (CD) system.

• Deuterium gas (D_2) and tritium gas (T_2) are separated by passing the mixture through the columns of the Cryogenic Distillation (CD) system, located in a cold box, which provides the thermal insulation necessary to maintain the cryogenic process temperature (24 K) and which also contains the components of a cryogenic cycle (cryogenic adsorption, heat exchangers, condensers, etc.). T_2 extracted at the bottom of the last cryogenic distillation column is transferred to the tritium handling and storage system, located in a special glove box, where it is immobilised on a metallic bed of spongy titanium.

• detritiated deuterium gas (D_2), from the CD system, is recirculated to the LPCE. The cooling required for the distillation of the deuterium/tritium mixture is provided by a helium gas cycle, respectively by a refrigeration unit based on a helium cooling cycle.

Non-power nuclear technological processes intended to demonstrate the viability of LFR technology

Worldwide, research activities in the field of nuclear energy are focused on the development of a new generation of reactors (Generation IV – Gen IV), with improved performance. In this context, the concept of fast neutron reactors has emerged in recent years as being particularly advantageous from the perspective of the sustainability of nuclear energy as a source with low-carbon emissions. The Generation IV International Forum (GIF), dedicated to the development of Generation IV reactors, supports six technologies: SFR, LFR, GFR, MSR, SCWR and VHTR. Promoted by GIF under the auspices of the OECD Nuclear Energy Agency (OECD/NEA), technologies based on fast neutron fission offer relevant advantages, such as a high level of nuclear safety, a significant reduction in the amount of radioactive waste, improved competitiveness and a much more efficient use of fuel resources.

In Europe, the development of low-carbon energy, together with ensuring energy security, is a major priority. LFR technology is among the technologies supported by the European Union for technological development and commercial deployment over the coming decades through strategic documents such as the SET Plan, the SNETP Strategic Research and Innovation Agenda (SRIA) and the ESNII Roadmap.

The main objectives of LFR technology, identical to those of Generation IV, are:

- minimising the quantities of radioactive waste produced;
- more efficient use of uranium resources;
- achieving increased economic efficiency;
- increasing operational safety.

Romania has been involved in research, development and design activities in the field of LFR fast reactor technology, developing skills by supporting national research programmes, but also by participating in EURATOM - Fission projects under the FP6, FP7 and currently H2020 Programmes. Within the framework of LFR development, the demonstration phase foresees the construction of the ALFRED reactor in order to demonstrate the technical and economic viability of the LFR concept.

Thanks to over twenty years of scientific research efforts, the availability of Lead Cooled Fast Reactor (LFR) technology has advanced significantly and is continuously increasing. These advances, shortening the distance to commercial implementation of mature

LFR systems, are attracting global industrial interest, revealing the urgent need for a key milestone in the roadmap: the construction and operation of an LFR demonstrator to support the viability of the LFR concept. The Advanced Lead Cooled Fast Reactor European Demonstrator (ALFRED) is the answer to this need.

The ALFRED infrastructure comprises 6 experimental facilities (ATHENA, ChemLab, HELENA2, ELF, Hands-On, Meltin'Pot), the ALFRED demonstration reactor and a coordination centre (HUB) intended to coordinate the experimental activities carried out in the ALFRED infrastructure and to carry out education and training activities in the field of LFR.

ALFRED (Advanced Lead Fast Reactor European Demonstrator) is a generation IV nuclear reactor designed to demonstrate, under real conditions, the operation of a liquid lead-cooled fast reactor. This type of reactor is not only intended for energy production, but also for testing and validating innovative technologies that could define the future of nuclear energy.

At the heart of the ALFRED reactor i**s the nuclear** core, where the controlled fission process takes place. The fuel used is, in the first phase, uranium oxide (UO_2), although the design is designed to allow testing of more advanced fuels in the future, including MOX (mixed uranium and plutonium oxide). Unlike conventional reactors, ALFRED does not use a moderator to slow down the neutrons, which means that the fission reaction takes place in a fast regime, with high-energy neutrons. This allows the conversion of non-fissile isotopes into active isotopes, as well as the possibility of reducing the amount and lifetime of radioactive waste.

One of the most distinctive elements of this reactor is the coolant: liquid lead. It circulates through the reactor core and takes the heat generated by fission, keeping the fuel at a safe operating temperature. Lead is a metal with excellent thermal properties, which allows it to operate at high temperatures (over 450°C), which increases the thermodynamic efficiency of energy conversion. At the same time, lead is chemically inert – it does not react explosively with water or air – which makes it safer compared to other coolants, such as sodium.

The heat carried by the lead is transferred, through a heat exchanger, to a secondary circuit, isolated from the primary one. In this second circuit, the heat is used to transform water into steam. This steam drives a turbine which, in turn, drives an electric generator, thus producing energy. However, unlike a classic nuclear power plant, ALFRED does not aim to maximise electricity production, but to demonstrate the reliability and safety of the entire system.

The fission reaction is controlled by control rods inserted into the core, but ALFRED is also designed to operate passively: in **the** event of a failure or emergency shutdown, the residual heat in the core can be evacuated without electricity, through natural processes such as convection. Furthermore, the materials from which the reactor is built, in particular the steels resistant to corrosion produced by liquid lead, are constantly tested and monitored. These tests are essential, because the use of lead as a coolant imposes very demanding technical conditions.

ALFRED is thus not just a reactor, but also a full-scale technological laboratory, designed to verify, test and pave the way for the future development of a generation of fast, efficient, safe and sustainable reactors that can operate commercially in the coming decades.

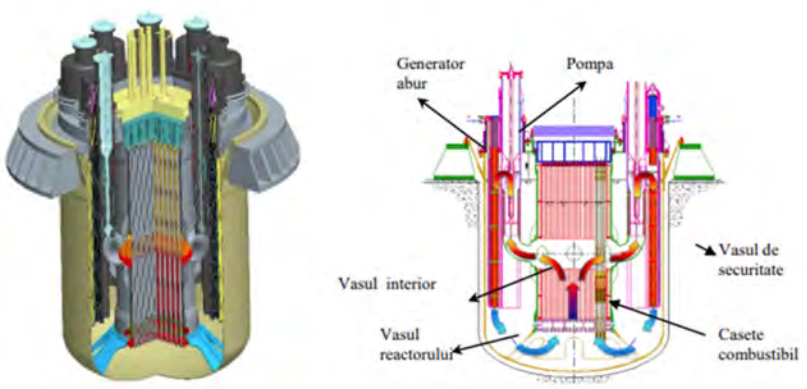


FIGURE 9- ALFRED - 3D VIEW AND VERTICAL SECTION THROUGH THE REACTOR CORE AND PRIMARY CIRCUIT (PROALFRED.NUCLEAR.RO)

2.3.2. JUSTIFICATION FOR IMPLEMENTING THE STRATEGY

Nuclear energy represents a sustainable alternative for the development of the energy sector, given the limited resources of energy raw materials, as well as the need to obtain electricity that does not produce greenhouse gas emissions. The role of nuclear energy becomes even more evident in achieving the ambitious targets for reducing greenhouse gas emissions, while ensuring energy security and an affordable price for end consumers, as well as increasing the country's energy independence.

According to Romania's Energy Strategy 2025-2035, with a perspective to 2050, approved by Government Decision No. 1491 of 21 November 2024, nuclear power generation is one of the priority directions for Romania's energy security and for reducing greenhouse gas emissions from the power-generation sector.

Dependence on energy resources from outside the European Union increases the country's vulnerability to fluctuations in energy markets, affecting the state's ability to effectively manage threats, protect the population and ensure the continuity of the functioning of institutions. Therefore, guaranteeing a constant source of energy is essential for the functioning of critical infrastructures - hospitals, communications, transport, defence. Also, from a social perspective, ensuring a robust and diversified energy mix is a guarantee of the well-being of citizens. This means not only the possibility of having continuous energy, but also job security, price stability and predictability of energy costs for households.

In the context of geopolitical tensions and the risk of escalating conflict between the Russian Federation and Ukraine, Romania must be prepared for potential disruptions in energy supply. Domestic conventional resources can contribute to creating a buffer against external shocks and can ensure the continuity of energy supply in such situations. In order to ensure the country's energy security, Romania must urgently expand the exploitation of nuclear energy resources and analyse the possibility of creating a legislative framework that would regulate the concept of reserve capacity from the perspective of costs for producers who will ensure this capacity, in accordance with European legislative provisions.

Nuclear energy is an important element for Romania's energy security and the reduction of GHG emissions in the energy production sector. Thus, the refurbishment of

existing nuclear units and the construction of new units are considered priority projects within the national energy strategy.

*The National Strategy for the Development o*f the Nuclear Sector foresees the construction of new large-scale and SMR nuclear reactors, which will be able to increase the share of clean energy in the national energy mix. The expansion of the national nuclear sector, with the construction of new large-scale units and small modular reactors (SMRs), will significantly contribute to increasing the production of low-carbon electricity, as well as to ensuring new energy supply solutions in new industrial applications.

In Romania, the current nuclear energy industry is represented by the Cernavodă nuclear power plant (Cernavodă NPP) where two CANDU-PHWR-6 nuclear units operate (Unit 1 from 1996 and Unit 2 from 2007), each providing an electrical power of approx. 705 MWe, under conditions of operational performance and economic efficiency, ensuring nuclear safety and the protection of the population, personnel and the environment. With the two reactors in operation at Cernavodă NPP, the nuclear energy industry contributes over 18% to the current total national energy production and about 33% to Romania's low-carbon energy production.

As nuclear generating units completed in the 1970s and 1980s approach the end of their service lives during 2030-2040, many countries are considering refurbishment and life extension or replacement with other technologies, including new nuclear capacity. Refurbishment of nuclear power plants can double their service lives and therefore the period during which they supply low-carbon electricity. In cost terms, and consequently in terms of subsequent market impact, extending the operating life of nuclear units is currently among the lowest-cost options across all energy sources, including renewable sources.

Romania's Energy Strategy 2025-2035, with a perspective to 2050, states that Romania needs pragmatic development benchmarks, and the vision of the Energy Strategy is to grow the Romanian energy sector. The development of the energy sector requires, on the one hand, coherent and clear energy policies, and on the other hand - investments in the production of energy with low-carbon emissions, by substituting the use of coal with natural gas and renewable energy sources or investments in increasing nuclear energy capacities, investments in the refurbishment, expansion and refurbishment of energy networks by introducing digitalisation and smart grids or the creation and completion, as appropriate, of cross-border interconnections with neighbouring countries and investments in storage capacities.

During normal operation of a CANDU nuclear power plant, tritium, a radioactive isotope of hydrogen, is formed in the heavy water used in nuclear systems. The formation of tritium has a major impact on the conduct of current operating activities, on specific radiation protection measures and programmes, and on the short, medium and long-term management of radioactive waste.

To reduce the tritium concentration and limit its contribution to the radiation doses received by plant personnel, a heavy-water tritium removal facility is required at Cernavodă NPP.

The Cernavodă Tritium Removal Facility (CTRF) will remove tritium from heavy water, maintain its concentration at the lowest practicable level and provide the economic benefits associated with tritium recovery.

The development perspective of the Romanian energy sector took into account the introduction of innovative technologies in nuclear energy based on sma*ll and modular reactors (*SMR-Small Modular Reactor) and new technologies based on generation IV nuclear reactors, as prerequisites for increasing the share of energy with low GHG emissions.

In the context of national and European decarbonisation objectives, including the updated PNIESC and the framework established by GEO no. 108/2022 on the decarbonisation of the energy sector, Romania aims to phase out lignite and coal-based electricity generation capacities from the energy mix. According to art. 3 para. (3) of GEO no. 108/2022, the total installed capacity of lignite and coal-based electricity generation capacities that will be phased out by 2030 at the latest is 4,920 MW, of which 3,070 MW by 31 December 2025 and 710 MW by 31 August 2026. In this context, the development of nuclear capacities contributes to ensuring energy security and reducing greenhouse gas emissions.

In this context, the opportunity of introducing SMR reactors into national decarbonised energy production is noteworthy, followed by the introduction of generation IV reactors, starting at the end of this decade.

Investments in research and development of advanced technologies, including nuclear, will place Romania on the global map as a centre of excellence in clean energy production and storage technologies. This will include the development of new types of generation IV nuclear reactors and innovative solutions for nuclear fuel and radioactive waste management.

Worldwide, research activities in the nuclear energy field are oriented towards the creation of a new generation of nuclear reactors (Generation IV) with improved performance, the concept of fast neutron reactors having emerged in recent years as extremely advantageous in terms of the sustainability of nuclear energy, as clean energy, without carbon emissions.

In Europe, the development of low-carbon energy is, alongside ensuring energy security, a high priority. The European Strategic Energy Technology Plan (SET Plan) supports the achievement of the overall objective of the EU strategy for sustainable, zero-carbon energy technologies of having at least one demonstration plant for Generation IV technologies by 2030. LFR (lead-cooled fast reactor) technology is extremely promising due to its enhanced safety features.

Within the LFR development, the demonstration phase envisages the construction of the ALFRED reactor in order to demonstrate the technical and economic viability of the LFR concept.

The Advanced Lead-cooled Fast Reactor European Demonstrator (ALFRED) and associated experimental facilities planned to be built in Romania represent a complex and flexible infrastructure that has been designed to meet the current and future needs generated by the technology of lead-cooled fast reactors (LFR). The ALFRED project aims to verify the LFR technology at scale, which involves testing the functional characteristics, fuel performance, materials, component systems, safety features, etc., as well as demonstrating the sustainability of the concept, in particular from an economic point of view (one of the main requirements of innovative Generation IV nuclear systems being economic efficiency). Given these needs, the ALFRED infrastructure was conceived with the main goal of accelerating the design process, demonstration of nuclear safety and licensing of the ALFRED reactor.

The LFR demonstrator is intended to show that a deployable lead-cooled SMR concept, based on existing technological solutions, is compatible with short-term global needs (2035-2040) related to decarbonisation and security of energy sources.

Innovative nuclear power systems, using advanced concepts belonging to a new generation of nuclear technologies (Generation IV), have the potential to achieve the highest performance in terms of sustainability, security, proliferation resistance and economy. The vision for a near future that benefits from LFR as a new sustainable energy source that is clean, resource-efficient, safe and economical - was the driving force behind the pan-European efforts that ultimately led to the ALFRED Project.

The European Lead-Cooled Fast Reactor Demonstrator is the necessary cornerstone to achieve this vision, projecting LFR technology from laboratories into the real world. The construction in Romania and successful operation of ALFRED will provide exhaustive proof of the technical viability of the concept and equip Europe with a unique platform to reach the level of readiness necessary to enable a leading position for this innovative technology at the global level.

In accordance with the National Strategy for the Development of the Nuclear Sector, Romania aims to expand and modernise its nuclear infrastructure through investments in research, education, nuclear safety and innovative applications. One of the essential pillars of this strategy is the consolidation of fundamental and applied research through infrastructures of excellence such as ELI-NP – *Extreme Light Infrastructure – Nuclear Physics*.

The ELI-NP project, located in Măgurele, is considered a major strategic investment, both from a scientific and technological point of view. In line with the objectives of the national strategy, this infrastructure aims to develop national capabilities in high-performance nuclear research, but also to directly apply the results in areas of public interest, such as nuclear medicine and energy security.

An important objective within the ELI-NP, explicitly supported by the strategy, is the construction of a specialised infrastructure for the production of radioactive beams and radioisotopes of medical interest. These radioisotopes play an essential role in the health sector, being used both in diagnostics (PET, SPECT) and in modern oncological treatments. In the current context, Romania relies largely on imports for these resources, which involves high costs and logistical risks. The implementation of a national production source, in line with the strategy, represents an important step towards health and technological autonomy.

In parallel, the strategy supports the development of fundamental research with long-term impact. The 10 PW laser system installed at ELI-NP, the only one of its kind in the world, provides access to an unprecedented light-matter interaction regime. This research tool allows the investigation of nuclear and subatomic phenomena relevant to particle physics, nuclear fusion, astrophysics and even nuclear safety. Thus, ELI-NP directly contributes to the achievement of the strategic objectives regarding scientific advancement and international cooperation in the nuclear sector.

One of the fundamental objectives of the National Strategy for the Development of the Nuclear Sector is the safe, sustainable and responsible management of radioactive waste generated by the use of nuclear energy and associated technological applications. The Strategy recognises that a sustainable development of the nuclear sector cannot exist without a solid policy on the treatment, storage and final disposal of this waste.

Currently, Romania has established the use of nuclear fuel in an open cycle, considering spent nuclear fuel as "high-level waste", which is to be permanently deposited in a deep geolo***gical repository, without*** the intention of recovery. This repository involves the permanent storage of spent nuclear fuel, high-level radioactive waste and long-lived low- and intermediate-level radioactive waste, in an appropriate facility, at great depths, using natural and engineered barriers, thus avoiding the risk of radioactive contamination of the biosphere.

Description of the implementation stages of the National Strategy for the Development of the Nuclear Sector

The SNDDN and PNN update is for the period 2026-2030, with a perspective to 2050. The life cycle of nuclear facilities is long. Practically, for all existing and planned nuclear facilities in the SNDDN and PNN, the life cycle is beyond 2050, for example the life cycle of nuclear power units U3 and U4 ends after 2100.

The objectives included in the National Strategy for the Development of the Nuclear Sector have different implementation periods, determined by a series of aspects including: the technical complexity of each, the completion of the necessary studies and approvals, the method of ensuring compliance with regulatory and nuclear safety requirements in the different stages of nuclear authorisation.

TABLE 11- IMPLEMENTATION STAGES AND SCHEDULE OF THE NATIONAL STRATEGY FOR THE DEVELOPMENT OF THE NUCLEAR SECTOR

Projects	Period	Actions
Refurbishment of Unit 1	2017 – 2022	Phase 1 of the project began in 2017 and had as its main objective the definition of the scope of the refurbishment of Unit 1 (retubing activities, design changes, implementation of recommendations from the assessment of the condition of systems and components, etc.) and the development of the Feasibility Study. Phase 1 was completed on 23.02.2022 by AGA Decision no. 4/23.02.2022, by which, at point 2, the Investment Decision regarding the Project for the refurbishment of Unit 1 of the Cernavodă NPP was approved based on the Feasibility Study.
	2022 – 2026	Phase 2 of the project began after the approval of the Investment Decision regarding the Project for the Refurbishment of Unit 1 of the Cernavodă NPP based on the Feasibility Study and includes the activities of preparing the works identified and defined in the first phase, securing financial resources, concluding engineering, procurement and construction contracts, procuring the necessary equipment, planning activities, as well as obtaining all necessary authorisations, approvals and notices.
	2027 – 2030	Phase 3 of the project will begin with the shutdown of Unit 1 and consists of the actual implementation of the works within the Refurbishment Project, followed by the commissioning of the unit and its trial operation.

Completion of Units 3 and 4	2030-2031	Commissioning of Unit 3-2030, Unit 4-2031.
CTRF Project (Cernavodă Tritium Removal Facility)	2023	The execution contract (EPC) was signed with Korea Hydro & Nuclear Power (KHNP), the company chosen to develop the project due to its experience in the field of similar facilities.
	2023	Obtaining the necessary permits has begun.
	2024	The siting authorisation, construction and installation authorisation, and building permit were obtained, and construction works began.
	2026**:**	Commissioning tests for the tritium removal facility are expected to begin.
	2027	Start of trial operation for the tritium removal facility, followed by handover to operation.
SMR	2019	Nuclearelectrica and NuScale signed a Memorandum of Understanding for the evaluation and development of SMR in Romania.
	2020	Romania signed an Intergovernmental Agreement with the US on nuclear projects, ratified in 2021.
	2021	At COP26, Nuclearelectrica and NuScale announced the plan to implement the first SMR in Europe.
	2022	The site of the former thermal power plant in Doicești is on the list of candidate sites for the development of SMRs, and is under evaluation.
	2022	The preliminary engineering design (FEED) for the SMR project in Romania.
	2023	Continuing engineering and design studies.
DFDSMA	2025-2027	Obtaining the Environmental Agreement and the siting authorisation According to Government Ordinance No. 7/2003 on the peaceful use of nuclear energy, "The location of nuclear power and research reactors, as well as of final repositories for radioactive waste and spent nuclear fuel, is approved by law, based on the National Strategy for the Development of the Nuclear Sector and the authorisations issued by the regulatory body."
	2027-2028	Design authorisation
	2028-2031	Building permit (including construction of the first eight cells).
	2030-2032	Operator selection and obtaining operating authorisation (first 8 cells).
	2032-2100	Operation and expansion.
	2100	Closure authorisation and post-closure monitoring.
Deep Geological Repository	2023	Selecting the storage concept.
	2024	Site selection strategy.
	2025	Research and development plan for implementation.
	2028	Host rock selection.
	2030	Site research/characterisation.
	2045	Siting authorisation.
	2050	repository construction.
	2055	Operating authorisation.
	2150	Post-closure control period.

The Doicești SMR is currently in an early stage, with a series of initial engineering and design activities and a technical analysis of the former Doicești power plant site underway. FEED 2 studies, which represent design and engineering activities to define and detail the technical solution, have recently begun, with an estimated duration of 15 months.

According to the updated project calendar, the module installation and commissioning phase is scheduled for the period 2029-2034, with the calendar to be further detailed after the completion of the FEED studies by the project company, RoPower Nuclear.

The DFDSMA is designed to be expandable in successive stages to provide additional storage capacity when needed. The repository will remain open until around 2100 to allow for the final disposal of all LILW-SL waste that will be produced by the decommissioning of the Cernavodă reactors.

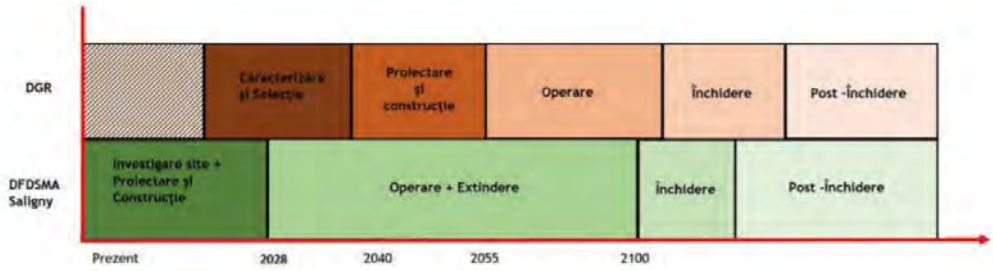


FIGURE 10 - PLANNED FINAL DISPOSAL FACILITIES FOR RADIOACTIVE WASTE AND SPENT NUCLEAR FUEL IN ROMANIA UNDER THE MEDIUM- AND LONG-TERM NATIONAL STRATEGY FOR THE SAFE MANAGEMENT OF SPENT NUCLEAR FUEL AND RADIOACTIVE WASTE

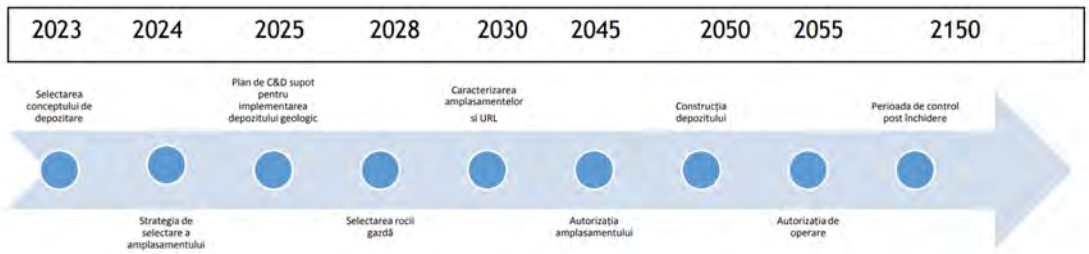


FIGURE 11 - IMPLEMENTATION SCHEDULE FOR THE GEOLOGICAL DISPOSAL PROGRAMME (IN ACCORDANCE WITH THE MEDIUM- AND LONG-TERM NATIONAL STRATEGY FOR THE SAFE MANAGEMENT OF SPENT NUCLEAR FUEL AND RADIOACTIVE WASTE)

The natural resources necessary for the implementation of the strategy (water abstraction, renewable resources, non-renewable resources, others) highlighting those that will be exploited within the protected natural area(s) of Community interest

For the operation of Units 1, 2, 3 and 4 at Cernavodă NPP, the main natural resource used is uranium. According to the Action Plan for implementing Romania's Energy Strategy 2025-2035, with a perspective to 2050, approved by Government Decision No. 1491/2024, Romania has an open nuclear fuel cycle based on Canadian CANDU technology. Uranium dioxide (UO_2), used to manufacture the nuclear fuel required for the Cernavodă reactors, is produced by processing and refining uranium of domestic or imported origin.

In order to increase the security of supply of raw materials necessary for the manufacture of nuclear fuel at the Nuclear Fuel Factory (FCN) Pitești and reduce import

dependence on the nuclear fuel production chain, the Nuclearelectrica S.A. (SNN) acquired the Uranium Concentrate Processing Plant from the National Uranium Company (CNU) in order to consolidate the nuclear cycle and streamline the cost of raw materials necessary for the manufacture of nuclear fuel for the Cernavodă NPP.

Also, in order to consolidate the nuclear fuel cycle, in 2021 SNN S.A. took over, free of charge, the concession licence for uranium-ore mining in the Tulgheș-Grințieș perimeter, Neamț County. Bringing this deposit into production will create the conditions for using domestically extracted uranium ore.

Unlike the CANDU reactors at Cernavodă NPP, which use natural, unenriched uranium, the new NuScale small modular reactors (SMRs) planned for implementation in Romania will use low-enriched uranium. The fuel will be uranium oxide enriched to a maximum of 4.95% U-235. This enables an SMR to achieve a higher energy density, use a compact design and require less frequent refuelling while maintaining a high level of nuclear safety. The source of uranium supply is not known at this stage and will be determined subsequently.

Another important resource, necessary for the implementation of the Strategy, is water. Water, a fundamental natural resource, plays a critical role in the operation of nuclear power plants, being used as a coolant to evacuate the residual heat generated in the reactor. In the case of the CANDU units at the Cernavodă NPP, the coolant is provided by taking water from the Danube River, with its passage through open cooling circuits. For the future small modular reactors (SMRs), the configuration of the cooling systems will be established later, the cooling-water supply source not yet being established.

Other natural resources used in the execution stage of the strategy's objectives are: soil (resulting from excavations and reused for fillings), stone, ballast, natural aggregates for the preparation of concrete (sand, gravel, etc.).

The materials that will be used to carry out the investments (natural aggregates - ballast, crushed stone, rough stone, gravel, sand) will be brought to the site by the contractors (including construction materials) and will not undergo technological processes, and will only be put into operation according to the construction and assembly technologies approved for each project. The materials are procured from authorised sources, being gradually transported to the installation site. Large stocks will not be formed in the area of the work fronts.

The soil, the land on which the strategy is implemented, represents a non-renewable natural resource. The soil resulting from the excavation will be used for backfilling.

As results from the overlapping of the projects with the land use map - Corine Land Cover - 2024, the core objectives provided for in the development strategy will be achieved on lands with an anthropogenic character, predominantly in the yard-construction land use category, but also agricultural lands (DFDSMA).

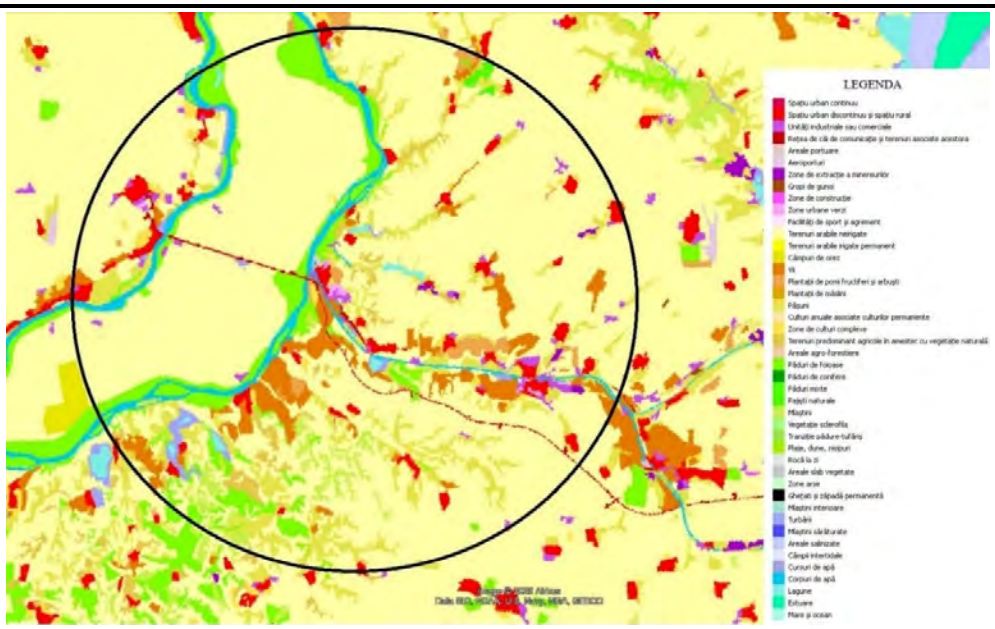


FIGURE 12- LAND USE WITHIN THE AREA OF INFLUENCE OF CERNAVODĂ NPP AND THE DFDSMA

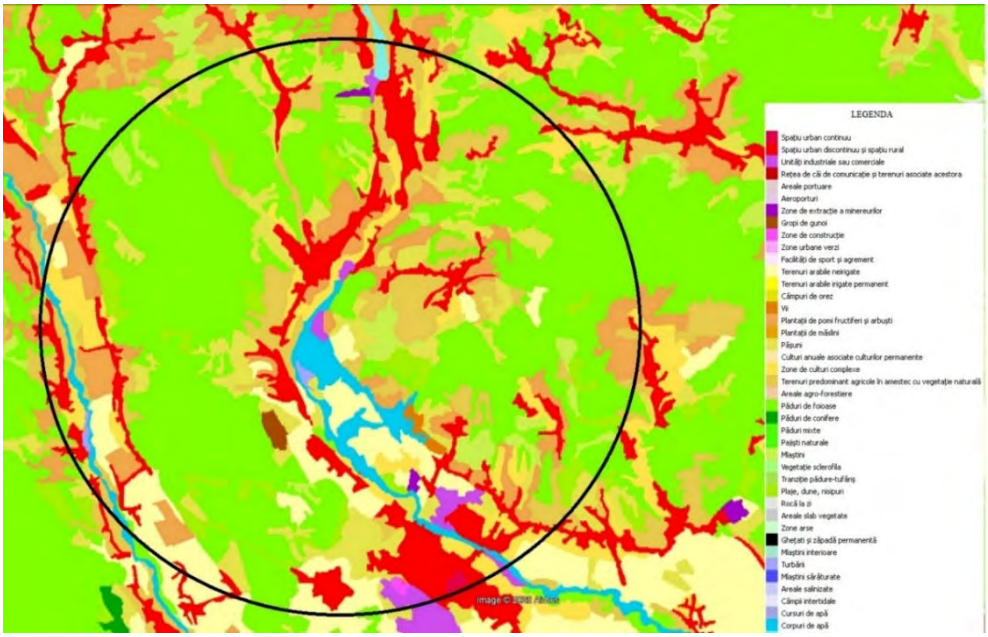


FIGURE 13- LAND USE WITHIN THE AREA OF INFLUENCE OF THE DOICEȘTI PLATFORM

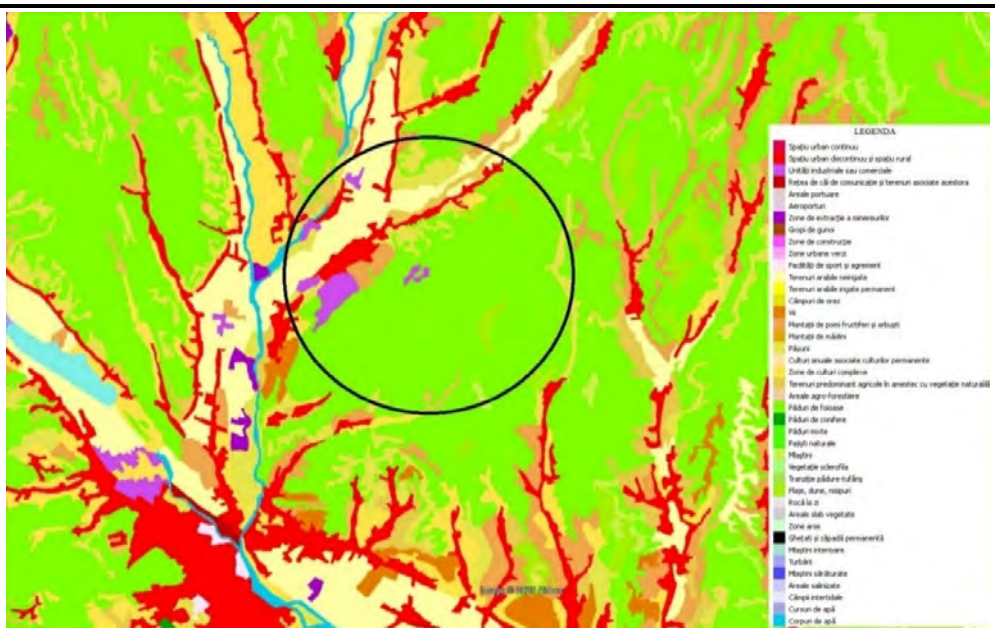


FIGURE 14- LAND USE WITHIN THE AREA OF INFLUENCE OF THE MIOVENI PLATFORM

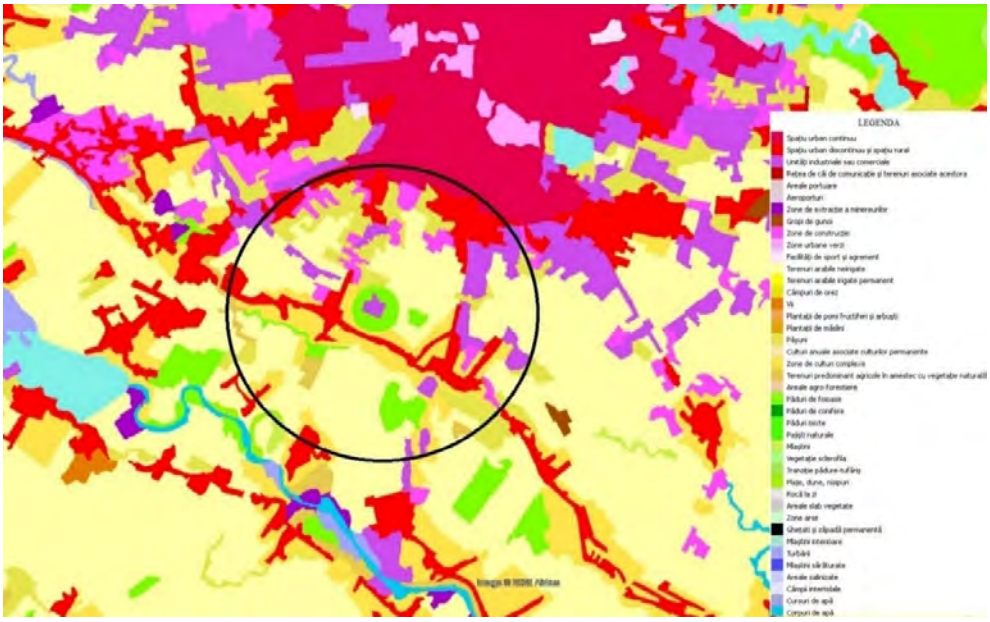


FIGURE 15- LAND USE WITHIN THE AREA OF INFLUENCE OF THE MĂGURELE PLATFORM

The resources necessary for the implementation of the projects of the National Nuclear Strategy and Programme will be made available by the companies that will carry out the construction works and by the suppliers of construction materials.

It is recommended to avoid the exploitation of natural resources within protected natural areas in order to implement the proposals of the National Nuclear Strategy and Programme.

TABLE 12 - INFORMATION ON PRODUCTION, RAW MATERIALS, SUBSTANCES AND CHEMICAL PREPARATIONS USED OR PRESENT IN VARIOUS ITEMS OF EQUIPMENT AT THE SITE

Information on the production being carried out	Within the Strategy, electricity generation is provided exclusively by power-generation facilities, such as Cernavodă NPP and the Doicești SMR project. The two units currently operating at Cernavodă NPP can generate approximately 10.6 TWh (net) of electricity per year, given their high capacity factor. The National Strategy for the Development of the Nuclear Sector envisages approximately doubling this output through the commissioning of Units 3 and 4, which are expected to contribute approximately 11 TWh per year. Consequently, nuclear energy could account for approximately 36% of Romania's electricity generation in the next decade. NuScale SMRs have a capacity of 77 MWe/module, and the Doicești plant will include six modules, with a total capacity of 462 MWe. The proposed investments at the RATEN ICN Mioveni and IFIN-HH Măgurele sites comprise research infrastructure and are not production facilities. They fall within the scope of scientific research, design and technological engineering activities and provide scientific and technical support for the development of nuclear power in Romania.
Information on raw materials used	*Uranium dioxide* During the operation of the nuclear power units at the Cernavodă NPP, the raw material for the manufacture of nuclear fuel bundles at the Pitești Nuclear Fuel Factory (FCN Pitești) is the sinterable uranium dioxide UO 2 powder resulting from the purification and conversion processes of technical uranium concentrates (the finished product of FPCU-Feldioara SRL). The uranium supply source is not known at this time in the case of the Doicești SMR, and will be determined later. *Water* The supply of technological (industrial) water is made from the Danube River, the first branch of the Danube-Black Sea Canal, through the diversion canal. The technology used for energy production using the nuclear process involves the use of a significant amount of water to cool the heat transfer systems. In the operation of the Cernavodă NPP, Danube water is used to ensure the takeover of the heat source from the condensers. The amount of water used is provided by the project and can only be adjusted within very small limits, depending mainly on the external temperature of the incoming water. According to the requirement of the Water Management Authorisation, a water requirement is issued annually for the following year. *Volumes of technological water authorised according to the Authorisation water management at Cernavodă NPP*

2024	Volum
Apă tehnologică	
Volumele și debitele de apă tehnologică pentru funcționarea celor 2 unități în regim permanent, 365 zile/an și 24 ore/zi	
Q zi maxim	9.331.200 m^3/zi (108.000 l/s)
Q zi mediu	6.863.616 m^3/zi (79.440 l/s)
V anual max.	3.405.888 mii m^3
V anual med.	2.505.220 mii m^3

Regarding domestic water, starting with 2031, with the increase in production through the commissioning of U3, domestic water consumption will increase by 50%, compared to the reference consumption (corresponding to 2023), with two units in operation.
Starting with 2032, with the increase in production through the commissioning of U4, domestic water consumption will increase by 50%, compared to the reference consumption (corresponding to 2023), with two units in operation.
From 2033 with 4 units in operation, domestic water consumption will increase by 100%, compared to the reference consumption (corresponding to 2023), with two units in operation.
Domestic water is used exclusively for washing or decontamination, being taken over by the sewerage network of the city of Cernavodă and transmitted to the treatment plant where it will be subjected to the treatment process so that the effluent complies with the discharge conditions imposed by the regulations in force.

Water-use targets for Cernavodă NPP

Ținte apă și resursele Marine CNE Cernavodă	UM	Anul de referință 2023*	Țintă pentru 2030	Țintă pentru 2035	Țintă pentru 2040	Țintă pentru 2045	Țintă până în 2050
Apă tehnologică (prelevată)	mii mc	2.406.239	2.574.688	2.485.607	2.485.607	2.485.607	2.485.607
Apă menajeră	mc	550.584	550.584	1.101.168	1.101.168	1.101.168	1.101.168
Apă tehnologică (recirculată)	mii mc	254.334	250.000	250.000	250.000	250.000	250.000
Apă tehnologică evacuata	mii mc	2.151.905	2.324.688	2.235.607	2.235.607	2.235.607	2.235.607

Under the Environmental Agreement of 25 September 2013 for the project "Continuation of the Construction and Completion Works for Units 3 and 4", cooling water from the four nuclear units will be discharged to the Danube through a cooling-water discharge system consisting of culverts, tunnels, an open concrete-lined channel and an earth channel discharging into the Danube. The system is designed for a discharge flow of 200 m^3/s through the concrete-lined channel. Circulating water and process water from Units 3 and 4 will be discharged to the Danube or, in special circumstances, to Reach II of the Danube-Black Sea Canal.
For future small modular reactors (SMRs), the configuration of the cooling systems and the cooling-water supply source will be established at a later stage.

Information on chemical substances	Cernavodă NPP uses hazardous substances/mixtures covered by Regulation (EC) No. 1,907/2006 of the European Parliament and of the Council of 18 December 2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals

or preparations used or contained in equipment	(REACH), establishing the European Chemicals Agency, amending Directive 1999/45/EC and repealing Council Regulation (EEC) No. 793/93 and Commission Regulation (EC) No. 1,488/94, as well as Council Directive 76/769/EEC and Commission Directives 91/155/EEC, 93/67/EEC, 93/105/EC and 200/21/EC, as subsequently amended and supplemented. Cernavodă NPP uses hazardous substances and mixtures for the chemical control of fluids in the plant's circuits and equipment, for maintenance and repair activities, for laboratory analyses and in activities/services for implementing modifications/projects developed on site. At the site level, procedures are established and approved regarding the management of chemical substances that ensure rigorous quantitative and qualitative control, as well as appropriate monitoring and reporting to the competent authorities. Chemical products purchased directly or through service contracts and used in activities within the Cernavodă NPP are classified, packaged and labelled according to the legal requirements in force (REACH Regulation, CLP Regulation, etc.). **Chemicals used in the operation of research infrastructure - LFR** Given that the investment serves research on LFR (Lead Cooled Fast Reactor) systems, both the ATHENA facility and the ChemLab laboratory use (molten) lead either as a primary coolant (ATHENA) or as a laboratory material (ChemLab). The total amount of lead is 880 tons. During operation, components of the experimental facilities that use lead may gradually accumulate solid deposits of lead oxides or corrosion products. These components can be cleaned using aqueous chemical solutions. Cleaning is carried out safely in dedicated basins containing an acidic aqueous solution. In some cases, cleaning may also be required for larger sections of the facility, not only for individual components.

3. RELEVANT ASPECTS OF THE CURRENT STATE OF THE ENVIRONMENT AND ITS LIKELY EVOLUTION IF THE PROPOSED STRATEGY IS NOT IMPLEMENTED

The characterisation of the current state of the environment was carried out based on the data and information available at the time of the Environmental Report, relating to the national territory. These were validated and made public through the Report on the State of the Environment in Romania – 2024, prepared by the National Agency for the Environment and Protected Areas, as well as through other relevant documents and documentation. The analysis of the current state of the environment was carried out for each environmental component considered relevant.

The environmental aspects analysed include: air quality, water, soil and subsoil geology, climate change, biodiversity, landscape, human settlements, population and human health, cultural heritage, material assets, as well as discomfort factors generated by noise, vibrations, heat, light and radiation.

3.1. Air

Air quality is a determining factor for the health of the population and for maintaining the balance of ecosystems, being influenced by multiple anthropogenic activities, such as industrial, transport, agriculture, waste management and energy production. In Romania, air quality assessment and monitoring is carried out through the National Air Quality Monitoring Network (RNMCA), coordinated by the National Agency for the Environment and Protected Areas.

The National Strategy for the Development of the Nuclear Sector aligns with the energy transition objectives set at European level through the "Fit for 55" legislative package, the Integrated National Energy and Climate Change Plan (PNIESC 2021–2030), as well as the European Green Deal. It aims to reduce greenhouse gas emissions and increase the share of low-carbon energy sources, including nuclear energy.

According to the National Inventory Document of Romania 2024, developed by the National Environmental Protection Agency, for the analysis of trends, the greenhouse gas emissions related to each sector were expressed in CO_2 equivalents, using the Global Warming Potential (GWP) values provided by the Intergovernmental Panel on Climate Change (IPCC) in the Fifth Assessment Report. The evolution of total greenhouse gas emissions is illustrated in the following graph.

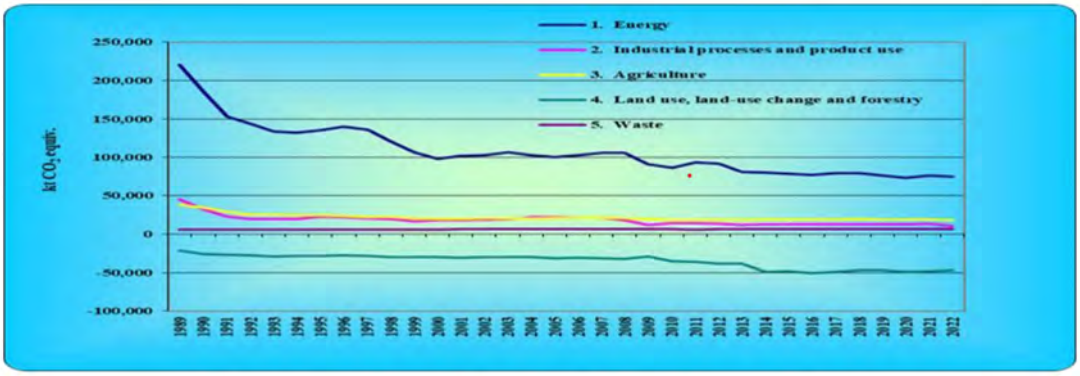


FIGURE 16 - TREND IN TOTAL GHG EMISSIONS BY SECTOR

The GHG emissions trend reflects the main developments in the country's economic development. The period is characterised by a transition process towards a market economy, economic restructuring, and the commissioning of the first reactor at the Cernavodă nuclear power plant (1996).

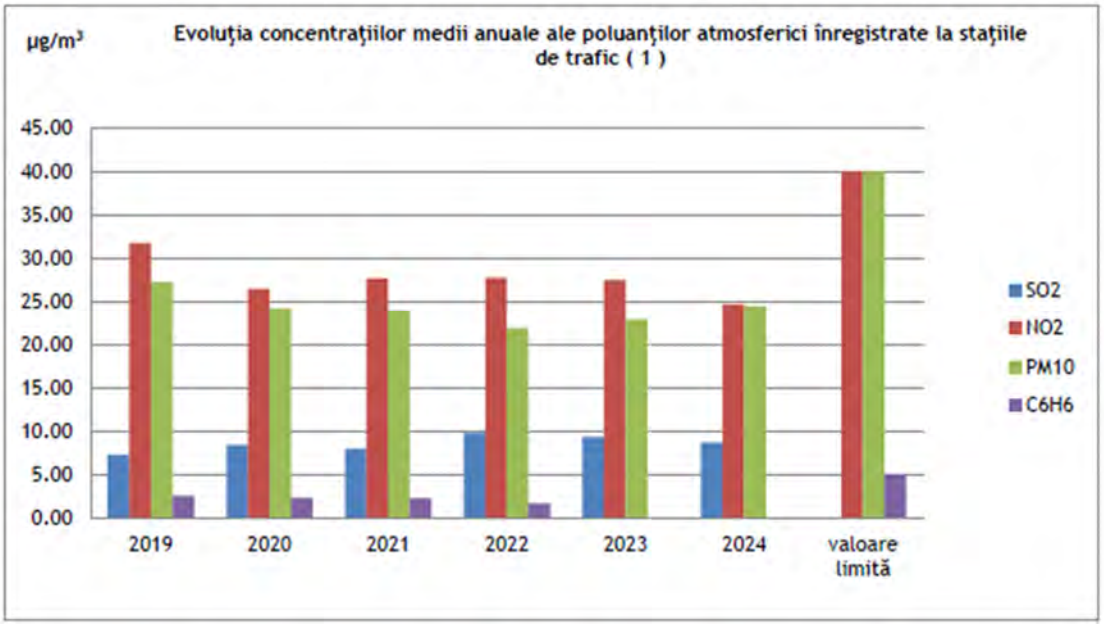
Emissions started to increase after 2000, as a consequence of the economic recovery; in 2009, emissions decreased significantly compared to the 2008 level, and in 2010 they continued to decrease, amid the economic crisis. In 2011, emissions started to increase again, while in 2012–2016 they decreased; in 2017–2018 they increased, and in 2019–2020 they decreased, following the level of economic activities. In 2021, emissions increased, while in 2022 they decreased.

According to ANPM data, the annual average concentrations of the atmospheric pollutants NO 2, SO 2, PM_{10}, O 3, C 6 H 6, Pb, As, Cd and Ni are determined within the RNMCA (National Air Quality Monitoring Network) at background, traffic and industrial stations annually, in relation to the annual limit value / target value.

From the ANPM data for 2024, it is found that the annual limit value for NO 2 was exceeded at station B-3, the target value for ozone was exceeded at 16 stations, at none of which it was exceeded more than 25 times/year.

Most air pollutants come from combustion in the energy industry, industrial activities that generate emissions of substances and particles that are released into the atmosphere and can reach harmful concentrations. Trends in the annual average concentrations of certain air pollutants from 2019-2024 recorded at different types of air quality monitoring stations in the RNMCA are presented in the following figures.

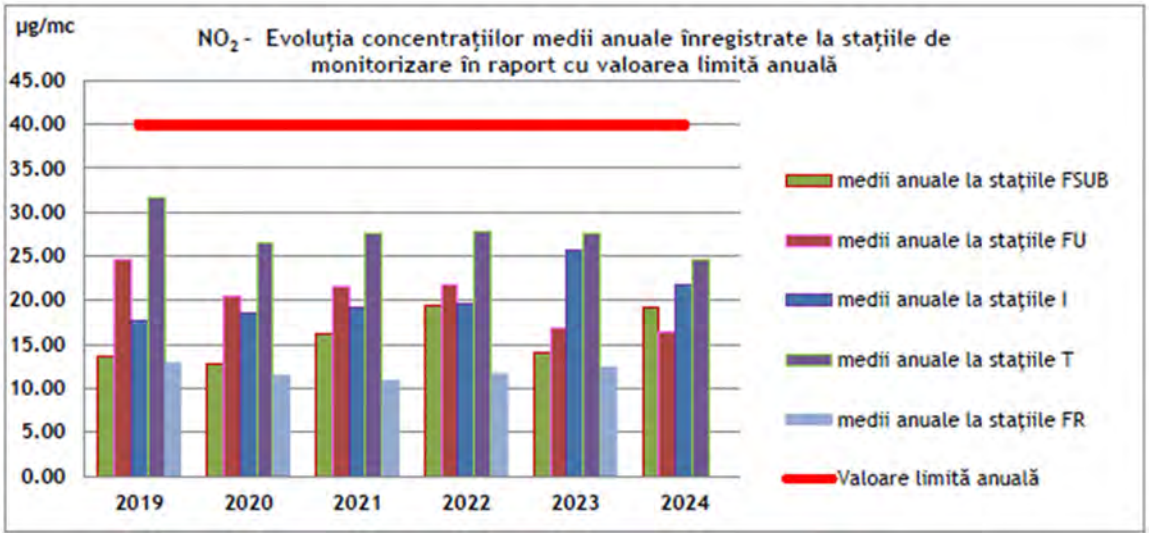
FIGURE 17 - *ANNUAL AVERAGE CONCENTRATIONS OF AIR POLLUTANTS (NO_2, SO_2, PM_{10}, C_6H_6, Pb, Cd, Ni AND As) RECORDED AT TRAFFIC MONITORING STATIONS, 2019-2024*



Source: RSM 2024- ANMAP

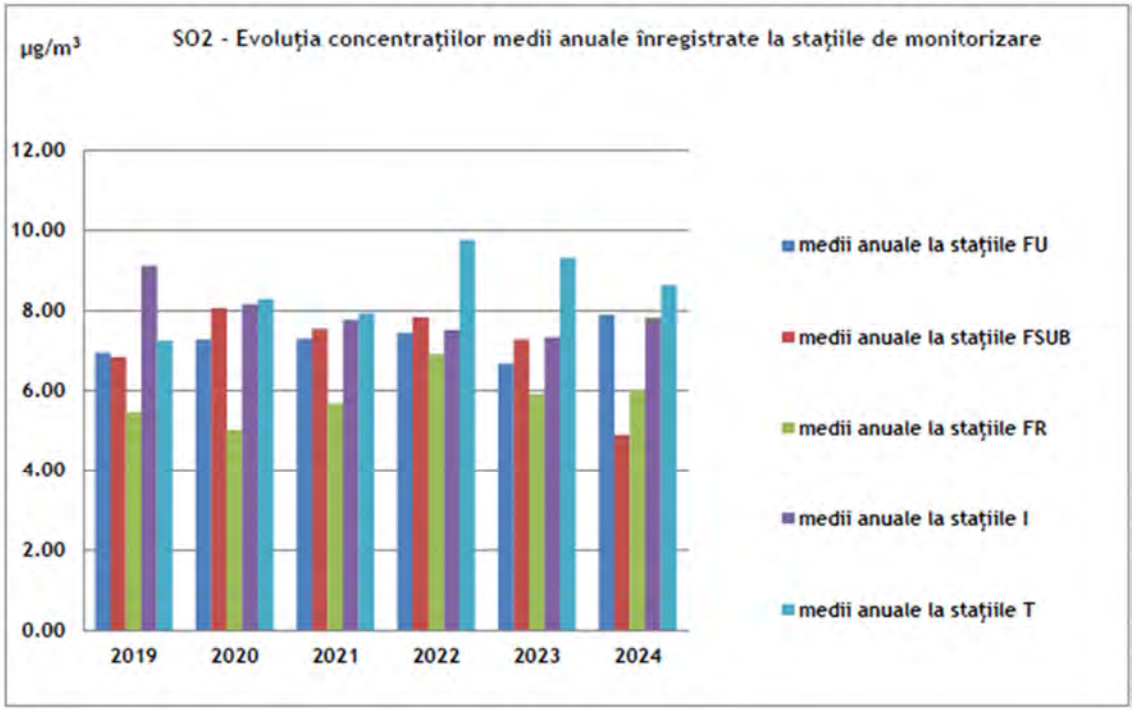
From the analysis of the data presented in the graphs in the figure above, it can be seen that in 2019, for all pollutants studied at traffic stations, increased annual average concentrations were recorded, which were usually below the limit values/target values, with a decrease in 2020. In 2021, the values increased, without exceeding the limit values/target values. In the period 2021-2023, the values obtained are comparable to those in 2021, remaining relatively constant, with a decreasing trend in 2024.

FIGURE 18 - *ANNUAL AVERAGE NO_2 CONCENTRATIONS RECORDED AT MONITORING STATIONS COMPARED WITH THE ANNUAL LIMIT VALUE AND TARGET VALUE, 2019-2024*



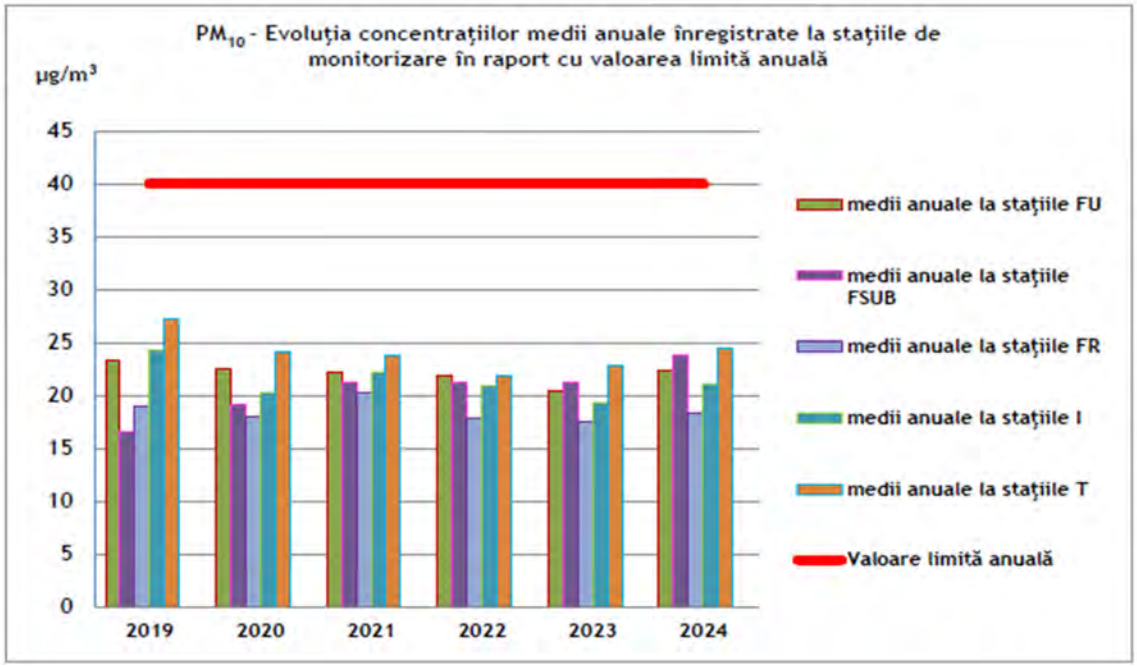
Source: RSM 2024- ANMAP

FIGURE 19 - *ANNUAL AVERAGE SO_2 CONCENTRATIONS RECORDED AT MONITORING STATIONS COMPARED WITH THE ANNUAL LIMIT VALUE AND TARGET VALUE, 2019-2024*



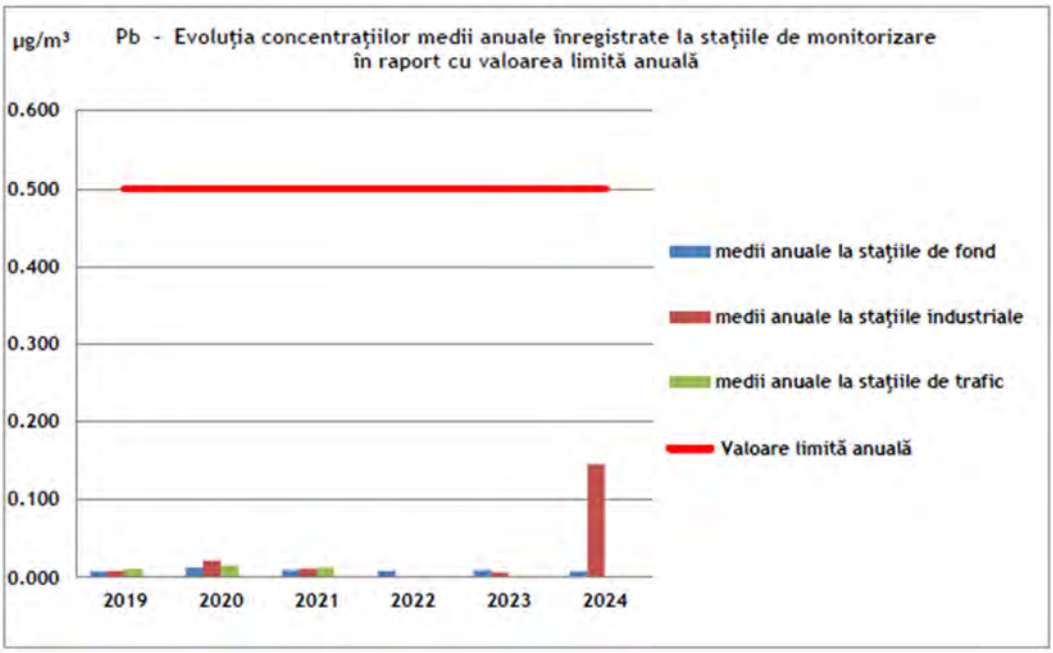
Source: RSM 2024- ANMAP

FIGURE 20 - *ANNUAL AVERAGE PM_{10} CONCENTRATIONS RECORDED AT MONITORING STATIONS COMPARED WITH THE ANNUAL LIMIT VALUE AND TARGET VALUE, 2019-2024*



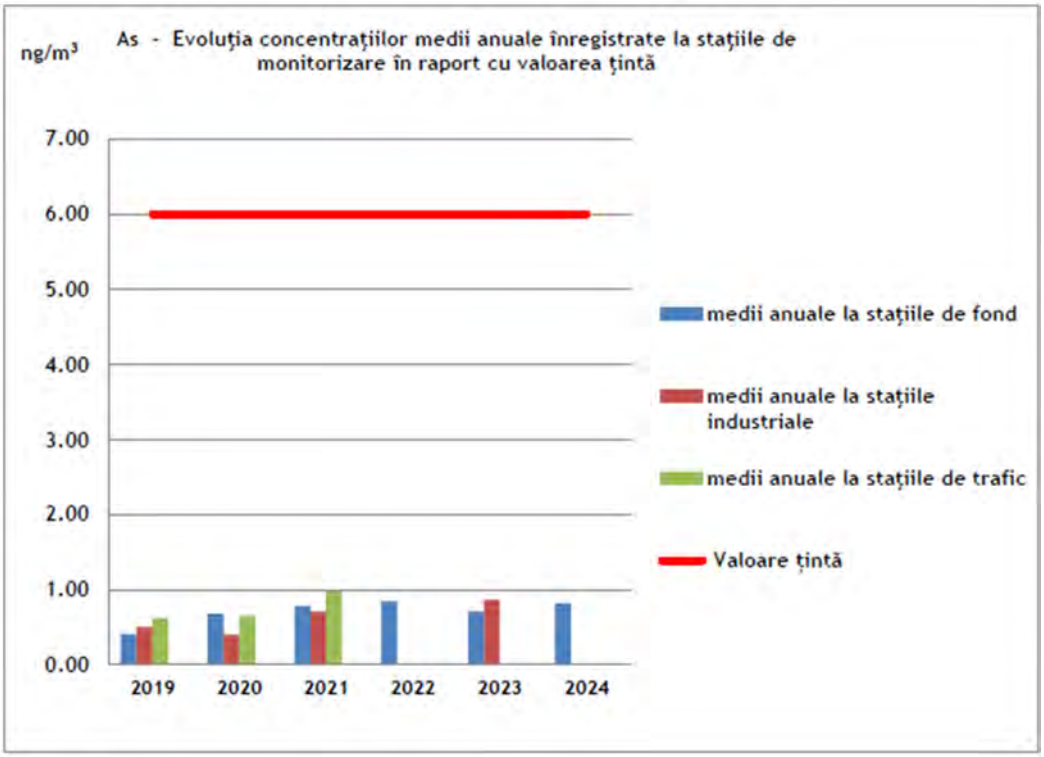
Source: RSM 2024- ANMAP

FIGURE 21 - ***ANNUAL AVERAGE Pb CONCENTRATIONS RECORDED AT MONITORING STATIONS COMPARED WITH THE ANNUAL LIMIT VALUE AND TARGET VALUE, 2019-2024***



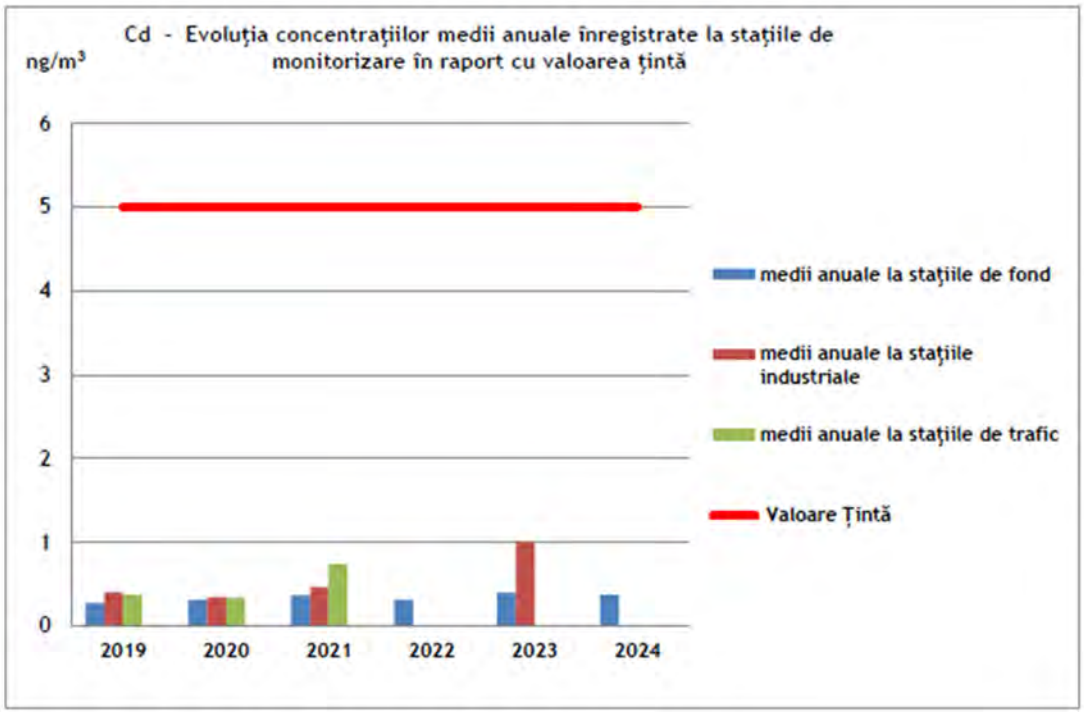
Source: RSM 2024- ANMAP

FIGURE 22 - ***ANNUAL AVERAGE As CONCENTRATIONS RECORDED AT MONITORING STATIONS COMPARED WITH THE ANNUAL LIMIT VALUE AND TARGET VALUE, 2019-2024***



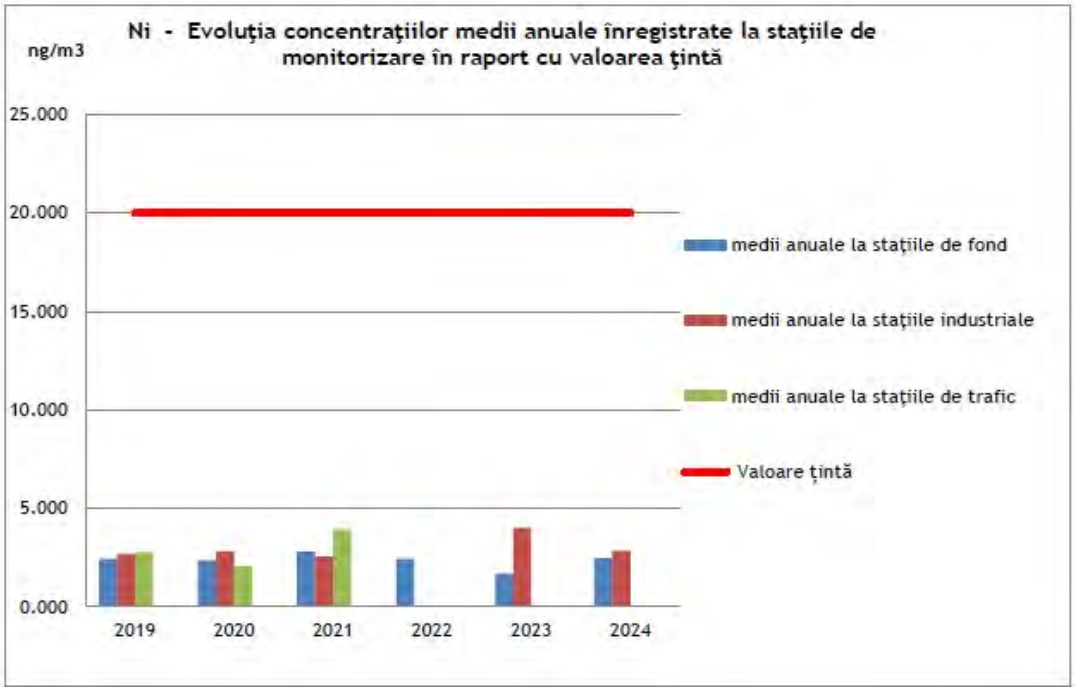
Source: RSM 2024- ANMAP

FIGURE 23 - ***ANNUAL AVERAGE Cd CONCENTRATIONS RECORDED AT MONITORING STATIONS COMPARED WITH THE ANNUAL LIMIT VALUE AND TARGET VALUE, 2019-2024***



Source: RSM 2024- ANMAP

FIGURE 24 - ***ANNUAL AVERAGE Ni CONCENTRATIONS RECORDED AT MONITORING STATIONS COMPARED WITH THE ANNUAL LIMIT VALUE AND TARGET VALUE, 2019-2024***

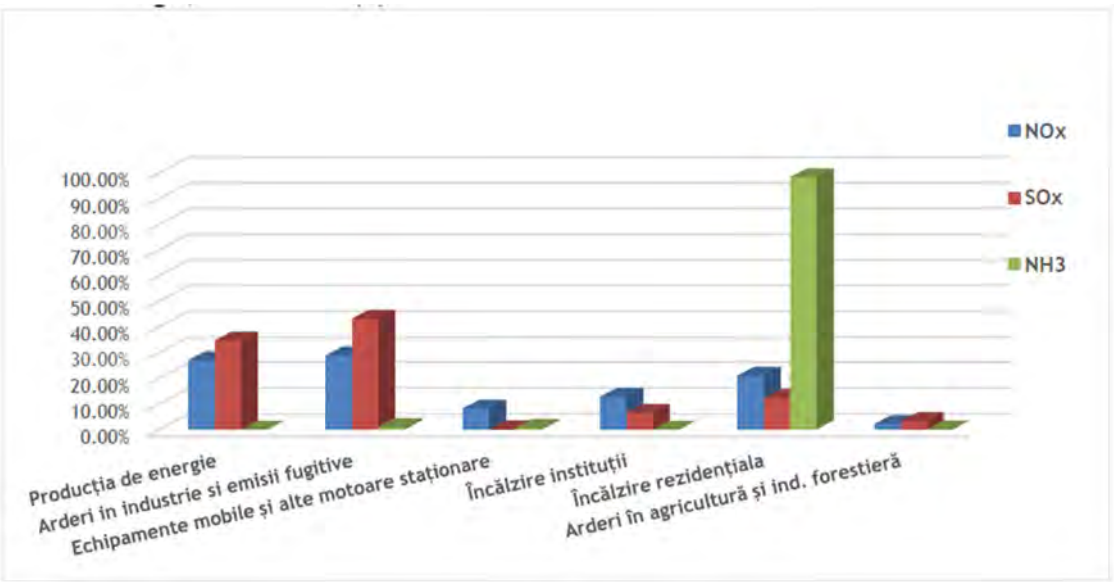


Source: RSM 2024- ANMAP

From the analysis of the data presented in the graphs in the figures above, it is found that, at all types of stations, for most pollutants studied, the average annual concentrations (which, as a rule, were below the limit values/target values), have a relatively constant value. In the period 2019 - 2020, the values showed a slightly decreasing trend, only to start increasing in 2021.

The gases with an acidifying effect on the atmosphere are: sulphur dioxide, nitrogen dioxide and ammonia. These pollutants come mainly from anthropogenic activities: burning fossil fuels (coal, oil, natural gas), metallurgy, agriculture, road traffic. The main source of ammonia is represented by agriculture, namely manure management and enteric fermentation from animal husbandry and the use of nitrogen fertilisers. The contribution of the sub-sectors of activity in the Energy sector to the polluting emissions of the substances: nitrogen oxides (NO X), ammonia (NH 3) and sulphur oxides (SO X), in relation to the total emissions in the Energy sector is graphically represented.

FIGURE 25 - *CONTRIBUTION OF ENERGY SUBSECTORS TO EMISSIONS OF ACIDIFYING POLLUTANTS (NOx, SOx AND NH_3), 2023 (%)*



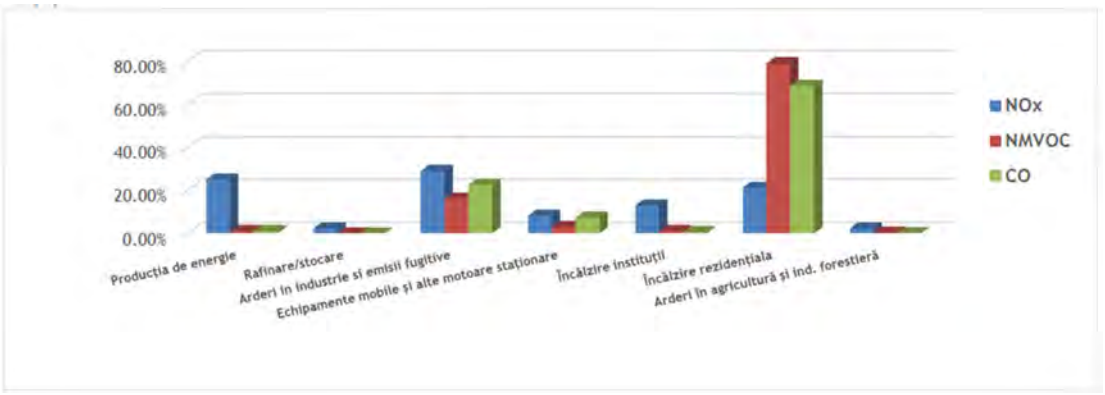
Source: RSM 2024- ANMAP

From the analysis of data on the contribution of sub-sectors of the Energy sector to pollutant emissions with an acidifying effect in this sector, for the reporting period, a share of 98.26% of ammonia resulting from residential heating activity and high values of SOx and NOx shares in energy production activity and industrial combustion are observed. Compared to the national total, the share of emissions from the Energy sector is 33.2% for NOx, 97.0% for SOx and 0.62% for NH_3.

Pollution with volatile organic compounds (VOCs) and nitrogen oxides (NOx), especially from the organic synthesis industry and the Energy sector (combustion plants, road traffic, industrial activities), contributes significantly to the formation of tropospheric ozone and photochemical smog. Tropospheric ozone, generated through photochemical reactions between VOCs and NOx, under conditions of intense solar radiation (especially in the hot

season, at temperatures >30°C), has adverse effects on human health (respiratory problems), vegetation (atrophy of some tree species, impact on crops), buildings and visibility in urban areas. In the presence of other pollutants (SO_2, CO), this type of pollution contributes to acid rain, the greenhouse effect and the degradation of environmental quality.

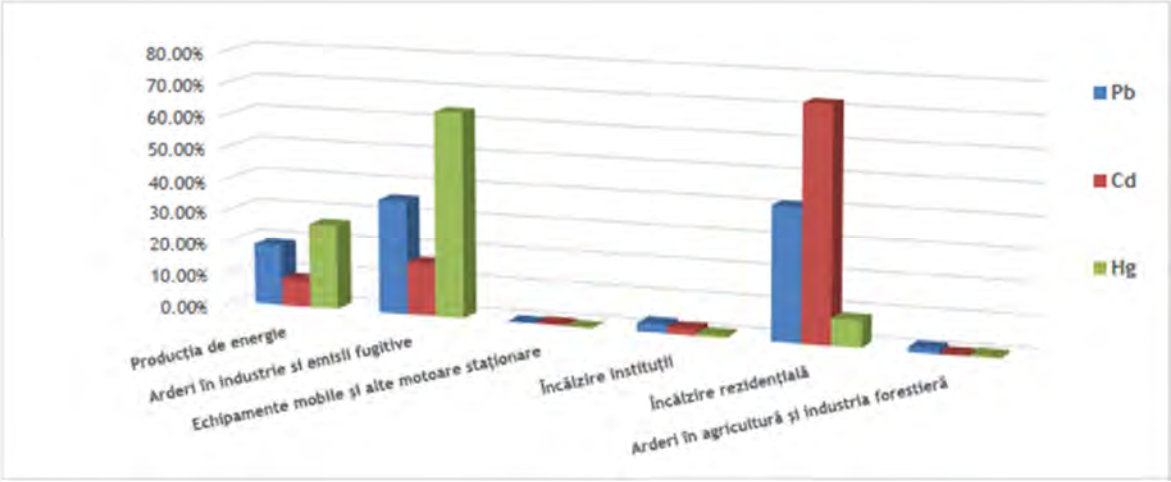
FIGURE 26 - *CONTRIBUTION OF ENERGY SUBSECTORS TO OZONE-PRECURSOR EMISSIONS, 2023 (%)*



Source: RSM 2024- ANMAP

Heavy metals (Hg, Pb, Cd, etc.) are persistent, non-degradable pollutants with a tendency to bioaccumulate in the food chain and toxic effects on human health. The main anthropogenic sources are combustion in the energy industries, non-ferrous metal metallurgy, non-metallic mineral industries, production processes, waste management, as well as road traffic and non-industrial combustion facilities. Although statistical data show a decreasing trend in emissions in recent years, the major share of heavy metal pollution still falls on the Energy sector and related industries, making it relevant to analyse the contribution by sub-sectors to total anthropogenic emissions.

FIGURE 27 - *CONTRIBUTION OF ENERGY SUBSECTORS TO HEAVY-METAL EMISSIONS, 2023 (%)*

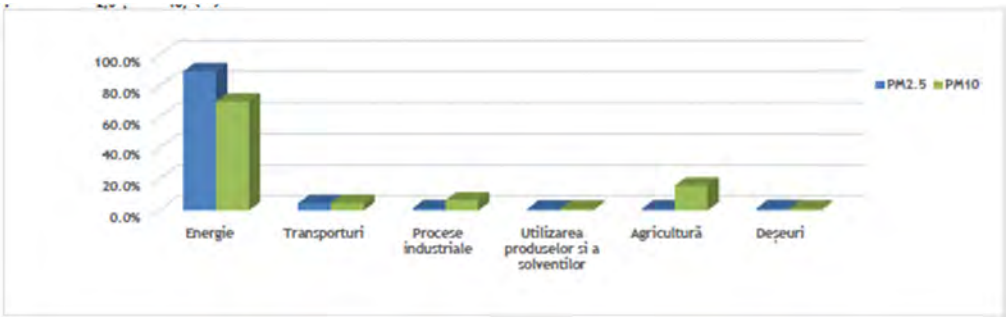


Source: RSM 2024- ANMAP

The analysis of the contribution of sub-sectors in the Energy sector to heavy metal emissions highlights high shares of mercury emissions from energy and heat production (26.6%) and from industrial combustion (63.91%). Cadmium is emitted predominantly from the residential heating subsector (72.66%), and lead comes mainly from residential heating (41.48%), industrial combustion and fugitive emissions (35.54%) and energy production (18.93%). Compared to the national total, the Energy sector contributes 30% to Pb emissions, 80.5% to Cd emissions and 53.6% to Hg emissions.

Of particular importance in assessing the degree of pollution are emissions of primary suspended particles PM2.5 and PM10.

FIGURE 28 - *CONTRIBUTION OF SECTORS TO NATIONAL PRIMARY $PM_{2.5}$ AND PM_{10} EMISSIONS, 2023 (%)*

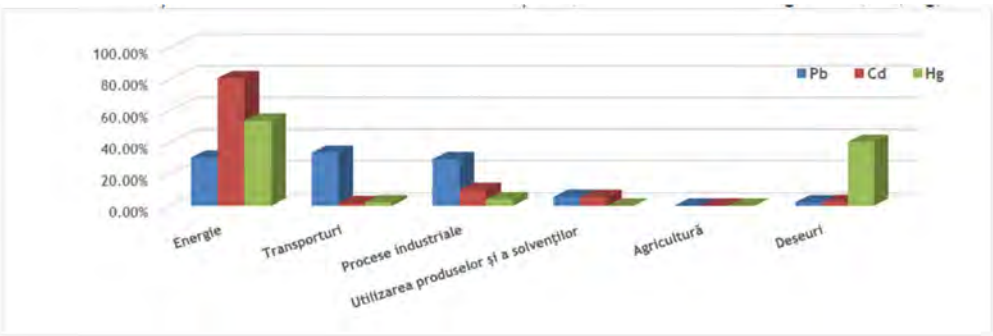


Source: RSM 2024- ANMAP

By comparing the values presented for different sectors of activity at national level, it is found that the share of the energy sector is the highest in primary particulate matter emissions (89.8% PM2.5, respectively 70.3% PM10), the majority in this sector being dust emissions generated in residential heating activity. With much lower shares, the agriculture and industrial processes sectors stand out for PM10 emissions (16.1%, respectively 6.6%).

Heavy metal emissions come mainly from the following sectors of activity: energy production and distribution, energy use in industry, industrial processes, road transport, non-road, commercial, institutional and residential transport, use of solvents and other products, agriculture, waste, other sources.

FIGURE 29 - CONTRIBUTION OF SECTORS TO NATIONAL PB, CD AND HG EMISSIONS, 2023 (%)



Source: RSM 2024- ANMAP

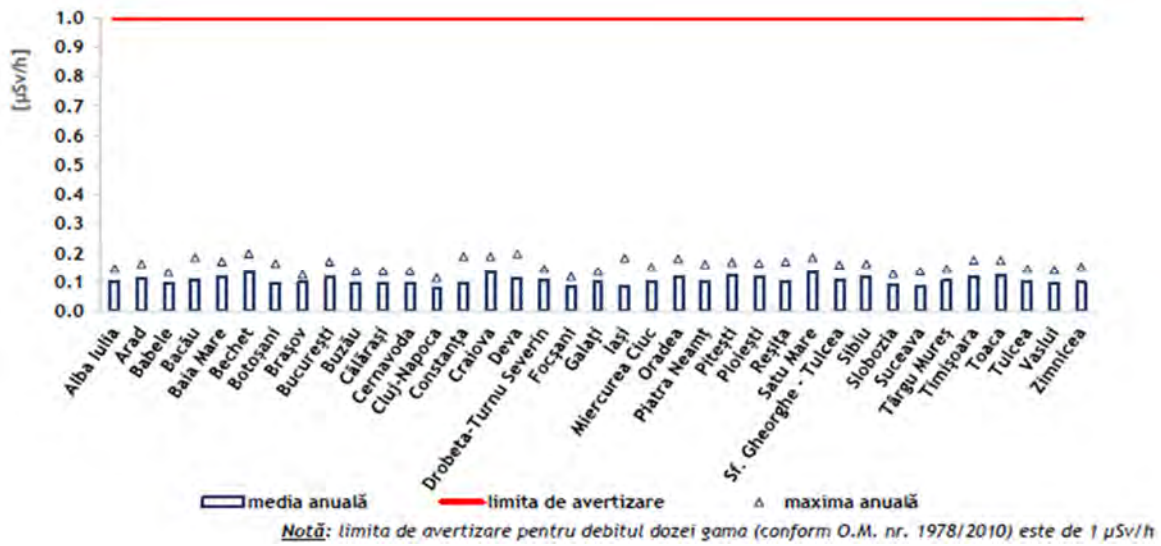
From the analysis of the presented data, it is found that the sectors of activity Energy, Transport, Industrial Processes, but also the Waste sector have the highest shares at national level, compared to other activities, in emissions of heavy metals Pb, Cd, Hg. According to RSM 2024, the share of iron and steel production activities in emissions of heavy metals Pb, Cd, Hg is predominant and constitutes a significant source of pollution at national level.

AIR RADIOACTIVITY GAMMA DOSE RATE

The determination of the gamma dose rate equivalent is carried out with an hourly frequency, through automatic stations distributed at national level.

In 2024 within the RNSRM, the average annual variation of the recorded gamma dose rate was in the range of 0.106 ÷ 0.136 μSv/h (figure 30)

FIGURE 30 - ***ANNUAL AVERAGE AND MAXIMUM AMBIENT GAMMA DOSE RATE EQUIVALENT RECORDED AT LOCATIONS IN ROMANIA, 2024***



Source: RSM 2024- ANMAP

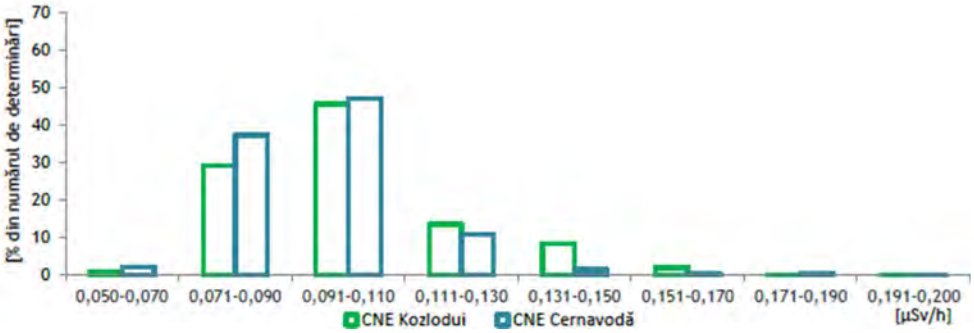
The multiannual variation of the gamma dose rate equivalent, at national level, from 2003 to 2024 is presented in the figure above. The annual average for 2024 (0.106 μSv/h) remained in the variation trend of previous years.

FIGURE 31 - *MULTIANNUAL AVERAGE AMBIENT GAMMA DOSE RATE EQUIVALENT RECORDED IN ROMANIA*

Source: RSM 2024- ANMAP

In the area of influence of the nuclear power plants, hourly monitoring of the variation of the gamma dose rate in the air was carried out by means of 43 automatic stations, of which 28 were distributed in the form of concentric circles around the Cernavodă NPP and 15 automatic stations, respectively, distributed in the form of a semicircle, for the Kozloduy NPP (on Romanian territory). The dose rate values measured by these automatic stations were within the multiannual variation range at national level.

FIGURE 32 - *PERCENTAGE DISTRIBUTION OF AMBIENT GAMMA DOSE RATE EQUIVALENT MEASUREMENTS BY AUTOMATIC STATIONS WITHIN THE AREAS OF INFLUENCE OF CERNAVODĂ NPP AND KOZLODUY NPP, 2024*

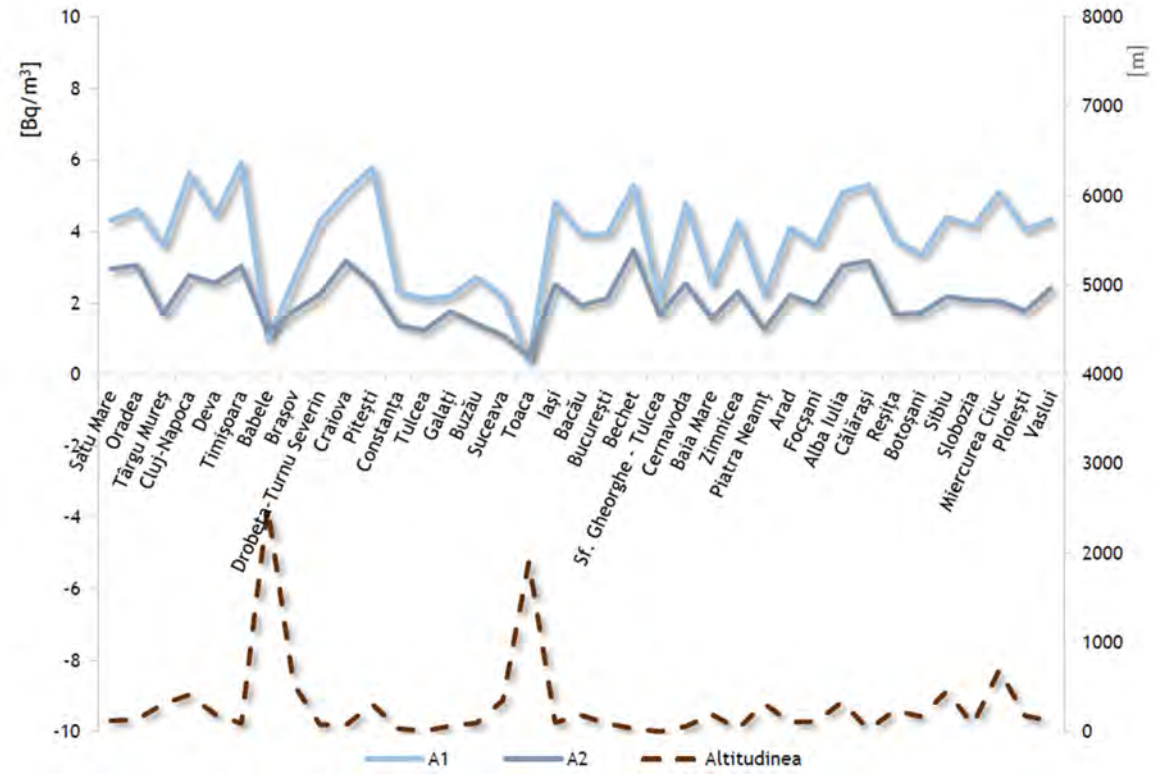


Source: RSM 2024- ANMAP

The schematic analysis shows that, in 2024, almost half of the determinations of the automatic stations in the areas of influence of the Cernavodă NPP (47.1%) and the Kozloduy NPP (45.6%) fell within the range of 0.091–0.110 µSv/h. Values in the upper range of 0.151–0.210 µSv/h were very rare, representing 0.9% in Cernavodă and 2.3% in Kozloduy. Overall, both at the national level and in these areas, the gamma dose rates remained within the limits of the natural radiation background.

RADIOACTIVITY OF ATMOSPHERIC AEROSOLS

FIGURE 33 - *DISTRIBUTION OF GROSS BETA ACTIVITY (ANNUAL AVERAGE, IMMEDIATE MEASUREMENTS) IN ATMOSPHERIC AEROSOL SAMPLES, SAMPLING LINES A1 AND A2, BY SAMPLING-POINT ALTITUDE, 2024*

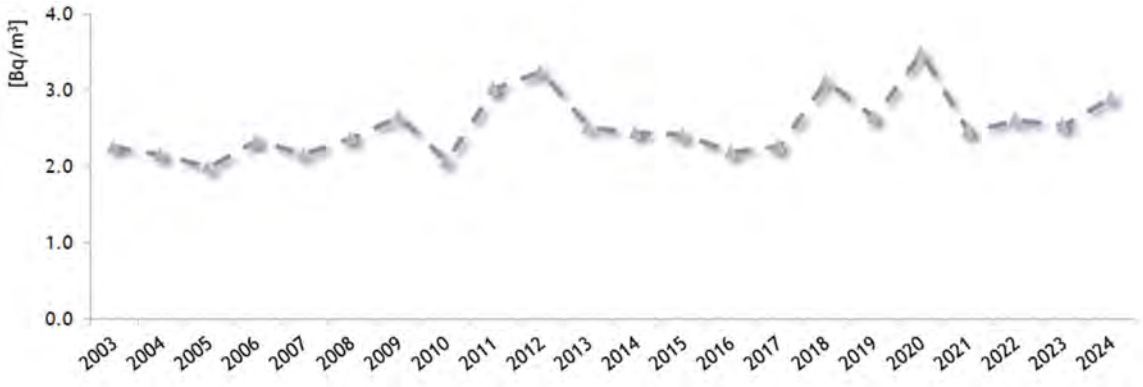


Note: the warning limit for atmospheric aerosols, immediate measurements (according to OM no. 1978/2010) is 50 Bq/m^3

Source: RSM 2024- ANMAP

The annual average value of the gross beta activity of atmospheric aerosols (immediate measurement) obtained in 2023 (2.5^4 Bq/m^3), is comparable to the multiannual average value (^{2}.52 Bq/m^3) calculated for the period 2003 ÷ 2022, falling within its variation limits (1.99 ÷ 3.49 Bq/m^3).

FIGURE 34 - ***MULTIANNUAL AVERAGE GROSS BETA ACTIVITY OF ATMOSPHERIC AEROSOLS IN ROMANIA - IMMEDIATE MEASUREMENTS***



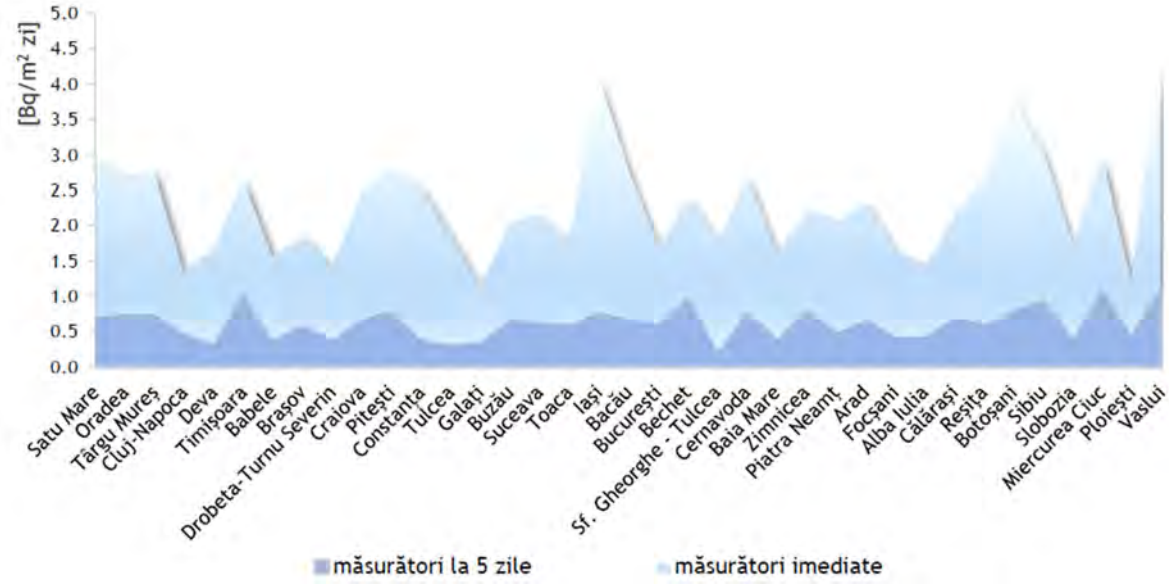
Note: the warning limit for atmospheric aerosols, immediate measurements (according to OM no. 1978/2010) is 50 Bq/m^3

Source: RSM 2024- ANMAP

RADIOACTIVITY OF TOTAL ATMOSPHERIC DEPOSITS AND PRECIPITATIONS

The variation of the gross beta activity of total atmospheric depositions, on the territory of Romania, in 2024 is presented graphically. The values presented were obtained by averaging the daily values recorded in 2024 and varied in the range of 0.75 - 3.30 Bq/m 2 day, f^{o}r immediate determinations and respectively 0.23 - 1.13 Bq/m 2 d^{a}y, for determinations every 5 days.

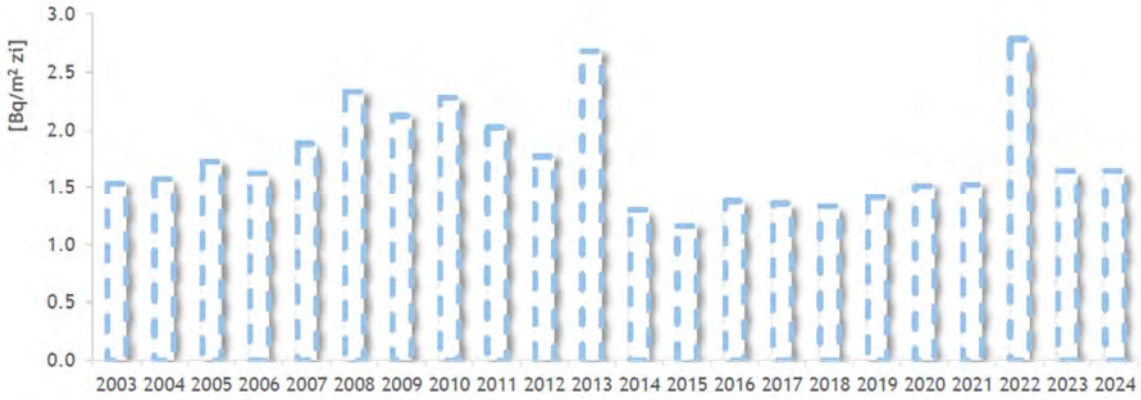
FIGURE 35 - ***ANNUAL AVERAGE GROSS BETA ACTIVITY OF TOTAL ATMOSPHERIC DEPOSITION IN ROMANIA, 2024 (IMMEDIATE AND FIVE-DAY MEASUREMENTS)***



Note: the warning limit for total atmospheric deposition (wet and dry), immediate measurements (according to OM no. 1978/2010) is 1000 Bq/m 2 ^{d}ay.

Source: RSM 2024- ANMAP

FIGURE 36 - ***MULTIANNUAL AVERAGE GROSS BETA ACTIVITY OF TOTAL ATMOSPHERIC DEPOSITION IN ROMANIA (IMMEDIATE MEASUREMENTS)***



Note: the warning limit for total atmospheric deposition (wet and dry), immediate measurements (according to OMnr. 1978/2010) is 1000 Bq/m 2 day.
Source: RSM 2024- ANMAP

The predominant source of atmospheric contamination in 2024 was the resuspension processes of Cs-137 from the ground resulting from nuclear accidents in previous years. No other artificial gamma-emitting radionuclides were identified, both at the national level and in the areas of influence of the Cernavodă NPP and the Kozloduy NPP (on Romanian territory).

3.2. HYDROLOGY - WATER

Romania's surface water resources come from two categories of sources, namely:

- inland rivers (including natural lakes);
- the Danube River.

For users in Romania, the main share in providing the necessary resource is held by inland rivers.

Natural lakes have low water volumes, with the exception of the coastal lakes in the Razelm - Sinoe lagoon system which, although they have appreciable volumes, have brackish water due to their connections with the Black Sea waters.

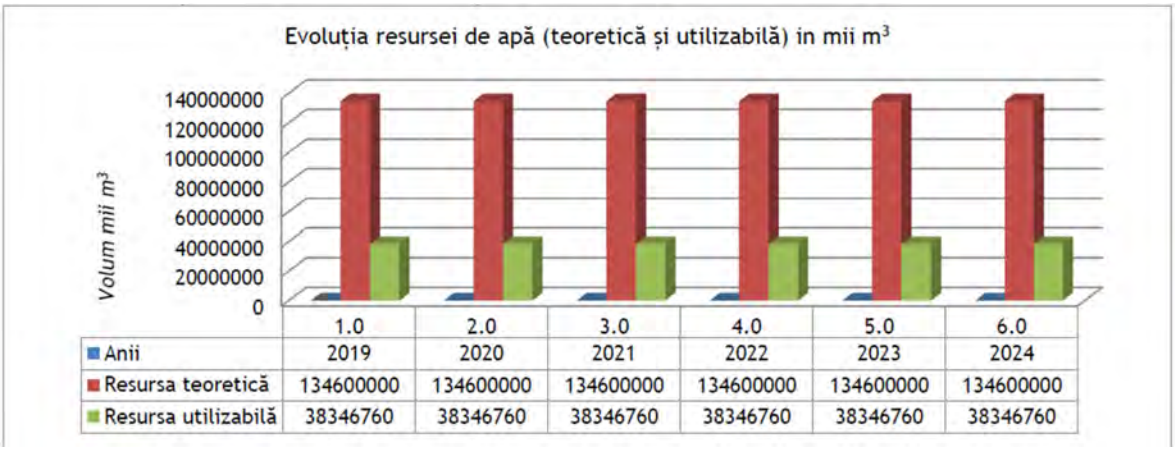
The Danube River, although it holds the lead in terms of the total volume of the resource, being located eccentrically with respect to the national territory, is less used as a source of usable water. To date, the main use of the water resource provided by the Danube is in the agricultural field (for irrigation).

The natural water resource of 2024 from inland rivers represented a drained volume of 23233*10 6 m³, ʷhⁱch places it approximately 44% below the multiannual average volume calculated for a long period (1991-2020), respectively 40870 *106m ^{3}.

In this context, the year 2024 can be considered a dry year along with 2017 and 2022, respectively.

Compared to the last 5 years (2019 – 2023), the volume leaked in 2024 is 33% lower than the multi-annual average of the annual stock (34867* 106m 3), elapsed ᵈuring the aforementioned interval.

FIGURE 37 - *WATER RESOURCES (THEORETICAL AND USABLE), 2019-2024 (THOUSAND m³)*



Source: RSM 2024- ANMAP

As surface water, the Danube River represents a fundamental strategic resource for the development and operation of the nuclear infrastructure in Romania. In the area related to the city of Cernavodă, the Danube has a width of 450 m and an average depth of 10 m. Regarding the navigability of the Danube at Cernavodă, the Cernavodă area represents a critical point for both the depth and the width of the navigable channel, both being below optimal standards. Also, the fluctuating flow rate and depending on the level of precipitation, especially in the summer season, affects all uses of the Danube, the most serious being the navigation capacity and the availability of cooling water for the Cernavodă Nuclear Power Plant. The completion of the hydrotechnical works on the Bala branch will ensure a regularisation of the water flows on the branches of the Danube (Bala, Borcea and Dunărea Veche). These works will contribute to maintaining the current bathymetry of CDMN Bief I, respectively to ensuring optimal parameters, in the long term, of cooling water for the simultaneous operation of 4 nuclear units of the Cernavodă NPP. After the completion of the works in Bala, future studies will consider reanalysing the estimates of the potential impact of climate change on the hydrological regime of minimum characteristic flows on the Danube, in order to validate the working hypotheses regarding the maintenance of the current flow value.

TABLE 13 - DANUBE RIVER WATER RESOURCES IN 2024 COMPARED WITH THE PREVIOUS PERIOD (2019-2023)

Stații hidrometrice de control pe fluviul Dunărea	Parametrul	$Q_{med\ anual}$ (m^3/s)							Q_{2024}/Q_{med} (%)
		2019	2020*	2021	2022	2023	MED 2019-2023	2024	
Baziaș	Q	4813	4419	5074	3954	5957	4843	5222	108
	V	151783	139738	160015	124693	187860	152818	165132	
	V 1/2	75891.5	69869	80007	62347	93930	76409	82566	
Sh Isaccea	Q	5593	4893,5*	2820	4370	6385	4792	5779	121
	V	176381	154742	189910	137812	201367	172042	182746	

Note: Q - Flow rate Q (m^3 /s), V - total volume (106m 3), V 1/2 - the values represent 50% of the volumes flowing on the Danube at the entrance to the country, related to Romania, the other half belonging to the Republic of Serbia.

Source: RSM 2024- ANMAP

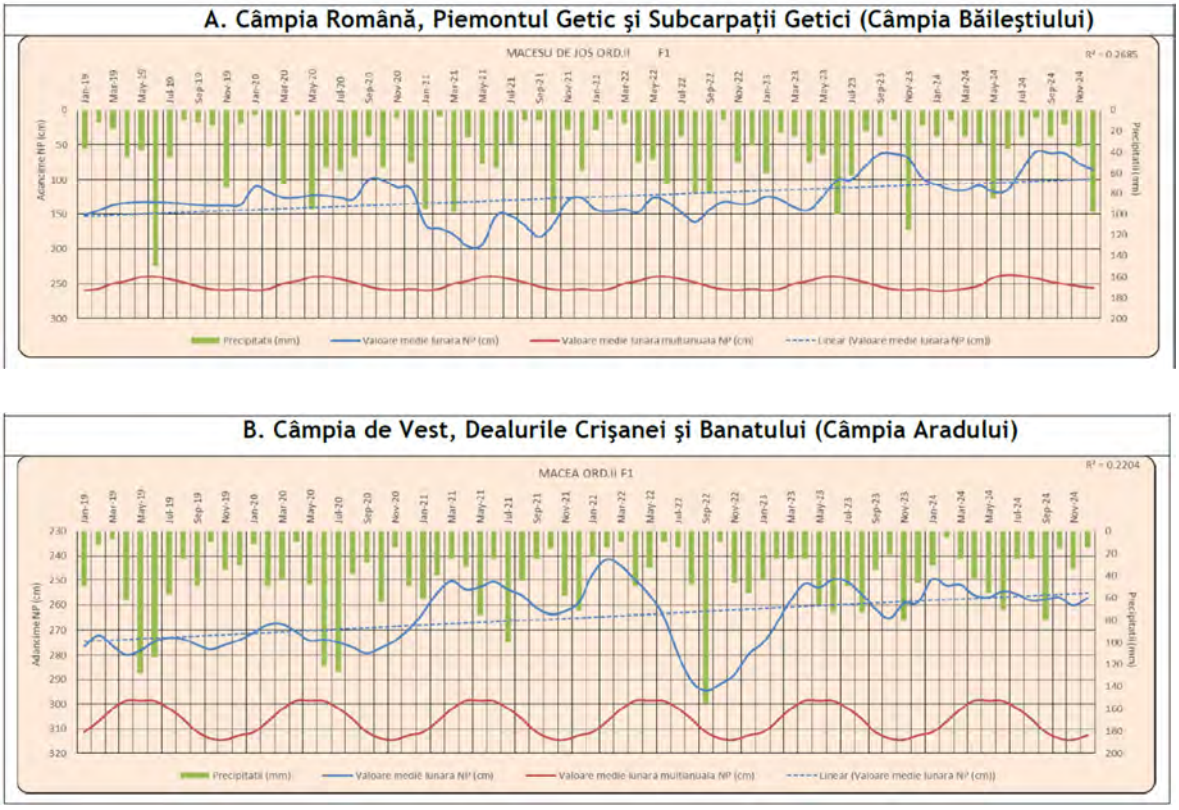
The Danube-Black Sea Canal has an average depth of 7.0 m and a width of 90 metres, and can accommodate vessels with draughts of up to 5.5 m. The Cernavodă lock is located at km 60+300 and has the following characteristics: length 310 m, width 25 m and depth 7.5 m.

Regarding groundwater resources, they were estimated at 9.68 billion m³ /year, of which 4.74 billion m³ /year are groundwater and 4.94 billion m³ /year are deep groundwater, representing about 25% of surface water. (estimate at 2014 level).

A total of 143 groundwater bodies have been identified, delimited and characterised in Romania. Of these, 115 are phreatic groundwater bodies and 28 are deep groundwater bodies.

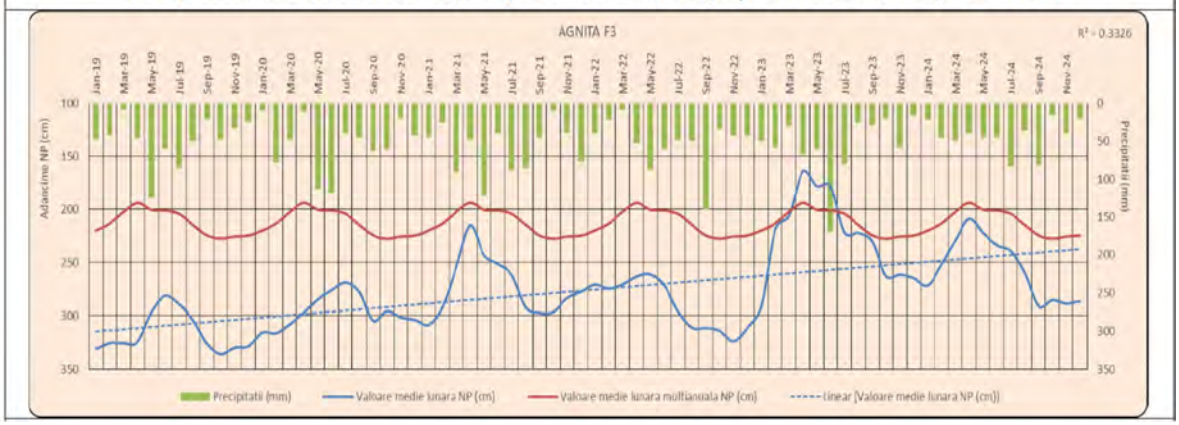
The figures below summarise trends in average annual piezometric levels over the period 2019-2021, based on five selected wells in each of the country's five major geographical regions.

FIGURE 38 - *MULTIANNUAL GROUNDWATER-LEVEL TRENDS IN SELECTED WELLS*

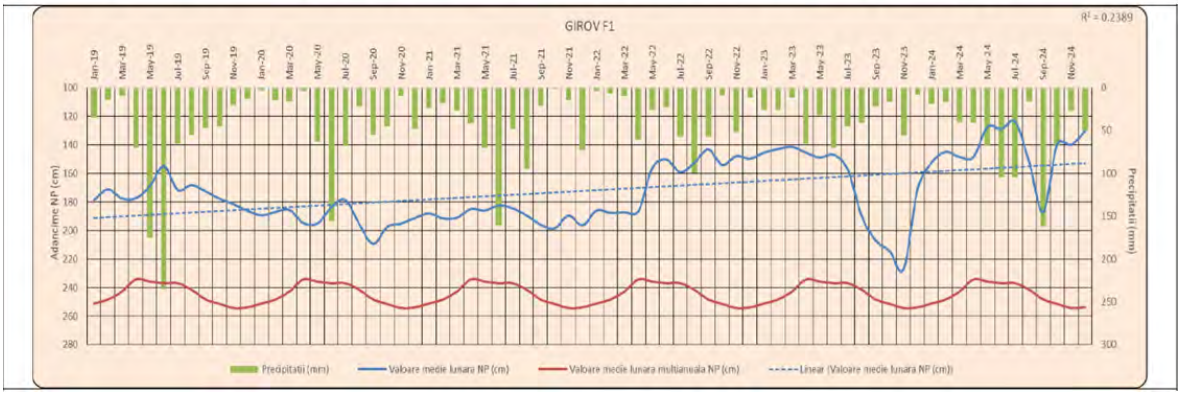


Source: RSM 2024- ANMAP

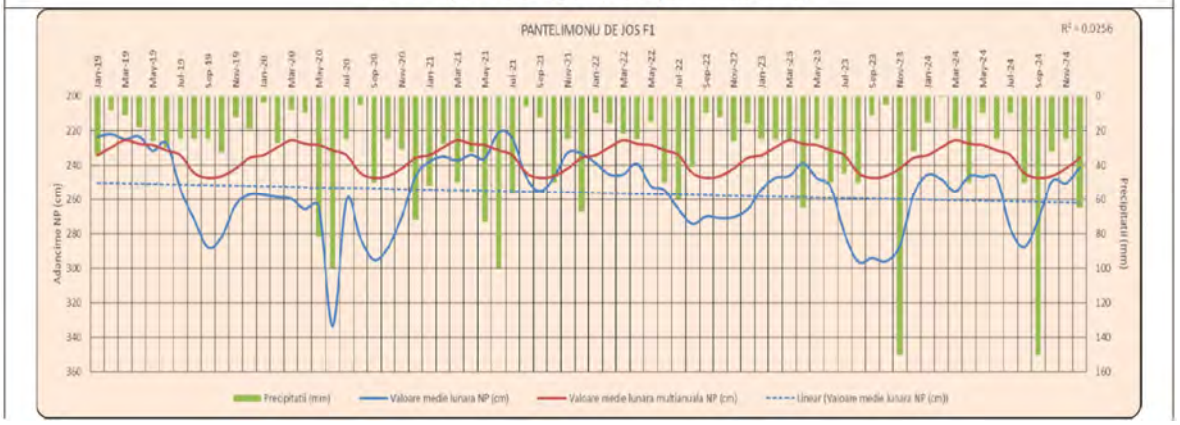
C. Depresiunea Transilvaniei şi depresiunile din Carpaţii Orientali (Podişul Rotbav)



D. Podişul Moldovei, Subcarpaţii Orientali şi de Curbură (Depresiunea Bistriţa - Cracău)



E. Podişul Dobrogei (Podişul Casimcea)



Source: RSM 2024- ANMAP

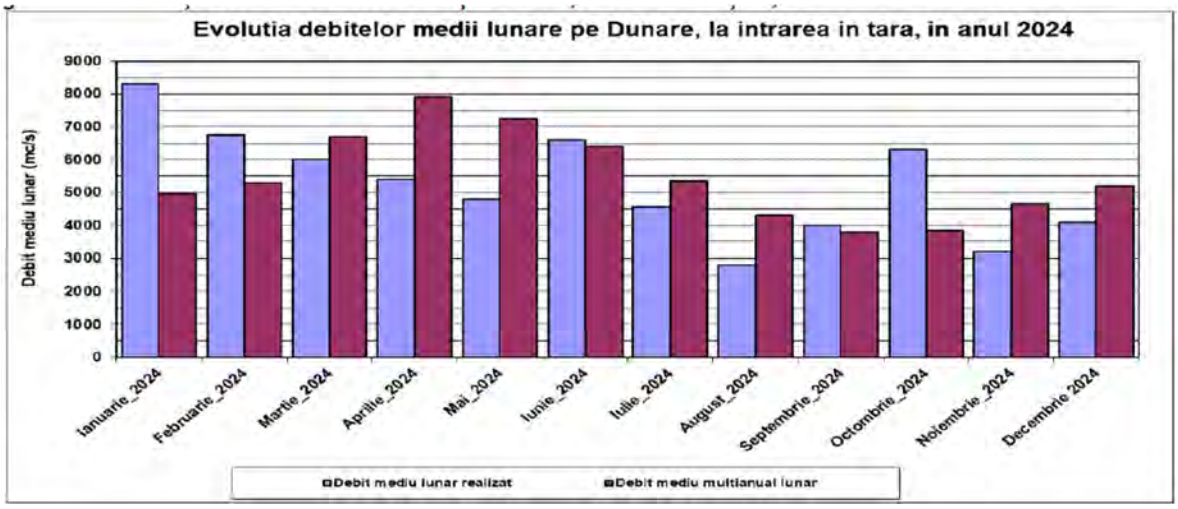
The evolution of the groundwater flow regime between January 2019 and December 2024 includes the consecutive succession of six shallow aquifer charging/discharging seasons.

The periods in which the most pronounced decreases occurred (between 52 - 86% of drilling) are: August - November 2019, May and August - November 2020, August - November 2021, June - August 2022, June - October 2023 and June - September 2024.

Danube River

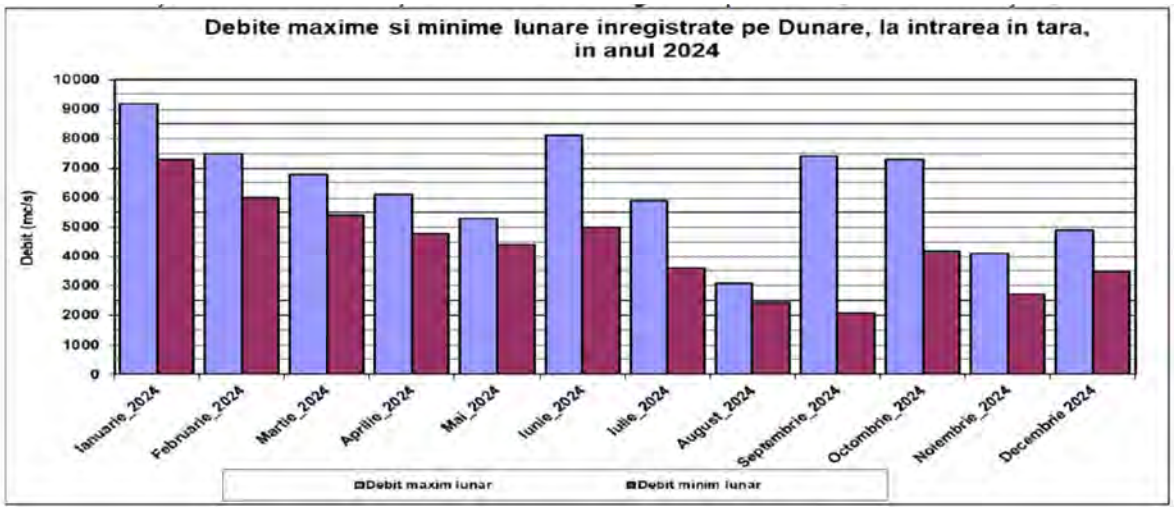
In 2024, the average monthly flows recorded on the Danube at the entrance to the country (Baziaș section) were above the multiannual monthly averages in the months of: January, February, June, September and October 2024 (103-167%) and below the multiannual monthly averages in the months of: March, April, May, July, August, November and December 2024, with values between 65-89% of these values.

FIGURE 39 - AVERAGE MONTHLY DANUBE FLOWS AT THE ENTRY INTO ROMANIA, 2024



Source: RSM 2024- ANMAP

FIGURE 40 - ***MAXIMUM AND MINIMUM MONTHLY DANUBE FLOWS AT THE ENTRY INTO ROMANIA, 2024***



Source: RSM 2024- ANMAP

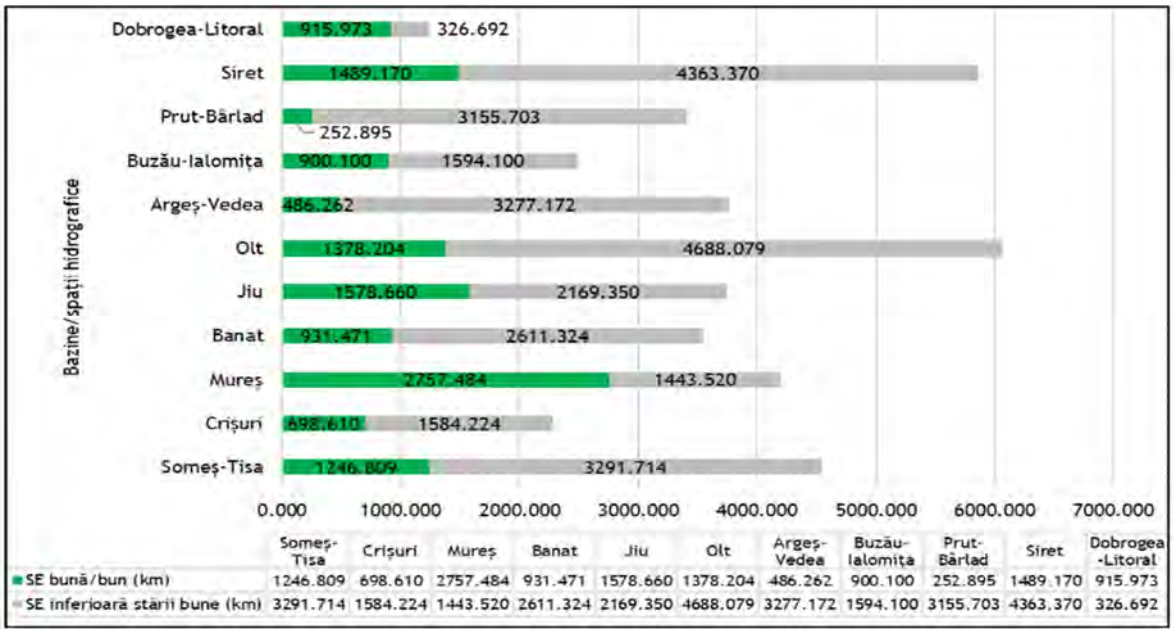
The maximum value of the Danube flow at the entrance to the country was 9200 m³ /s between January 13-14, 2024, and the minimum value was 2100 m³ /s on September 11, 2024.

Analysing the evolution of monthly minimum flows in 2024, a decreasing trend is observed in the intervals January - May and July - September and in November 2024,

respectively an increasing trend in June, October and December 2024. Regarding maximum flows, they presented a similar evolution to that of minimum flows.

Assessment of the ecological status/ecological potential of watercourses

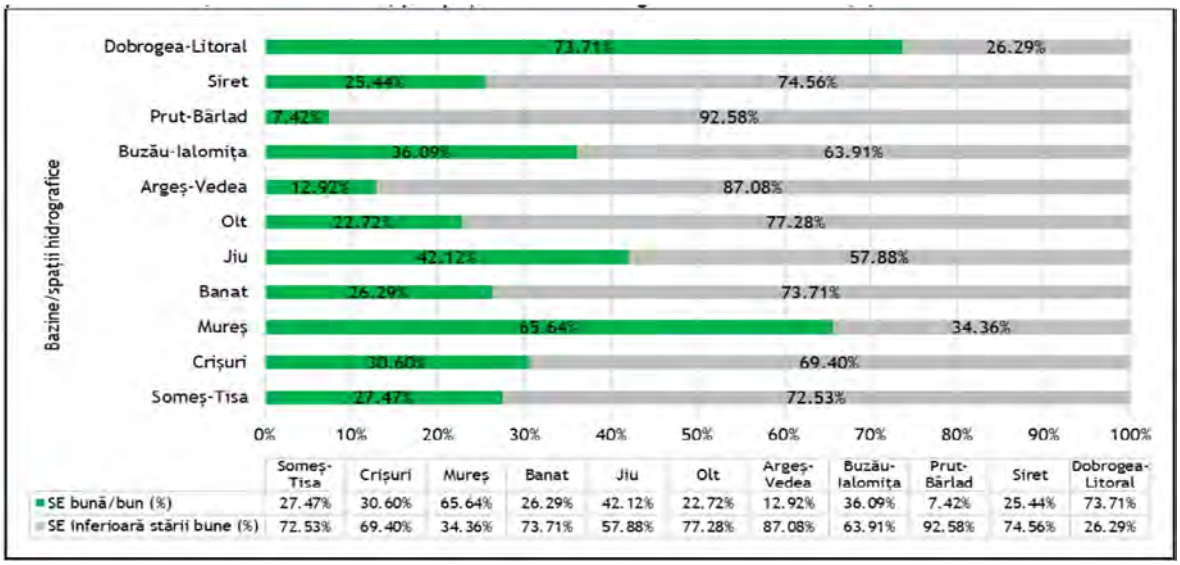
FIGURE 41 - *ECOLOGICAL STATUS/POTENTIAL OF MONITORED WATERCOURSES (NATURAL, HEAVILY MODIFIED AND ARTIFICIAL RIVER WATER BODIES), BY RIVER BASIN/DISTRICT, 2024 (km)*



	Someș-Tisa	Crișuri	Mureș	Banat	Jiu	Olt	Argeș-Vedea	Buzău-Ialomița	Prut-Bârlad	Siret	Dobrogea-Litoral
SE bună/bun (km)	1246.809	698.610	2757.484	931.471	1578.660	1378.204	486.262	900.100	252.895	1489.170	915.973
SE inferioară stării bune (km)	3291.714	1584.224	1443.520	2611.324	2169.350	4688.079	3277.172	1594.100	3155.703	4363.370	326.692

Source: RSM 2024- ANMAP

FIGURE 42 - *ECOLOGICAL STATUS/POTENTIAL OF MONITORED WATERCOURSES (NATURAL, HEAVILY MODIFIED AND ARTIFICIAL RIVER WATER BODIES), BY RIVER BASIN/DISTRICT, 2024 (%)*



	Someș-Tisa	Crișuri	Mureș	Banat	Jiu	Olt	Argeș-Vedea	Buzău-Ialomița	Prut-Bârlad	Siret	Dobrogea-Litoral
SE bună/bun (%)	27.47%	30.60%	65.64%	26.29%	42.12%	22.72%	12.92%	36.09%	7.42%	25.44%	73.71%
SE inferioară stării bune (%)	72.53%	69.40%	34.36%	73.71%	57.88%	77.28%	87.08%	63.91%	92.58%	74.56%	26.29%

Source: RSM 2024- ANMAP

Water resource use, 2019 - 2024

Compared with 2019, Romania's water demand increased in 2024 by 2.345 billion cubic metres, from 7.37 billion cubic metres to 9.715 billion cubic metres. It was distributed among the three user categories as follows: 1.47 billion cubic metres for the population in 2024, compared with 1.2 billion cubic metres in 2019; 3.96 billion cubic metres for agriculture in 2024, compared with 1.65 billion cubic metres in 2019; and 4.517 billion cubic metres for the industrial sector in 2024, compared with 4.28 billion cubic metres in 2019. Compared with the previous year, total water demand increased in 2023 by 0.42 billion cubic metres; demand for the population increased, while demand in agriculture and the industrial sector decreased.

The volume of water abstracted (used) in 2024 was 8.27 billion cubic metres, an increase of 1.3 billion cubic metres compared with 2019, when the volume abstracted was 6.97 billion cubic metres.

TABLE 14 - WATER DEMAND COMPARED WITH WATER ABSTRACTION VOLUMES BY USER CATEGORY IN ROMANIA, 2019-2024 (THOUSAND M^3)

Sursa	Ani	Populație		Industrie		Agricultură		TOTAL	
		Cerință	Prelevat	Cerință	Prelevat	Cerință	Prelevat	Cerință	Prelevat
Suprafață	2019	615797	612211	1730382	1322859	1120766	1028841	3466945	2963911
	2020	627178	593018	1909807	1155263	1171368	1135911	3708353	2884192
	2021	606789	663620	1735509	1219753	1271531	1396849	3613829	3280222
	2022	689464	632006	1523969	1131514	1443972	1513865	3657405	3277385
	2023	697299	670400	1527102	1053258	1798572	1408690	4022973	3132348
	2024	743870	647483	1315376	963675	2119104	1567580	4178350	3178738
Subteran	2019	521195	492378	184000	159092	60841	53341	766036	704811
	2020	539058	411372	195651	198892	67492	185296	802201	795560
	2021	598991	535101	201856	194748	87979	75896	888826	805745
	2022	582726	548605	229193	151561	87643	83210	899562	783376
	2023	631839	549114	223433	145082	118692	88884	973964	783080
	2024	647865	606124	208505	147077	113614	99356	969984	852557
Dunăre	2019	67222	71904	2592137	2719039	467507	508740	3126866	3299683
	2020	68523	73362	2720136	2676840	599604	958882	3388263	3709084
	2021	80274	70729	2742255	2691300	801420	1007633	3623949	3769662
	2022	81125	75286	2674606	2648208	1269054	1357726	4024785	4081220
	2023	80884	75645	2733185	2708594	1464358	1291099	4278427	4075338
	2024	80844	80214	2739973	2652876	1728004	1499120	4548821	4232210
Marea Neagră	2019	74	47	10339	6405			10413	6452
	2020	74	27	9602	7320			9676	7347
	2021	117	40	17297	7928			17414	7968
	2022	212	48	21069	8701			21281	8749
	2023	108	32	18070	10790			18178	10822
	2024	95	13	18070	9009			18165	9022
TOTAL	2019	1204288	1176540	4516858	4207395	1649114	1590922	7370260	6974857
TOTAL	2020	1234833	1077779	4835196	4038315	1838464	2280089	7908493	7396183
TOTAL	2021	1286171	1269490	4696917	4113729	2160930	2480378	8144018	7863597
TOTAL	2022	1353527	1255945	4448837	3939984	2800669	2954801	8603033	8150730
TOTAL	2023	1410130	1295191	4501790	3917724	3381622	2788673	9293542	8001588
TOTAL	2024	1472674	1333834	4281924	3772637	3960722	3166056	9715320	8272527

Source: RSM 2024- ANMAP

Specialists from the National Institute of Hydrology and Water Management (INHGA) show that average annual river flows will decrease by 20-30% between 2021-2050 and by 30-40% by 2071-2100.

TABLE 15 - GROUNDWATER BODIES ASSOCIATED WITH SPECIAL PROTECTION AREAS WITHIN THE AREA OF INFLUENCE OF THE SNDDN AND PNN

Code and name of groundwater body	ROSPA presence
RODL05 - CENTRAL DOBROGIA	ROSPA0002 Allah Bair - Capidava
RODL10 - SOUTHERN DOBROGIA	ROSPA0001 Aliman - Adamclisi ROSPA0002 Allah Bair - Capidava ROSPA0007 Balta Vederoasa ROSPA0039 Dunăre-Ostroave ROSPA0054 Lacul Dunăreni
ROIL11 DANUBE MEADOW	ROSPA0002 Allah Bair – Capidava ROSPA0007 Balta Vederoasa ROSPA0012 Brațul Borcea ROSPA0039 Danube – Ostroave
ROLIL14 GIMBĂȘANI - SUDITI	ROSPA0012 Brațul Borcea
ROIL17 FETEȘTI	ROSPA0012 Brațul Borcea

3.3. Soil and land use

From the inventory carried out by ICPA in collaboration with 37 OSPA in the years 1994 -1998 for 41 counties and together with other research units, on about 12 million ha of agricultural land, of which on about 7.5 million ha of arable land (about 80% of the arable area), soil quality is affected to a greater or lesser extent by one or more restrictions. Their unfavourable effects are expressed by the degradation of soil characteristics and functions, with the diminution of bioproductive capacity, as well as - in a particularly serious way - by the impairment of the quality of agricultural products and food security, with significant consequences on the quality of life of the population.

These constraints are generated either by natural factors (climate, relief, soil properties, etc.) or by anthropogenic pressures associated with agricultural and industrial activities; in many situations, the aforementioned factors act cumulatively, amplifying degradation processes, with effects ranging from reducing soil quality to compromising their functions.

Drought can occur on about 7.1 million ha. Peri**odic excess of soil moisture** affects about 3.8 million ha, of which a large part of the perimeters have been drained and drained, which do not function with the expected efficiency. A series of perimeters in areas with old or inefficient, unmaintained embankments are periodically flooded, causing significant damage through the destruction of households, crops, livestock, communication routes and loss of human life. Water eros**ion is present t**o varying degrees on 6.3 million ha, of which about 2.3 million ha are equipped with anti-erosion works, currently heavily degraded for the most part; this together with landslides (about 0.7 million ha) causes soil losses of up to 41.5 t/ha/year. Wind erosion is pre**sent on almost 0**.4 million ha, with the risk of expansion, knowing that in recent years some forests and protective curtains have been cleared in areas

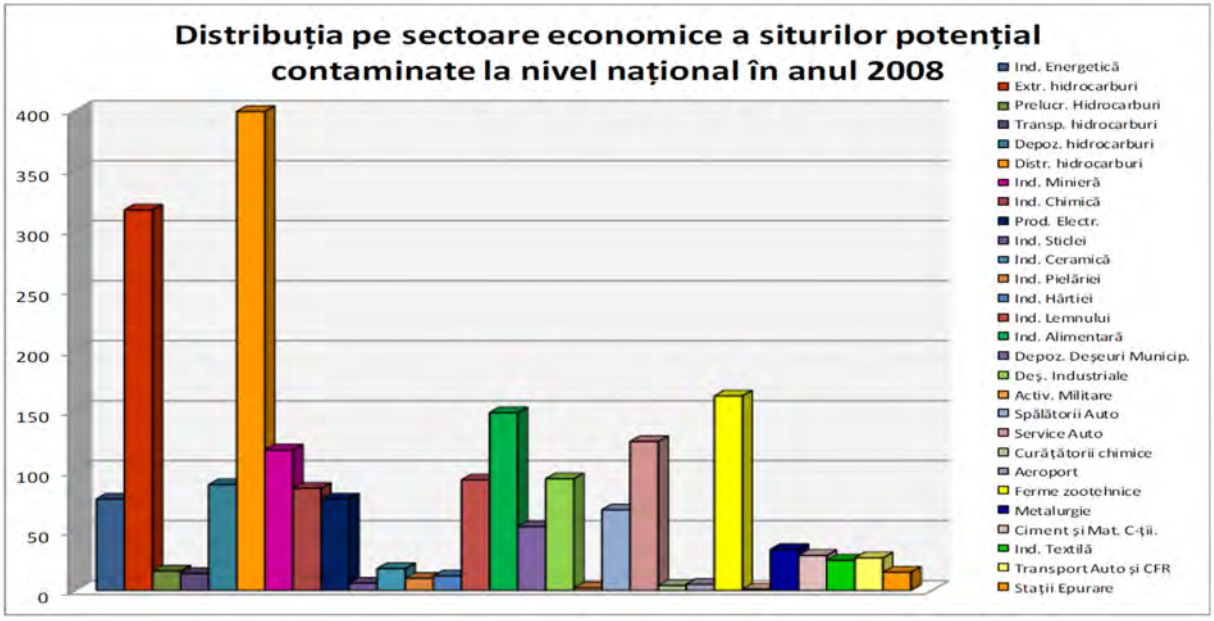
with sandy soils, susceptible to this degradation process. The respective soils have low edaphic volume, low water retention capacity and suffer from drought, having low fertility. Excessive skeletal content in the upper part of the soil it affects about 0.3 million ha.

The management of potentially contaminated and contaminated sites aims to minimise any adverse effects of pollutants on human health and the environment.

A preliminary national inventory of potentially contaminated sites was drawn up in 2008 based on the responses to the questionnaires provided for in Annexes 1 and 2 of Government Decision No. 1408/2007 on the methods of investigating and assessing soil and subsoil pollution. According to this inventory, there were 1628 potentially contaminated sites in Romania, distributed by economic sectors as follows:

- 151 potentially contaminated sites from the mining and metallurgical industry;
- 834 potentially contaminated sites from the oil industry;
- 85 potentially contaminated sites from the chemical industry;
- 558 potentially contaminated sites from other activities (activities specific to the energy, electrical-engineering and electronics, glass, ceramics, textiles and leather, pulp and paper, wood, cement, machinery-manufacturing and food industries; military activities; land-transport and airport activities; and agricultural and livestock activities).

FIGURE 43 - DISTRIBUTION OF POTENTIALLY CONTAMINATED SITES BY ECONOMIC SECTOR IN ROMANIA, 2008



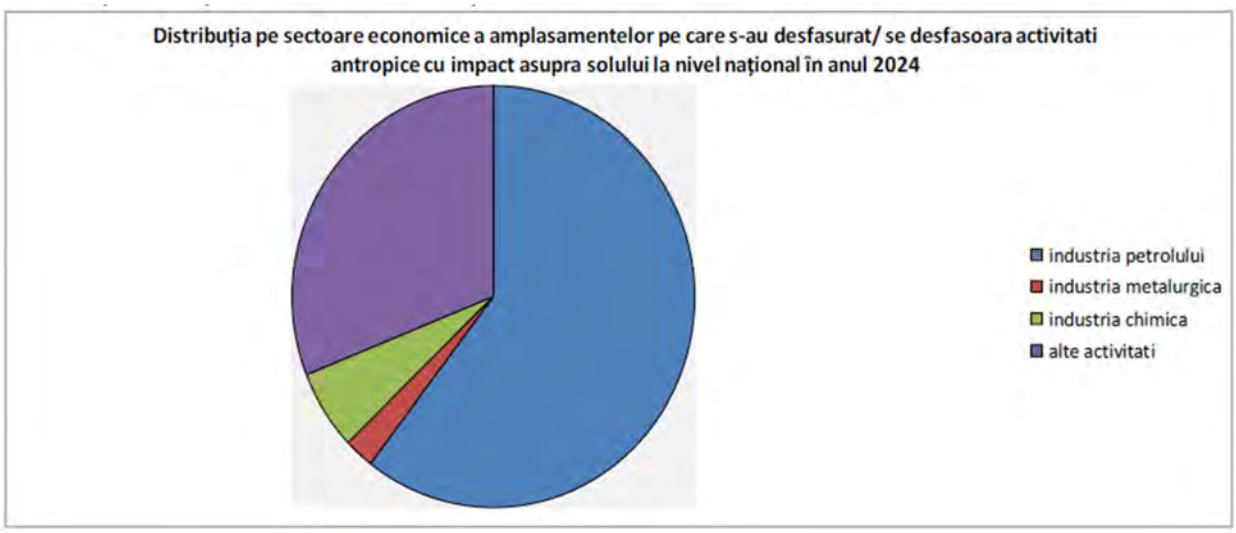
Source: RSM 2024- ANMAP

The synthetic situation at the level of 2024 of the sites where anthropogenic activities with an impact on the soil were/are carried out, based on the information communicated by the county environmental protection agencies and centralised at national level, is graphically represented in the figure above. According to this re-inventory, since the publication of Law 74/2019 on the management of potentially contaminated and

contaminated sites and until the date of the national inventory update, a number of 2412 sites were identified, distributed by economic sectors, as follows:

- 1525 oil industry sites (extraction, processing, transportation, storage, distribution);
- 44 locations in the metallurgical industry;
- 103 chemical industry sites;
- 740 locations from other activities (specific activities of industries: energy, textile, wood, glass, cement and construction materials, food, road transport, CFR, air and naval transport, zootechnical activities, sewage treatment plants, etc.).

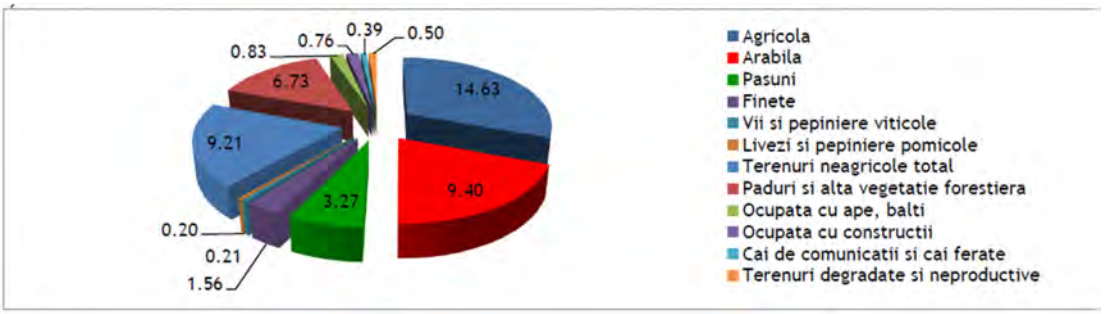
FIGURE 44 - DISTRIBUTION BY ECONOMIC SECTOR OF SITES WHERE ANTHROPOGENIC ACTIVITIES WITH SOIL IMPACTS HAVE BEEN OR ARE BEING CARRIED OUT IN ROMANIA, 2024



Source: RSM 2024- ANMAP

Trends regarding the change in land use: the agricultural area in our country registered a constant decreasing trend during the period 2000-2014. Arable land, those occupied by vineyards and orchards also registered decreases compared to 1990. In the case of areas occupied by pastures, increases were noted during the period 1990-2000, after which they decreased constantly. The areas occupied by hayfields, during the period 1990-2014, registered a increasing trend with a maximum in 2014.

FIGURE 45 - LAND FUND BY LAND-USE CATEGORY, 2014 (million ha)



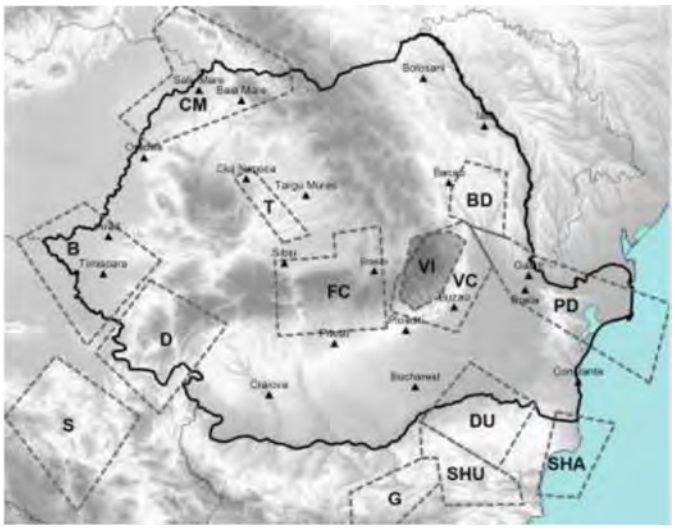
Source: RSM 2024- ANMAP

In 2024, compared to 2023, the areas arranged for irrigation (3484 ha), drainage and combating soil erosion (1 ha) increased. In the period 2017-2024, a trend of increase in the area arranged for irrigation was observed, with a maximum in 2024. In 2024, compared to 2023, both the area prepared by ANIF for irrigation and the area contracted for water delivery increased.

Seismological activity

Romania's seismicity is given by a combination of the Vrancea intermediate-depth subcrustal seismic source and 13 crustal (surface) seismic sources.

FIGURE 46 - *SEISMIC SOURCES IN ROMANIA*



Source: National Seismic Risk Reduction Strategy

Recorded data show that some of these seismic sources can generate earthquakes with moment magnitudes Mw>6.5, which can cause significant deaths and economic losses. The following table indicates the estimated minimum and maximum magnitudes that could be generated by these sources, as well as the average number of earthquakes with a magnitude greater than or equal to the minimum magnitude that can occur in a 25-year period.

TABLE 16 - CHARACTERISTICS OF SEISMIC SOURCES

Seismic source		Expected minimum magnitude	Expected maximum magnitude	Average number of earthquakes with magnitude greater than or equal to the minimum magnitude over 25 years
Banat		4.5	6.4	4
Bârlad Depression		4.5	5.8	2
Crișana Maramureș		4.5	6.6	3
Danube		4.5	6	4
Dulovo		4.5	6.6	2
Făgăraș-Câmpulung		4.5	6.8	3
Gorna		4.5	7.4	3
Pre-Dobrogea Depression		4.5	5.7	2
Serbia		4.5	6.1	15
Shabla		4.5	7.8	3
Shumen		4.5	6.3	2
Transylvania		4.5	6.2	1
Vrancea (shallow)		4.5	6.3	3
Vrancea (intermediate depth)	60–90 km	4.9	7.0	4
	90–120 km	4.9	8.0	16
	120–150 km	4.9	8.1	30
	150–180 km	4.9	6.6	6

Source: National Seismic Risk Reduction Strategy

Seismic hazard at the national level is divided into the following 3 areas:

- The low seismic hazard area includes regions exposed to ag values ≤150 cm/s ^{2} (≤0.15g);
- The area with medium seismic hazard includes regions exposed to 150 cm/s ^{2} (0.15g) < ag ≤350 cm/s ^{2} (≤0.35g);
- The area with high seismic hazard includes regions exposed to ag >350 cm/s ^{2} (>0.35g).

3.4. NATURE CONSERVATION AND BIODIVERSITY

Following the positioning of the project sites in relation to protected natural areas, none of the projects envisaged within the SNDDN, whose location is known, is located within protected natural areas of Community interest. The only protected natural areas likely to be affected by the implementation of the strategy are located in the area of influence of the Cernavodă NPP and, respectively, of the DFDSMA repository. In the area of influence of the Mioveni platform, only the Lacul lui Barca Nature Reserve is found.

Regarding the Deep Geological Repository project, since its exact location has not yet been established, it is not possible to identify the protected natural areas likely to be affected.

To identify ANPIC that could be affected by the implementation of the strategy, the perimeters of the project sites (where their location is known) and their areas of influence were overlapped with the boundaries of the protected natural areas.

To analyse the impact of the objectives proposed within the National Strategy for the Development of the Nuclear Sector on Natura 2000 sites, the following areas of influence were established:

- Zone "0" – at which the direct impact generated by the footprint of the built objectives is manifested;
- Area of influence – at which the potential impact generated by the discharge of cooling water from the Cernavodă NPP and the radiation generated by the objectives is assessed.

In fact, the two areas of impact manifestation also coincide with the stages of project implementation: area 0 being associated with the construction stage and the area of influence, associated with the stage of operation of the strategy's objectives.

The areas of influence of the SNDDN objectives are as follows:

- The Cernavodă NPP platform (which includes the projects Refurbishment of Units 1 and 2, Completion of Units 3 and 4, Heavy water detritiation works) – the Cernavodă NPP influence area was divided into 3 distinct manifestation areas, respectively 10, 20, 30 km (the Cernavodă NPP influence area in accordance with CNCAN requirements and international practice, taking into account radiological risk analyses).
- Mioveni Research Platform (ALFRED) and Măgurele Platform (ELI-NP) – 5 km influence areas, given the research nature and the small size of the possible radiological and technological effects.
- Doicești Platform (Small Modular Reactors- SMR) – 10 km area of influence, corresponding to possible interactions with the environment. The area of influence for an SMR is estimated at approximately 10 km, compared to 30 km for large reactors, such as those at Cernavodă NPP, because SMRs have a much lower installed capacity, a reduced radiological inventory and use passive safety systems, which significantly limit the potential for the release of radioactive substances. Thus, in hypothetical accident scenarios, emissions would be much lower and radiological effects would manifest themselves in a much smaller area.
- DFDSMA location – for DFDSMA, a 3 km influence zone was considered, justified by the type of radioactive waste stored (low and medium-level radioactive waste), the multi-barrier protection system, and the local nature of potential hydrogeological effects.
- DGA location - is currently unknown, the project being only in the host rock selection phase. In this context, several location areas have been proposed, without the final location being established. Therefore, the assessment of the effects on protected natural areas is carried out exclusively at a strategic level, given the preliminary nature of the project and the lack of a concrete location.

TABLE 17 - PROTECTED NATURAL AREAS OF COMMUNITY INTEREST WITHIN THE AREA OF INFLUENCE OF THE PROJECTS

Platform	10 km	20 km	30 km
CERNAVODA NPP	ROSCI0022 Canaralele Dunării ROSCI0412 Ivrinezu ROSPA0039 Dunăre-Ostroave ROSPA0002 Alah Bair-Capidava	ROSPA0001 Aliman Adamclisi ROSPA0007 Balta Vederoasa ROSCI0071 Dumbrăveni – Urluia Valley – Vederoasa Lake ROSPA0012 Brațul Borcea ROSCI0319 Mlaștina de la Fetești ROSCI0353 Peștera Deleni ROSCI0278 Bordușani-Borcea	ROSCI0053 Alah-Bair Hill ROSCI0172 The Forest and Valley of the Canaraua Fetii-Iortmac ROSPA0054 Lacul Dunăreni
DFDSMA Platform	ROSPA0039 Dunăre-Ostroave	-	-

Below we present the habitats and species of Community interest located in the area of influence of the projects:

TABLE 18 - PROTECTED NATURAL AREAS OF COMMUNITY INTEREST WITHIN THE AREA OF INFLUENCE OF THE PROJECTS

Platform	10 km	20 km	30 km
CERNAVODA NPP	ROSCI0022 Canaralele Dunării ROSCI0412 Ivrinezu ROSPA0039 Dunăre-Ostroave ROSPA0002 Alah Bair-Capidava	ROSPA0001 Aliman Adamclisi ROSPA0007 Balta Vederoasa ROSCI0071 Dumbrăveni – Urluia Valley – Vederoasa Lake ROSPA0012 Brațul Borcea ROSCI0319 Mlaștina de la Fetești ROSCI0353 Peștera Deleni ROSCI0278 Bordușani-Borcea	ROSCI0053 Alah-Bair Hill ROSCI0172 The Forest and Valley of the Canaraua Fetii-Iortmac ROSPA0054 Lacul Dunăreni
DFDSMA Platform	ROSPA0039 Dunăre-Ostroave	-	-

TABLE 19 - NUMBER OF NATURA 2000 SITES WITHIN THE AREA OF INFLUENCE OF THE SNDDN OBJECTIVES

Natura 2000 site type	Total number of Natura 2000 sites within the area of influence of the SNDDN objectives
SPA	6
SCI/SAC	8

Analysis of the impact of the implementation of the National Strategy for the Development of the **N**uclear Sector in Romania on protected natural areas was limited for the Cernavodă NPP platform to a perimeter of 30 km around it, as this is considered, according to the regulations in force, the area of direct influence for nuclear energy objectives.

The number of habitats of Community interest located in the area of influence of the projects proposed by SNDDN and PNN are presented below, for each ANPIC. Also, for each SCI, the number of species of Community interest is presented:

TABLE 20 - HABITATS OF COMMUNITY INTEREST IN SCIs/SACs WITHIN THE AREA OF INFLUENCE OF THE SNDDN AND PNN OBJECTIVES

Name of SCI/SAC located in the area of influence of the SNDDN and PNN objectives	**No. of habitats**	**habitats**
ROSCI0022 Canaralele Dunării	15	3130 Oligotrophic to mesotrophic standing waters with Littorellete*a uniflorae and/or Isoëto-Nanojuncetea vegetation* 3140 Strongly oligo-mesotrophic waters with benthic vegetation of Chara sp*ecies* 3150 Natural eutrophic lakes with Magnopotamion *or Hydrocharit*ion *type vegetation* 40C0* Ponto-Sarmatian deciduous thickets 62C0* Pontic-Sarmatian steppes 6430 Edge communities with tall hygrophilous grasses from plains to montane and alpine levels 6440 Cnidion dubii flood meadows 6510 Low altitude meadows (Alop*ecurus pratensis, Sanguisorba officinalis*) 91AA* Ponto-Sarmatian forest vegetation with downy oak 91F0 Mixed riparian forests wi*th Quercus robur, Ulmus laevis, Fraxinus exce*lsior *or Fraxinus angusti*folia along large rivers (*Ulmenion minoris)* 91I0* Eurosiberian forest-steppe vegetation with *Quercus spp.* 91M0 Pannonian-Balkanic turkey oak-sessile oak forests 92A0 Salix alba and Populus alba galleries 92D0 Riparian galleries and thickets (Nerio-Tamaricetea and Securinegion tinctoriae)
ROSCI0412 Ivrinezu	0	-
ROSCI0071 Dumbrăveni–Valea Urluia–Lacul Vederoasa	8	40C0* Ponto-Sarmatian deciduous thickets 6430 Edge communities with tall hygrophilous grasses from the plains and from the mountain to the alpine level 3150 Natural eutrophic lakes with Magnopotamion *or Hydrochari*tion-*type vegetation* 91AA* Ponto-Sarmatian vegetation with downy oak 91M0 Pannonian-Balkanic turkey oak-sessile oak forests 62C0* Pontic-Sarmatian steppes 91F0 Mixed riparian forests wi*th Quercus robur, Ulmus laevis, Fraxinus exc*elsor *or Fraxinus angustif*olia, along large rivers - Ulmenion minoris - 91I0* Eurosiberian forest-steppe vegetation with *Quercus spp.*
ROSCI0319 Mlaștina de la Fetești	1	92A0 Salix alba and Populus alba galleries
ROSCI0353 Peștera Deleni	0	-
ROSCI0278 Bordușani-Borcea	4	3160 Natural dystrophic lakes and ponds 3270 Rivers with muddy banks, with vegetation of *Chenopodion rubri* and *Bidention* 62C0* Pontic-Sarmatian steppes 92A0 Salix alba and Populus alba gallery forests
ROSCI0053 Dealul Alah-Bair	1	62C0* Pontic-Sarmatian steppes
ROSCI0172 Pădurea și Valea Canaraua Fetii-Iortmac	8	3150 Natural eutrophic lakes with Magnopotamion *or Hydrocharit*ion-*type vegetation* 3260 Water courses from plain to montane levels with Ranunculion fluitantis and Callitricho-Batrachion vegetation

		62C0* Pontic-Sarmatian steppes 40C0* Ponto-Sarmatian deciduous thickets 6430 Edge communities with tall hygrophilous grasses from the plains and from the mountain to the alpine level 91AA* Ponto-Sarmatian vegetation with downy oak 91I0* Eurosiberian forest-steppe vegetation with *Quercus spp*. 91M0 Pannonian-Balkanic turkey oak-sessile oak forests

TABLE 21 - SPECIES OF COMMUNITY INTEREST IN SITES OF COMMUNITY IMPORTANCE WITHIN THE AREA OF INFLUENCE OF THE SNDDN AND PNN OBJECTIVES

Name of SCI/SAC located in the area of influence of the SNDDN and PNN objectives	**No. of species of Community interest**	**Species**
ROSCI0022 Canaralele Dunării	25	*Campanula romanica, Moehringia jankae, Anisus vorticulus, Alosa immaculata, Alosa tanaica, Aspius aspius, Cobitis taenia Complex, Eudontomyzon mariae, Gymnocephalus baloni, Gymnocephalus schraetzer, Misgurnus fossilis, Pelecus cultratus, Rhodeus amarus, Romanogobio kesslerii, Romanogobio vladykovi, Sabanejewia bulgarica, Zingel streber, Zingel zingel, Triturus dobrogicus, Bombina bombina, Emys orbicularis, Testudo graeca, Spermophilus citellus, Mesocricetus newtoni, Lutra lutra*
ROSCI0412 Ivrinezu	4	*Testudo graeca, Elaphe sauromates, Spermophilus citellus, Mesocricetus newtoni*
ROSCI0071 Dumbrăveni – Urluia Valley – Vederoasa Lake	26	*Miniopterus schreibersii, Rhinolophus mehelyi, Lutra lutra, Spermophilus citellus, Mesocricetus newtoni, Vormela peregusna, Bombina bombina, Triturus dobrogicus, Elaphe sauromates, Emys orbicularis, Testudo graeca, Testudo hermanni, Aspius aspius, Cobitis taenia, Misgurnus fossilis, Pelecus cultratus, Rhodeus sericeus amarus, Romanogobio vladykovi, Catopta trhips, Eriogaster catax, Lycaena dispar, Lucanus cervus, Centaurea jankae, Himantoglossum jankae, Potentilla emilii-popii, Echium russicum*
ROSCI0319 The Fetești Swamp	4	*Lutra lutra, Bombina bombina, Triturus dobrogicus, Emys orbicularis*
ROSCI0353 Deleni Cave	2	*Mesocricetus newtoni, Spermophilus citellus*
ROSCI0278 Bordușani-Borcea	2	*Bombina bombina, Emys orbicularis*
ROSCI0053 Alah-Bair Hill	6	*Campanula romanica, Potentilla emilii-popii, Pulsatilla grandis, Lycaena dispar, Callimorpha quadripunctaria, Pseudophilotes bavius*
ROSCI0172 The Forest and Valley of the Canaraua Fetii- Iortmac	30	*Lutra lutra, Vormela peregusna, Spermophilus citellus, Miniopterus schreibersii, Myotis emarginatus, Rhinolophus ferrumequinum, Rhinolophus mehelyi, Rhinolophus hipposideros, Testudo graeca, Testudo hermanni, Emys orbicularis, Bombina bombina, Elaphe sauromates, Aspius aspius, Rhodeus sericeus amarus, Romanogobio vladykovi, Misgurnus fossilis, Pelecus cultratus, Cerambyx cerdo, Paracalopterus caloptenoides, Lycaena dispar, Eriogaster catax, Pseudophilotes bavius, Euphydryas maturna, Callimorpha quadripunctaria, Lucanus cervus, Himantoglossum jankae, Marsilea quadrifolia, Potentilla emilii-popii, Echium russicum*

*according to Standard Forms

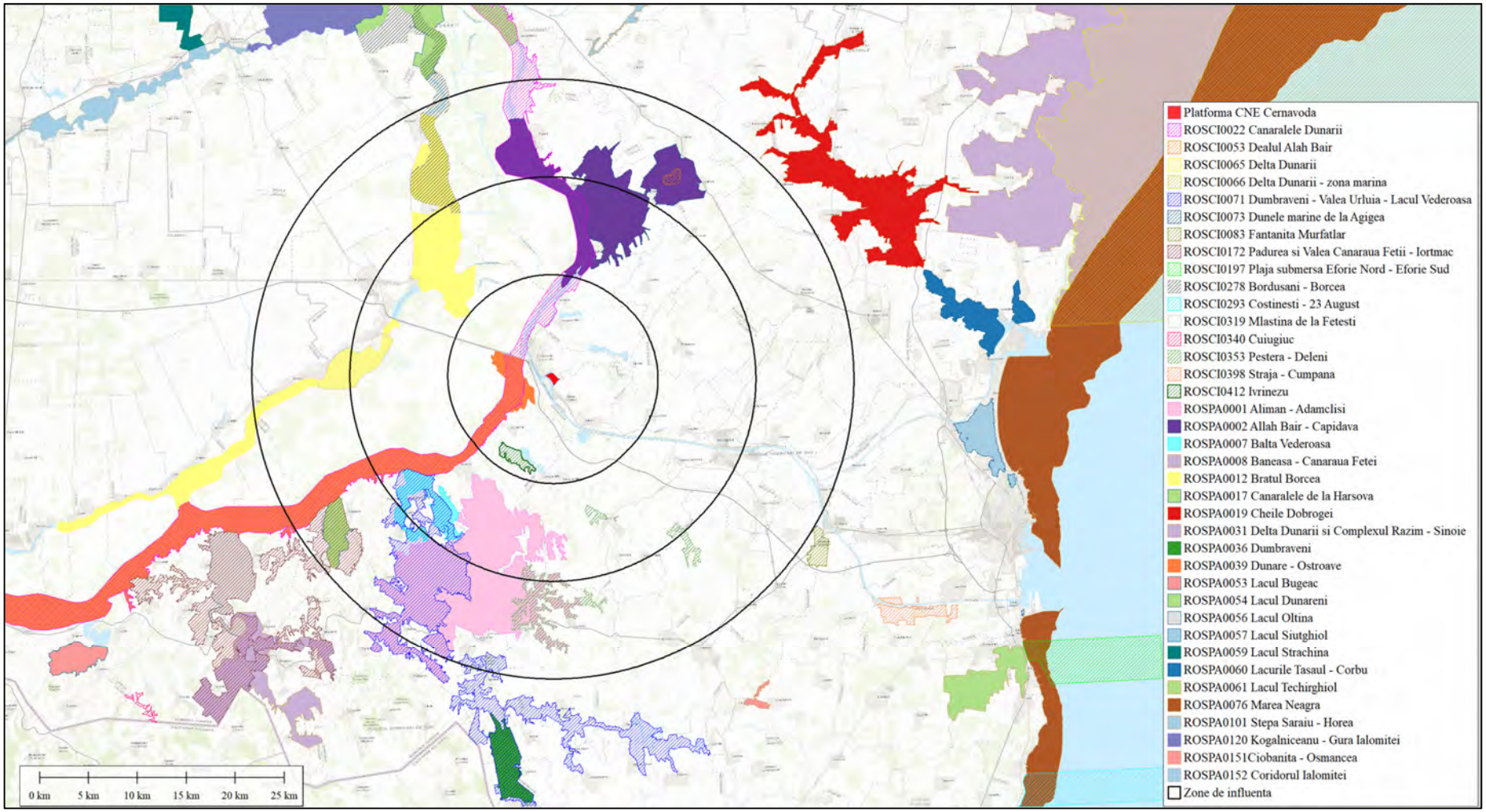


FIGURE 47- CERNAVODĂ NPP AREAS OF INFLUENCE: 10 KM, 20 KM AND 30 KM

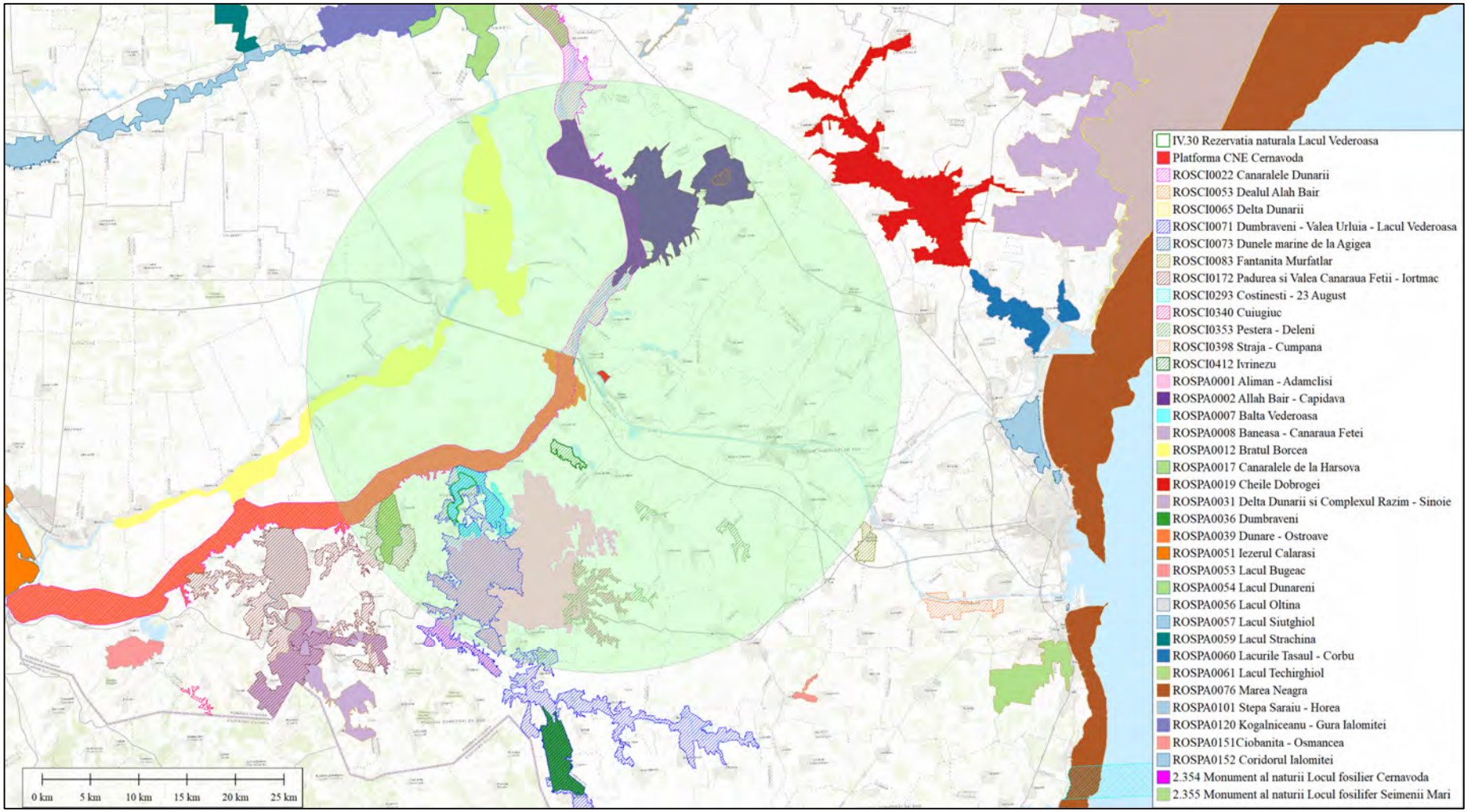


FIGURE 48 - CERNAVODĂ NPP IN RELATION TO THE NEAREST PROTECTED NATURAL AREAS - 30 KM DIRECT AREA OF INFLUENCE

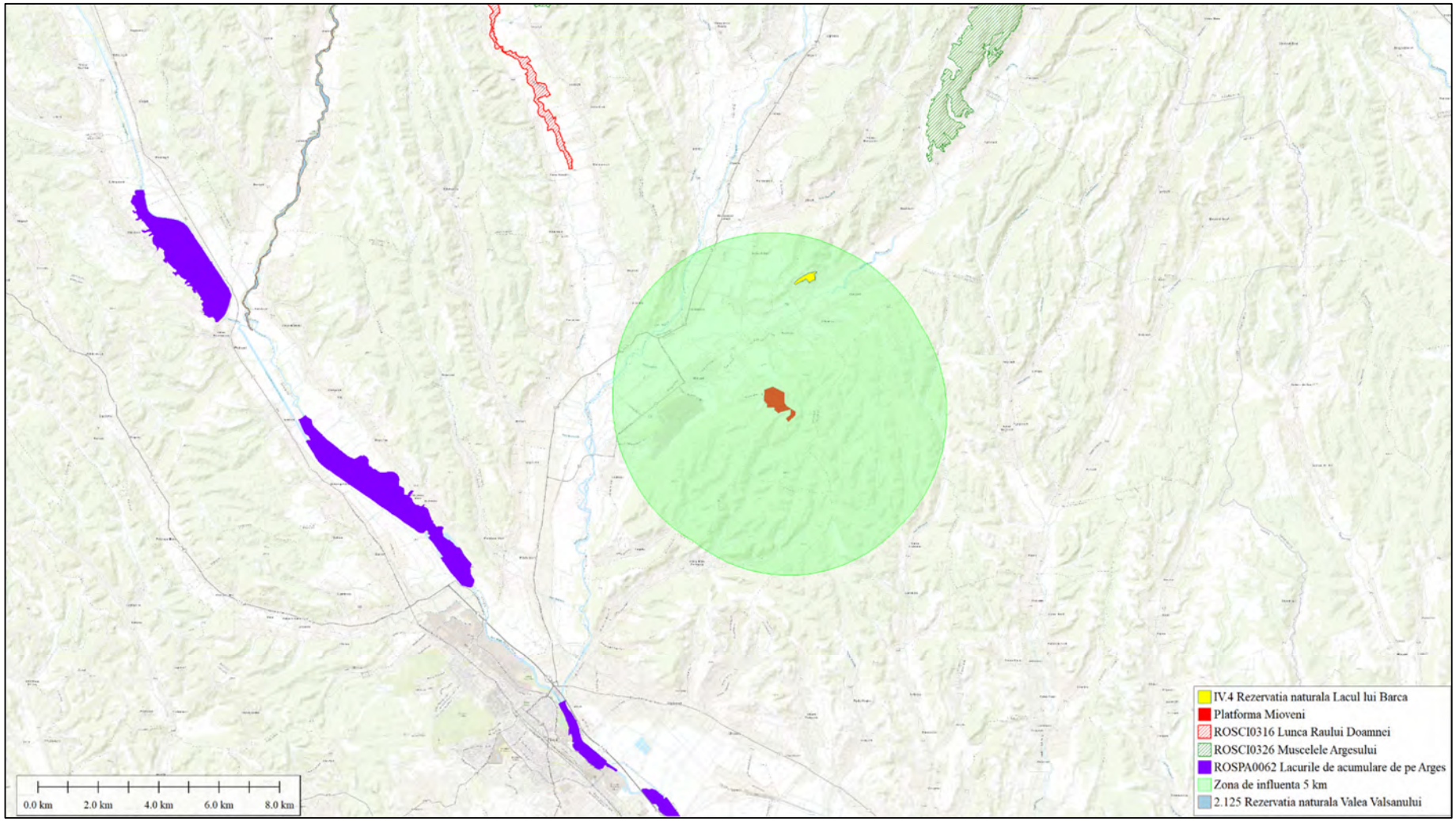


FIGURE 49 - MIOVENI PLATFORM IN RELATION TO PROTECTED NATURAL AREAS - 5 KM AREA OF INFLUENCE

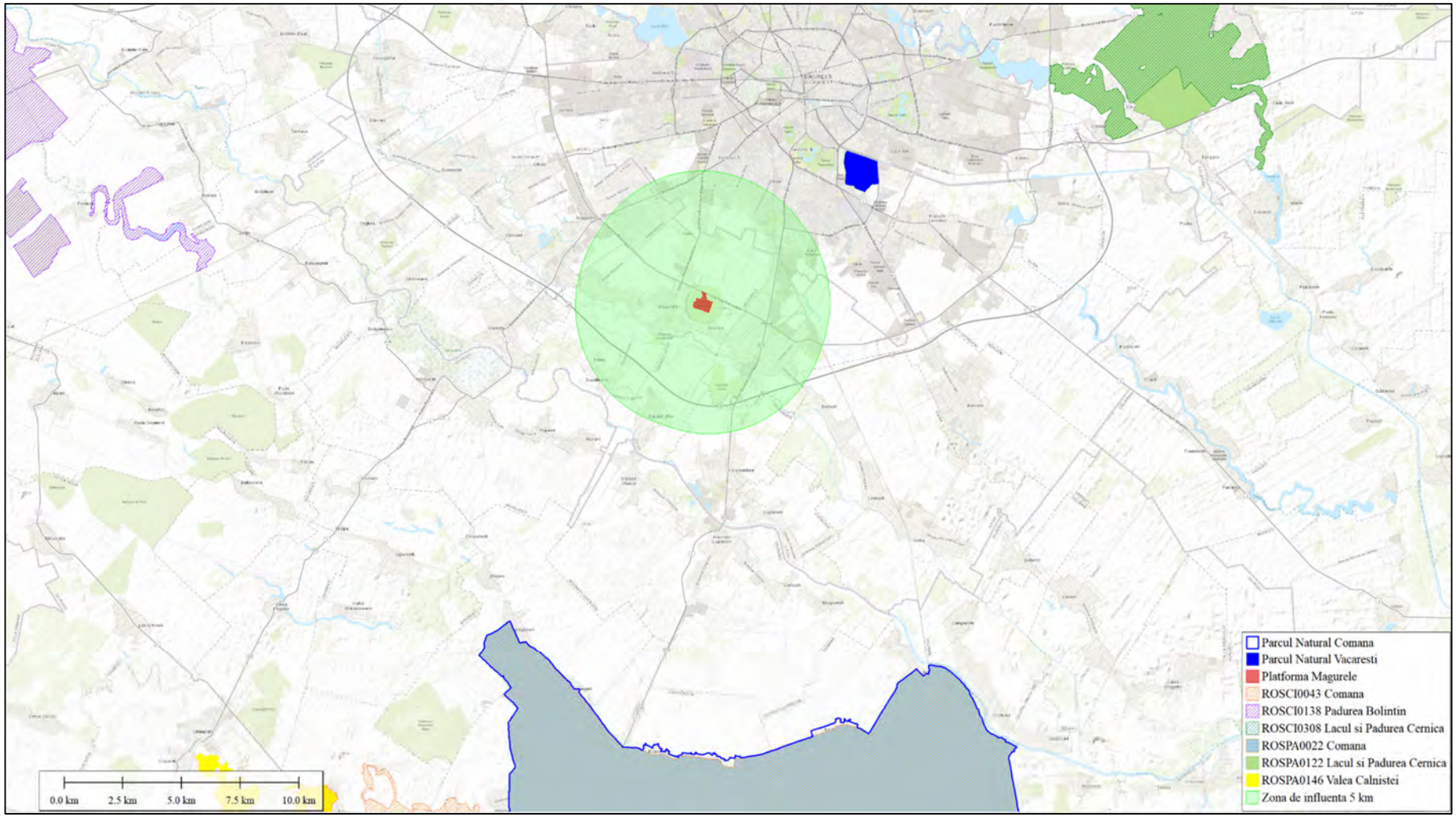


FIGURE 50 - MĂGURELE PLATFORM IN RELATION TO PROTECTED NATURAL AREAS - 5 KM AREA OF INFLUENCE

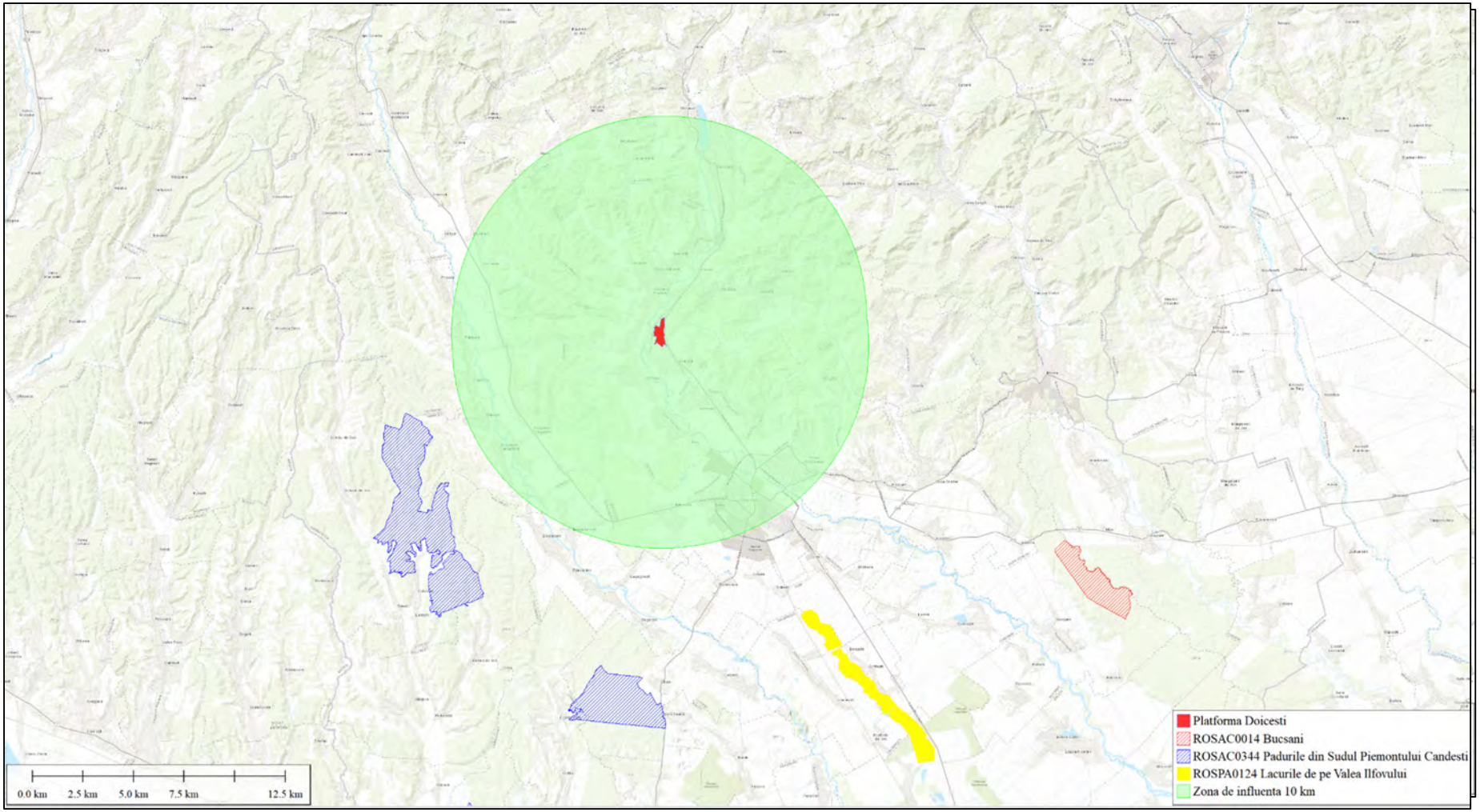


FIGURE 51 - DOICEȘTI PLATFORM IN RELATION TO PROTECTED NATURAL AREAS - 10 KM AREA OF INFLUENCE

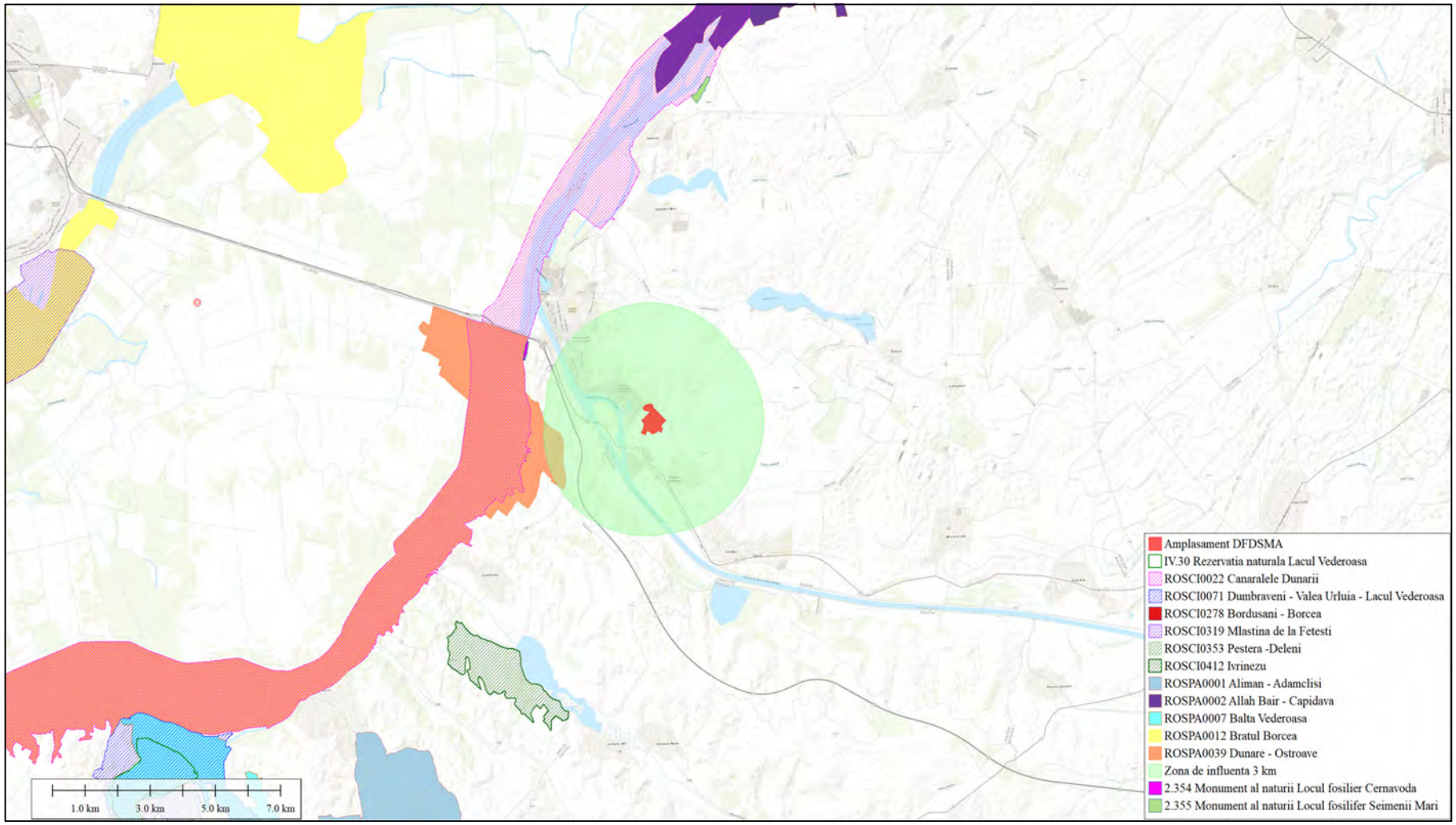


FIGURE 52 - DFDSMA IN RELATION TO PROTECTED NATURAL AREAS - 3 KM AREA OF INFLUENCE

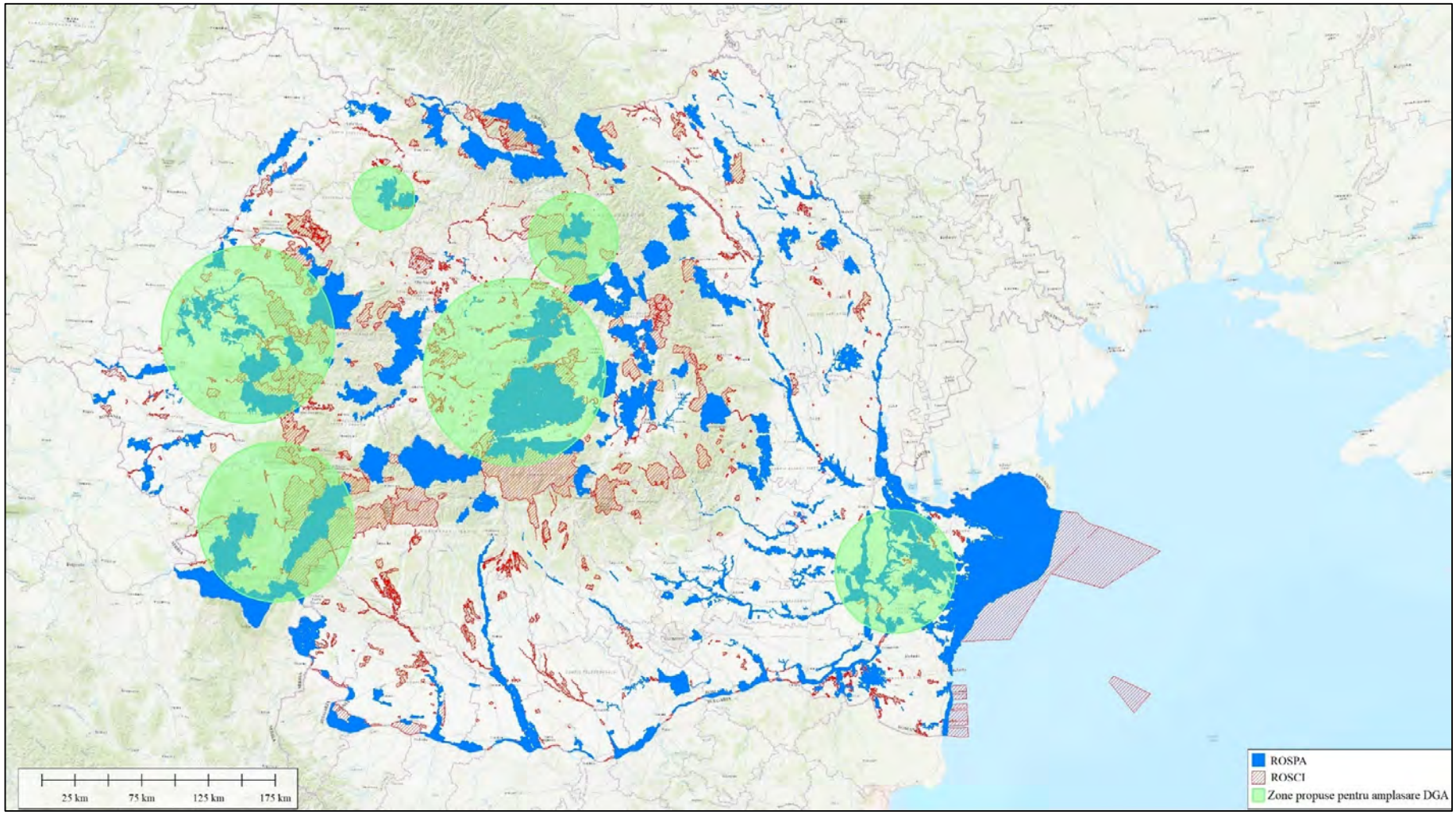


FIGURE 53 - POTENTIAL SITING AREAS FOR THE DEEP GEOLOGICAL REPOSITORY

TABLE 22 - TABULAR PRESENTATION OF THE STRATEGY OBJECTIVES AND DISTANCES FROM PROTECTED NATURAL AREAS

Strategy objectives	Location	Distance from the nearest ANPIC	Other additional information
Completion of units 3 and 4 at Cernavodă NPP	Cernavodă NPP	2.4 km from ROSPA0039 Dunăre-Ostroave 3.1 km from ROSCI0022 Canaralele Dunării 3.5 km from Cernavodă Fossil Site Natural Monument	Outside protected natural areas
Refurbishment of Units 1 and 2 at Cernavodă NPP	Cernavodă NPP	2.9 km from ROSCI0022 Canaralele Dunării 2.3 km from ROSPA0039 Dunăre-Ostroave 3.2 km from Cernavodă Fossil Site Natural Monument	Outside protected natural areas
Authorisation, construction and commissioning of DFDSMA	The outskirts of the commune of Saligny Cernavodă NPP exclusion zone	2.03 km from ROSPA0039 Dunăre-Ostroave 3.00 km from ROSCI0022 Canaralele Dunării 3.74 km from Cernavodă Fossil Site Natural Monument	Outside protected natural areas
Construction works of the Cernavodă Tritium Removal Facility (CTRF), on the Cernavodă NPP platform	Cernavodă NPP	<2 km from ROSPA0039 Dunăre-Ostroave <3 km from ROSCI0022 Canaralele Dunării	Outside protected natural areas
Construction of experimental support facilities for the ALFRED demonstrator	Mioveni Platform	11.5 km from ROSPA0062 Lacurile de acumulare Argeș 9.5 km from ROSCI0326 Muscelele Argeșului 10 km from ROSCI0316 Lunca Râul Doamnei. 3.7 km from Lacul lui Bârcă Nature Reserve	Outside protected natural areas
Construction of the ALFRED demonstrator, intended to demonstrate the viability of LFR technology	Mioveni Platform	11.5 km from ROSPA0062 Lacurile de acumulare Argeș 9.5 km from ROSCI0326 Muscelele Argeșului 10 km from ROSCI0316 Lunca Râul Doamnei. 3.7 km from Lacul lui Bârcă Nature Reserve	Outside protected natural areas
Construction of a research infrastructure for the production of radioactive beams and radioisotopes of medical interest	The Măgurele Platform	7.7 km from RONPA0954 Parcul Natural Văcărești 15.2 km from the common boundary of the Comana Natural Park with ROSCI0043 Comana and	Outside protected natural areas

Strategy objectives	Location	Distance from the nearest ANPIC	Other additional information
		ROSPA0022 Comana 20.9 km from ROSCI0138 Pădurea Bolintin	
Developing technologies for fundamental and applied nuclear physics research with the high - power laser system at ELI-NP	The Măgurele Platform	7.7 km from RONPA0954 Parcul Natural Văcărești 15.2 km from the common boundary of the Comana Natural Park with ROSCI0043 Comana and ROSPA0022 Comana 20.9 km from ROSCI0138 Pădurea Bolintin	Outside protected natural areas
Authorisation and commissioning of the DGA	The site has not yet been determined. The host rock has not yet been selected.	The distance from protected areas is unknown. The location of the DGA will take into account environmental protection provisions, so it will be located outside protected natural areas.	-
Construction of a new type of nuclear power plant based on SMR modules	Doicești Platform	- Approx. 12 km from ROSAC0344 Forests of the Southern Piedmont of Cândești - Approx. 15 km from ROSPA0124 Lakes of the Ilfov Valley - Approx. 21 km from ROSAC0014 Bucșani	Outside of any ANPIC – approximate measurement taking into account the location of the Doicești thermal power plant

This study integrates the results of field activities, carried out in order to prepare the appropriate assessment study for the project "Continuation of construction and completion works of units 3 and 4 at Cernavodă NPP ", a study developed by the National Institute for Research and Development of the Danube Delta (INCDDD), as well as the results of its own field activities, aimed at completing and updating information on environmental conditions in the areas targeted by the implementation and other projects proposed by the strategy.

Results of field activities according to the Appropriate Assessment Study for the project "Continuation of construction works and completion of units 3 and 4 at Cernavodă NPP "

These activities focused on biodiversity monitoring and assessment of the conservation status of the habitats and species of Community interest for which the Natura 2000 sites within the area of influence of Cernavodă NPP were designated, as well as on identifying biodiversity features potentially affected by implementation of the nuclear-sector projects.

The Appropriate Assessment Study for the project “Continuation of the construction and completion works for Units 3 and 4 at Cernavodă NPP” focused on the potential biodiversity impact of the cooling water discharged by Units 3 and 4, i.e. by a four-unit nuclear power plant located in the vicinity of Natura 2000 sites of Community interest.

Field trips carried out for the Development of the Appropriate Assessment Study showed that in the area of the Cernavodă NPP effluent discharge point, on the right side of the Old Danube branch, the habitat types indicated in the Natura 2000 Standard Form of the ROSCI0022 Canaralele Dunării site are not present.

Along an approximately 3-4 km section downstream of the effluent discharge point, where the bank is high, the tree layer consists of Salix alba (white willow) and Populus alba (white poplar), which do not form gallery woodland; most occur as isolated specimens or in groups of three or four. Other species identified in the field are characteristic of high-moisture areas and are widely distributed in similar ecosystems. The hydrophilous, hygrophilous and ruderal plants identified along this short section of the Danube were: Carduus dobrogensis – Dobrogea thistle; Ranunculus spp. – buttercup; Adonis aestivalis – summer pheasant’s-eye; Convolvulus cantabricus – Cantabrian bindweed; Achillea clypeolata – yellow yarrow; Euphorbia dobrogensis – Dobrogea spurge; Chenopodium album – fat-hen; Centaurea cyanus – cornflower; Amorpha fruticosa – false indigo-bush; Salix alba – white willow; Cirsium arvense – creeping thistle; Phragmites communis – common reed; Capsella bursa-pastoris – shepherd’s purse; Cardaria draba – hoary cress; Papaver rhoeas – common poppy; Rumex crispus – curled dock; Ulmus minor – field elm; Populus alba – white poplar (silver poplar); Festuca callieri – fescue; Butomus umbellatus – flowering rush; Matricaria inodora – scentless mayweed; Solanum nigrum – black nightshade; Portulaca oleracea – common purslane; Tussilago farfara – coltsfoot; Sonchus asper – prickly sow-thistle; Vicia narbonensis – Narbon vetch.

These species present in the area of the effluent discharge point are not among the species requiring protection, mentioned in the Natura 2000 standard form of the ROSCI0022 Canaralele Dunării site. Also, on this section there are plots of agricultural land on which corn (Zea mays) *is grow*n.

Field observations downstream of the discharge point, over several years during the period of continuous discharge of Unit 1 effluent (approximately 12 years), did not reveal any effects on the biocenosis. Even after almost a year of simultaneous operation of Units 1 and 2, no effects on the biocenosis were observed in the sector downstream of the discharge point.

Among the amphipods, which account for most organisms in the samples, specimens of Corophium curvispinum build tubes from mud or muddy sand and attach them to submerged objects. The tubes are also attached to the valves of Dreissena polymorpha shells, and studies have shown a correlation between the two species. C. curvispinum is therefore present only at sampling points where D. polymorpha has also been recorded, because the latter's shells provide both a substrate for attachment of C. curvispinum tubes and a specific feeding habitat, with detritus accumulating in areas covered by D. polymorpha.

As for the population of Corbi*cula fluminea, it h*as a high reproductive potential: an adult individual can produce over 68,000 pediveliger larvae (last larval stage) per year. As a result, this species can constitute very high densities in short periods of time. Adults can grow up to 50-70 mm and live between 3 and 4 years.

Taking into account the high invasive potential of this species, the appropriate assessment study emphasises the importance of monitoring studies of the dynamics of this species, in parallel with the distribution dynamics of the native sp*ecies Dreissena poly*morpha. Given the results of previously conducted field investigations, it cannot be concluded that the native species (D*reissena polymorpha)* would be replaced by the allochthon*ous one (Corbicula* fluminea) due to the influence of the area with modified wat*er* temperatures. Even if in stations with high abundances o*f the Corbicula flum*inea species, the numbe*r of Dreissena polymor*pha individuals is low (or even its absence is observed in certain periods of the year), the possible pressure exerted by the allochthonous species cannot be the only factor responsible for this species dynamics. The cooling water discharge channel from the Cernavodă NPP may, however, represent a reservoir for Co*rbicula fluminea,* where this non-native species finds favourable conditions for development even during winter, from where it can disperse passively, with the help of the Danube currents downstream. Even in this case, observations have shown that the numbers decrease significantly, from station P0 (the cooling water discharge channel from the Cernavodă NPP) to station S2 (near the Seimeni locality) and further to station S1 (near the Capidava locality). In the spring period, the abundance of this non-native species is considerably lower compared to other seasons of the year.

In the investigated Danube sector, belonging to ROSCI0022 Canaralele Dunării, 52 fish species (both demersal and pelagic species) have been observed so far. The overwhelming majority of species are constantly present in ROSCI0022 Canaralele Dunării, even if their number varies from season to season, depending on the biology of the respective species. Thus, most species were observed in the summer period, and the lowest number of species was recorded in the winter period.

Several species are present temporarily in ROSCI0022 Canaralele Dunării during their spawning periods, particularly species migrating from the Black Sea to this area and to Danube sectors upstream of this Natura 2000 site, including the Black Sea shad (Alosa immaculata), Alosa tanaica and sturgeons. Of these, the Black Sea shad (A. immaculata) has its most important spawning area in Romania between Călărași and Brăila, including within ROSCI0022 Canaralele Dunării. Adults do not feed during the spawning period, and after

spawning the overwhelming majority of spawners die. Consequently, the species forms part of the food spectrum of ichthyophagous and necrophagous species for a period limited to several months, generally from April to August, with this role in the food web being most relevant from May to July.

The increased biomass of Corbicula species, potentially favoured by the modified-temperature water downstream of the Cernavodă NPP cooling-water discharge channel, attracts benthivorous fish species. The greater abundance of fish in the discharge channel and in the modified-temperature area also attracts more predatory fish. This is further demonstrated by the much higher number of recreational anglers using these areas - both the warm-water area and the area with accumulations of Corbicula molluscs - compared with other sectors of the river.

In the sector between Rasova and Capidava of the Danube valley, 116 bird species were identified, including 41 species belonging to the aquatic bird group – of these, 28 species of aquatic birds are more frequently/constantly present (at least during certain periods of the year) in the area of the river sector where the area with modified temperatures is also located. Among the aquatic birds, which were observed feeding in the riparian areas and along the Danube and congregating on the river banks or on islands, 8 species have larger flocks. The largest flocks of aquatic birds were recorded during the summer period on the Danube sector between the cooling water discharge channel of the Cernavodă NPP and the Seimeni locality. In the other seasons of the year, the flocks were approximately the same size as those on other sectors of the river with the same habitat characteristics as the one in the sector investigated in the present study.

With regard to other groups of aquatic and semi-aquatic vertebrates (amphibians, reptiles and mammals), population sizes are approximately the same as in other river sectors with habitat characteristics similar to those of the sector investigated in this study. Among these vertebrate groups, only anurans had larger populations in shallow standing-water habitats both upstream and downstream of the Cernavodă NPP cooling-water discharge channel, although at a considerable distance from the channel (for example, in floodplain areas on the right bank of the Danube, approximately opposite Tichilești, Constanța County). However, this type of habitat (large ponds with abundant aquatic and semi-aquatic vegetation, etc.) is not present in the riparian zone of the river sector containing the modified-temperature plume.

According to monitoring undertaken to assess the impact of the project “Refurbishment of Cernavodă NPP Unit 1 and Expansion of the Interim Spent Fuel Storage Facility with MACSTOR 400 Modules” at the Cernavodă NPP site, vegetation cover is sparse and has a highly ruderalised structure dominated by xerophilous and xerothermophilous species characteristic of ruderal plant communities with no conservation value. In some areas there are thickets of Rosa sp., Crataegus monogyna and Prunus cerasifera. Isolated Robinia pseudoacacia specimens also occur and are regularly removed during maintenance of the internal areas of the Cernavodă NPP site.

Results of field activities carried out for the development of the Appropriate Assessment Study

In addition to this monitoring, the consultant carried out its own field surveys to supplement and update the information on environmental conditions in the areas concerned by implementation of the other projects proposed under the Strategy. Field surveys were undertaken in the areas of the Mioveni, Măgurele and Doicești platforms and at the DFDSMA site, for which preparation of separate Appropriate Assessment studies was not required.

Field activities consisted of direct observations of environmental conditions, identification of existing habitats, assessment of the degree of anthropisation, as well as documentation of current land use and possible anthropogenic pressures on the environment. The data obtained allowed a characterisation of the proposed sites and a more rigorous substantiation of the analysis regarding the possible interactions between the strategy objectives and the environment.

The field surveys undertaken by the consultant as part of the assessment of the National Strategy for the Development of the Nuclear Sector showed that the other areas proposed for implementation of the Strategy are also highly anthropised, consisting mainly of industrial land or, in the case of the DFDSMA, agricultural land under continuous anthropogenic pressure. No natural habitats of Community interest or flora or fauna species of high conservation value were identified. Therefore, the local environmental conditions are compatible with the implementation of the objectives provided for in the Strategy.

3.5. Climate change

The Summary for Policymakers of Volume I18) of the IPCC's Sixth Assessment Report (AR6), published in August 2021, showed that the magnitude of recent changes in the climate system is unprecedented over many centuries to many thousands of years. Global average surface air temperature, which has already increased by about 1.1 °C above pre-industrial levels, is set to continue to rise under all emission scenarios considered. Volume II19) of AR6, published in March 2022, presents ample and robust evidence supporting the conclusion that human-induced climate change has already caused widespread negative impacts and significant damage to nature and human society. Due to changes in climate parameters (for example: amount of precipitation, temperature - amplitude of heat waves and harshness of winter, duration of cold and heat waves, wind speed, global solar radiation, sea surface temperature, etc.) various types of impact of climate risk phenomena on key sectors in Romania have been manifested.

The authors of the Summary for Policymakers of Volume III20) of AR6, published in April 2022, reveal that in order to be on track to meet the target of limiting global temperature increase to 1.5°C by the end of this century, we must peak emissions by the end of 2025 at the latest, followed by substantial reductions in emissions in the 2030s, 2040s and 2050s. The effects of strong, rapid and sustained reductions in greenhouse gas (GHG) emissions will begin to appear approximately 20 years after their initiation. It is anticipated that GHG emissions will continue to increase if the implementation and at least maintenance of current policies is not done in the coming period, leading to an average global warming of 3.2°C

compared to pre-industrial levels, by 2100. (National Strategy on Adaptation to Climate Change for the period 2024-2030, with a perspective to 2050).

Total national GHG emissions

The largest contributor to total national GHG emissions is CO_2, followed by CH_4 and N_2O. The share of each direct GHG in total emissions in 1989 and 2022, respectively, as well as the average share of each direct GHG in total emissions for the period 1989–2022, are presented in the table below.

Total GHG emissions, excluding, expressed in CO_2 equivalents for the period 1989–2022, are presented in the table below.

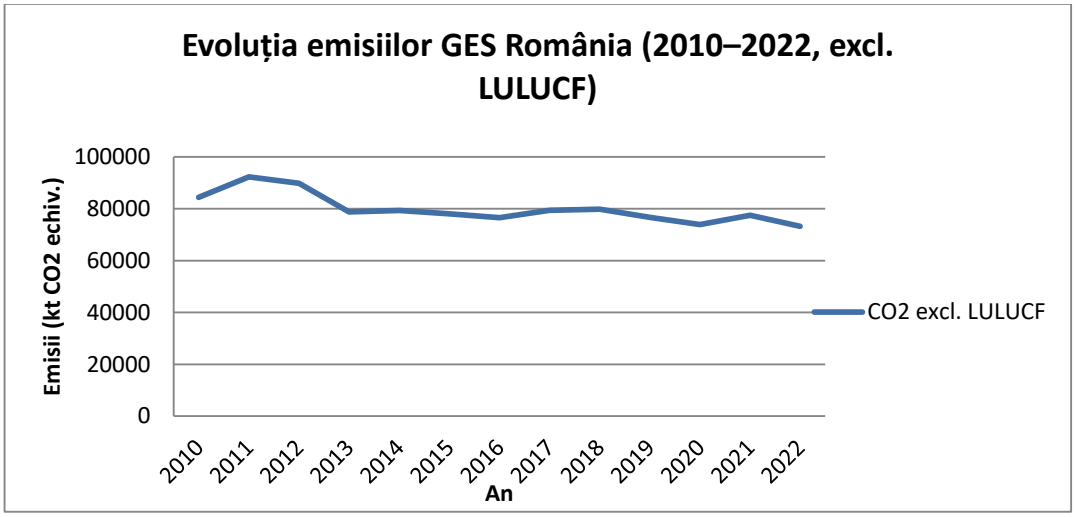
TABLE 23 - SHARE OF EACH DIRECT GREENHOUSE GAS (CO_2, CH_4, N_2O AND FLUORINATED GASES) IN TOTAL EMISSIONS: 1989 (BASE YEAR IN THE INVENTORY), 2022 (MOST RECENTLY REPORTED YEAR) AND THE AVERAGE FOR 1989-2022

GHG	1989 (%)	2022 (%)	Average for the entire period 1989–2022 (%)
CO_2	67.51%	66.61%	67.07%
CH_4	23.93%	23.16%	24.29%
N_2O	7.27%	8.39%	7.62%
HFCs	0.00%	0.0179%	0.57%
PFCs	1.29%	0.00%	0.44%
SF_6	0.00%	0.00046%	0.02%
NF_3	0.00%	0.00%	0.00%

Source: National Inventory Document of Romania 2024

Comparatively, the graph below shows the evolution during the period 2010-2022 for all sectors.

FIGURE 54 - GHG EMISSIONS IN ROMANIA, 2010-2022



Source: National Inventory Document of Romania 2024, Table 2.1, Trends by gas [kt CO_2 equivalent]

Total greenhouse gas emissions (excluding the contribution of the Land Use, Land Use Change and Forestry - LULUCF) sector decreased in 2023 by approximately 2.29%, compared to the level of emissions recorded in 2022.

The share of greenhouse gas emissions from the Energy sector in total greenhouse gas emissions (excluding the contribution of the LULUCF sector) for 2023 was approximately 68.58%, and the contribution of the sub-sectors attributed to the Energy sector is as follows:

- Energy Industry 21.80%;
- Manufacturing and Construction Industry 16.10%;
- Transportation 31.06%;
- Fugitive emissions from fuels 12.43%;
- Other sub-sectors 18.60%.

The contribution of the other sectors in INEGES for 2023 is represented as follows:

- Industrial Processes and Product Use (IPPU) is approximately 8.11%;
- Agriculture represents 17.23%;
- Waste is 6.08%.

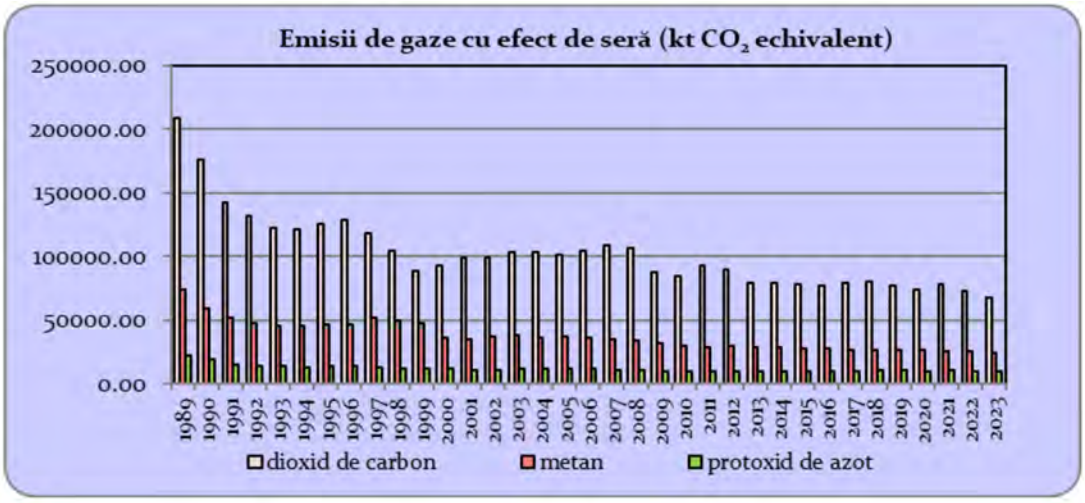
TABLE 24 - GREENHOUSE GAS EMISSIONS BY SECTOR

Nr. Crt.	Sector/Sub-sector - INEGES	Emisii ($kt CO_2$ echiv.)		Tendința (%)	
		2022	2023		
1	**Energie**	74.945,33	71.232,52	-4,95	↘
	-Industria energetică	18.004,38	15.532,07	-13,73	↘
	-Industria prelucrătoare și construcțiile	13.150,12	11.470,65	-12,77	↘
	-Transporturi	21.158,52	22.124,76	4,57	↗
	-Comercial instituțional	2.127,77	2.288,47	7,55	↗
	-Rezidențial	8.450,69	8.103,55	-4,11	↘
	-Emisii fugitive din combustibili	9.175,95	8.855,98	-3,49	↘
2	**Procese industriale și utilizarea produselor**	10.380,75	8.419,14	-18,90	↘
3	**Agricultură**	18.000,82	17.891,23	-0,61	↘
4	**Deșeuri**	6.340,35	6.319,56	-0,33	↘
5	**Total GES (excluding LULUCF)**	109.667,26	103.862,45	-5,29	↘

Source: RSM-2024-ANMAP

Among the greenhouse gases monitored at national level, carbon dioxide represents the pollutant with the most significant share, followed by methane and nitrous oxide.

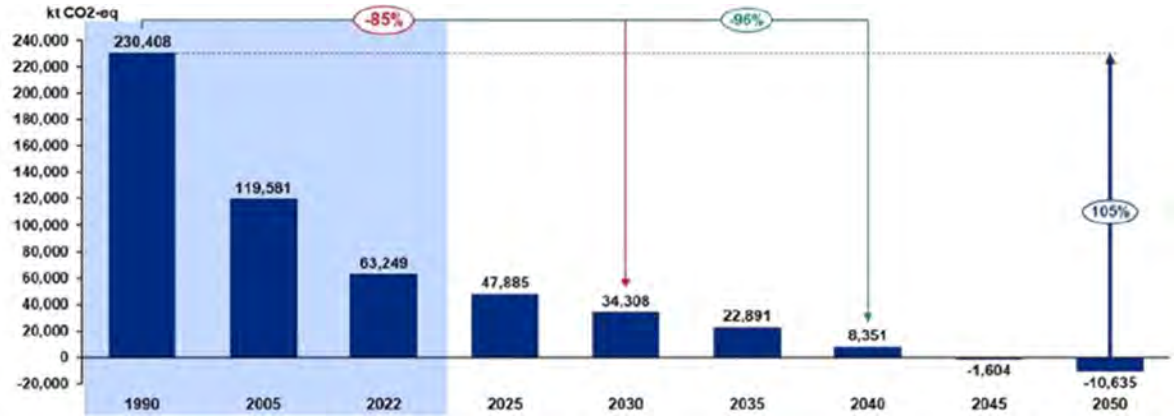
FIGURE 55 - NATIONAL GREENHOUSE GAS EMISSION TRENDS BY GAS, 1989-2023



Source: RSM-2024-ANMAP

The projected trajectory shows that by 2025, 93% of the 2030 net GHG emissions reduction target will have already been achieved. The long-term objective is to achieve a 96% reduction in GHG emissions by 2040, with a full reduction in GHG emissions to be achieved by 2050. This implies a 105% reduction in net GHG emissions in 2050, compared to 1990 levels.

FIGURE 56 - TARGETS AND ESTIMATED TRAJECTORY FOR REDUCING NET NATIONAL GHG EMISSIONS (INCLUDING LULUCF)



Source: INEGES 1989 – 2021 submitted to the UNFCCC (National Inventory Report - NIR and Common Reporting Format - CRF tables, submitted in March 2024)-RSM 2024 ANMAP

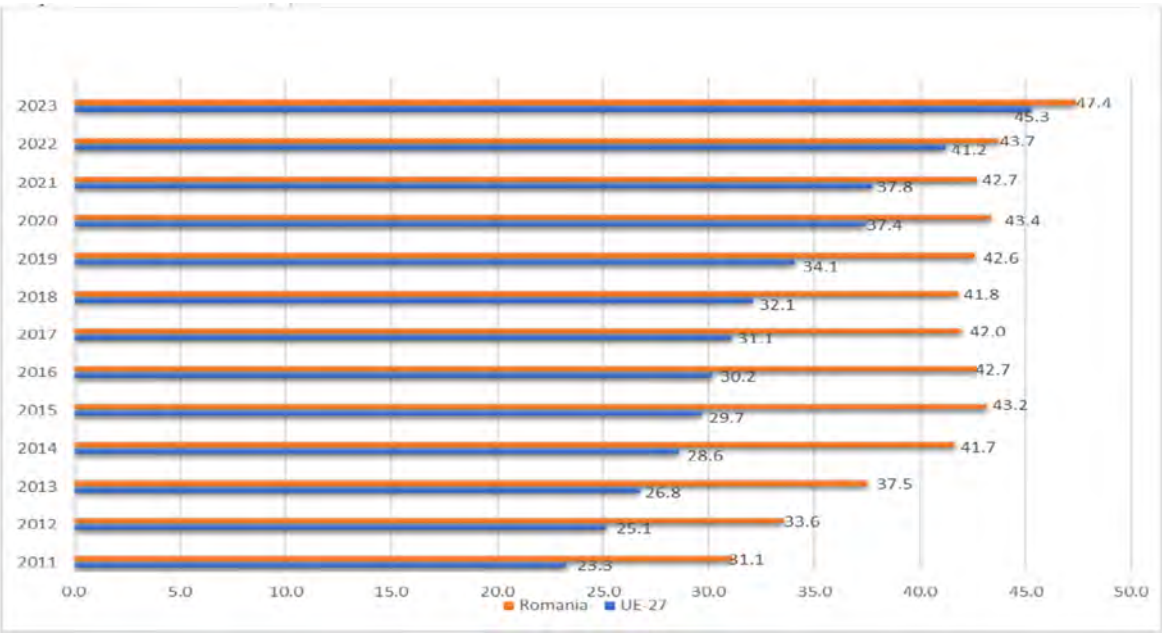
ACTIONS FOR CLIMATE CHANGE MITIGATION AND ADAPTATION

At the national level, the data presented indicate an increase in the use of biofuels in 2023 by 246.02% compared to 2010.

Between 2011 and 2023, the share of electricity from renewable sources increased significantly in the EU-27, from 23.3% to 45.3%. Romania started from a higher level (31.1% in 2011), rose to 43.2% in 2015, had a small decline to 41.8% in 2018, then increased again, reaching 47.4% in 2023.

Overall, both at the EU level and in Romania, there is a clear trend of increasing the use of renewable sources in electricity production, which supports the transition to a greener energy system and contributes to reducing GHG emissions from the energy sector.

FIGURE 57 - SHARE OF ELECTRICITY GENERATED FROM RENEWABLE ENERGY SOURCES IN ROMANIA AND THE EU-27, 2011-2023 (%)

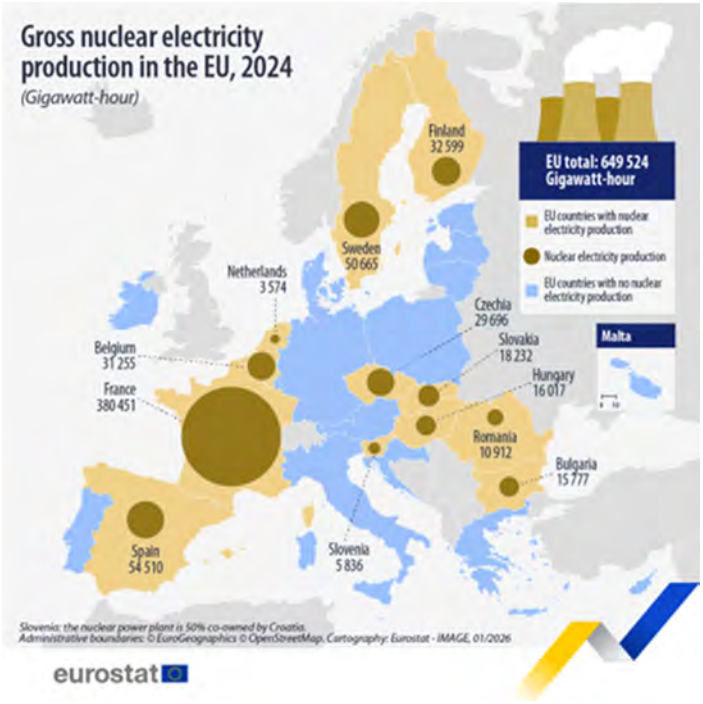


Source: RSM 2024 ANMAP

Statistical data show that nuclear energy production in the EU has recently increased, after a period of decline.

In 2024, electricity production from nuclear power plants in the European Union increased by 4.8% compared to 2023. This was the second consecutive year of growth, after the decrease recorded in 2022 (https*://ec.europa.eu/eurostat), 12 Euro*pean Union Member States had operational nuclear reactors: Belgium, Bulgaria, Czech Republic, Spain, France, Hungary, the Netherlands, Romania, Slovenia, Slovakia, Finland and Sweden.

FIGURE 58 - NUCLEAR ELECTRICITY GENERATION IN THE EUROPEAN UNION



Source: https://ec.europa.eu/eurostat

3.6. LANDSCAPE

The landscape represents the visible expression of the interaction between natural components (relief, water, vegetation) and anthropogenic ones (infrastructures, settlements, economic activities). In the context of nuclear development, the assessment of the impact on the landscape takes into account both the aesthetic and cultural dimension of the visual environment, as well as its social perception.

Romania has a high landscape diversity, specific to mountainous, plateau, hilly and plain areas, with special natural and cultural values, many of which are included in Natura 2000 sites or in protected natural areas of national interest.

The existing locations and objectives of the nuclear sector - such as the Cernavodă Nuclear Power Plant (NPP), the Măgurele Institute of Nuclear Physics or radioactive waste repositories - are located in areas with predominantly anthropised landscapes, characterised by the presence of industrial infrastructures, energy transmission lines and technical constructions.

Landscape changes in these areas are already stabilised and visual influences are localised.

The Cernavodă Nuclear Power Plant (NPP) is the most important nuclear energy facility in Romania and the main landscape landmark of its kind. It is located on the right bank of the Danube, in the southeastern area of Constanța County, near the city of Cernavodă.

The landscape of the area is heavily anthropised, dominated by industrial and energy infrastructures: the Cernavodă dam and lock, the Danube–Black Sea canal, high-voltage electricity transmission lines and associated storage areas. The natural elements, represented

by the Danube meadow and the nearby hilly relief, have been partially modified by hydrotechnical and industrial works.

The presence of reactors 1 and 2, the envelopes for reactors 3 and 4, the envelope of the former Unit 5, the concrete modules of DICA, the technological pipes and the related infrastructure give a strong industrial character to the local landscape, but the visual impact is perceived as stabilised and socially accepted, due to the age of the facility and its integration into the economic identity of the region.

The location area of the Institute of Physics and Nuclear Engineering "Horia Hulubei" - Măgurele has an urban-periurban landscape, dominated by administrative buildings, laboratories and technical platforms. In recent years, the expansion of the research infrastructure (including the ELI-NP - Extreme Light Infrastructure project) has led to the emergence of modern buildings, aesthetically integrated into the urban environment.

The visual impact on the landscape is minor and localised, without affecting significant aesthetic or natural values, as the area was already intended for scientific and industrial activities.

The historical Băița landfill is located in a mountainous area in northern Bihor County, in a natural landscape with high aesthetic value. However, the landfill is located in an old, disused, underground mining gallery, with no significant visible expression on the surface. The impact on the landscape is insignificant, as the visible infrastructure is minimal and the site is isolated and naturally integrated into the forested mountain landscape.

Located within the Cernavodă NPP site, the interim storage facility for spent fuel visually integrates into the same industrial landscape, without introducing new dominant elements. The buildings and technical structures follow the existing architectural line of the platform, and the additional visual effects are minor. In the area of the future DFDSMA repository, the landscape alternates from floodplain to steep channels, agricultural lands dotted with ravines formed by the flow of torrents, hills and valleys covered with steppe meadows, and scrub.

The potential location of the small modular reactors (SMRs) is the Doicești area, Dâmbovița, and uses the land of a former thermal power plant, located in a degraded industrial area.

3.7. HUMAN SETTLEMENTS AND PUBLIC HEALTH

Romania has a stable, slightly decreasing population, with ageing trends and an uneven territorial distribution, concentrated in large urban centres and along the main economic corridors. In areas where nuclear facilities are located, the socio-economic structure is influenced by the presence of industrial and energy infrastructures.

From an administrative perspective, the National Strategy sites in Constanța County are located within the administrative territories of the city of Cernavodă and Saligny commune. The SNDDN and PNN provide for the Cernavodă Tritium Removal Facility (CTRF) and expansion of the Interim Spent Fuel Storage Facility (DICA) on the Cernavodă NPP platform, while the DFDSMA is proposed within the Cernavodă NPP exclusion zone, outside the built-up area of Saligny commune.

The city of Cernavodă

Location

The city of Cernavodă is located in Constanța County, the historical region of Dobrogea, part of the South-East Development Region. According to the Eurostat classification through the Nomenclature of Territorial Units for Statistics, the city of Cernavodă is a territorial unit of type LAU1 2, which includes communes, cities and municipalities. The administrative unit is formed by a single locality, namely the city of Cernavodă.

The city's area is 4,371.65 ha, representing 0.62% of the area of Constanța county of 707,100 ha.

Neighbouring localities

To the west, the city opens onto the Danube for a distance of 6.8 km. Through the ensemble of Danube bridges, the city is connected to Ialomita County, the closest localities being the commune of Stelnica and the municipality of Fetești, the latter at a distance of 24 km.

The city borders:

- to the south with the locality of Rasova, the village of Cochirleni, the distance being 20 km;
- to the southeast with the localities of Saligny, at a distance of 5 km, Făclia and Ștefan cel Mare;
- to the north with the localities of Seimenii Mari and Seimenii Mici at an average distance of 12km.

These neighbourhoods facilitate social and economic interactions between the city and the aforementioned communes, with the city functioning as a hub for the neighbouring rural area and as an initiator of cooperation projects aimed at meeting common needs.

Neighbourhood relations are formalised through an association established under Ordinance No. 26/2000 on associations and foundations, namely the Association for the Development of the Cernavodă Area, which brings together the localities of Cernavodă, Saligny, Seimeni, Rasova and Aliman.

Relief

The city's relief is hilly with a tabular-structural appearance, broadly undulating, with sinuous valleys. The administrative territory of the city covers areas with variable elevations, from the Danube floodplain (+9.00/+10.00 m above sea level) to the peaks of the Vifor, Hinog, Sofia hills, the northern area of the city (+ 80.00 m/+ 100.00 m above sea level). The low altitudes, limited fragmentation and advanced flattening are the favourable factors that contributed to the accessibility and anthropisation of the area.

Land use

The total area of the administrative territory of the city of Cernavodă is 4,371.65 ha, divided into the urban and extra-urban areas of the city.

The analysis of the evolution over time of the destination of the areas related to the urban land and the prospects for expanding the city's urban area were carried out within the General Urban Plan approved in September 2014. Thus, the expansion of this area from 699.36 ha to 762.88 ha was proposed and approved, by 63.52 ha, respectively by 9.08%, the

share of the increase being attributed to the main body of the city (residential area, public institutions and community services, green spaces, industrial area). It was also planned to expand the area intended for builders' housing (by 3.07 ha), in view of the start of construction works on units 3 and 4 of the Cernavodă Nuclear Power Plant.

Analysis of land use in the administrative territory outside the built-up area indicates a balanced structure of non-agricultural uses, favouring natural land unaffected by human activities: forests and water bodies account for 59.86%, while built-up land, transport infrastructure and special-regime land account for 40.14%, reflecting the presence of the nuclear power plant 2 km east of Cernavodă within its administrative territory. Agricultural land is overwhelmingly dominated by arable land (56.49%), followed at a considerable distance by vineyards and pasture/hayfields; this structure reflects local interests driven by agricultural-market demand.

Population

The population of the City of Cernavodă on January 1, 2017 was 19,187 people, decreasing compared to previous years, respectively by 865 people compared to 2010.

Information about the town of Saligny, on whose territory the DFDSMA is proposed to be located.

Saligny commune

Location

The commune of Saligny is located in the western part of Constanța County. It includes three villages: Făclia, Saligny (residence), and Ștefan cel Mare.

The commune is located in the southern part of the Dobrogea Plateau, in the west of Constanța County, in the Valea Carasu subunit, with an altitude of up to 50 m.

The Carasu Valley is a corridor that stretched along the current Danube-Black Sea Canal. In fact, along this geographical formation, most of the canal (the Cernavodă - Basarabi portion) was built, which delimits the northern and southern plateaus of Constanta County, right next to the Saligny commune.

According to some researchers, the Carasu Valley is considered to be an ancient course of the Danube.

Located in the Dobrogean steppe area, on a high, undulating plain, on slopes that descend towards the Carasu Valley meadow, falling within the climatic parameters of the Dobrogean steppe, the area is characterised by hot summers and relatively cold winters with sudden transitions from winter to summer and vice versa.

Due to its location and the hills surrounding the commune, there is a variation in wind direction and intensity even during the same day.

The dominant winds in winter are the Crivățul and the Austru, the former causing sudden drops in temperature, strong blizzards in winter, and the latter causing dryness in summer and frost in winter.

The general appearance is of a calcareous plain covered with thick loess deposits. Chernozems occupy most of the commune's surface and have the highest natural fertility. They were formed on loess, clays, alluviums, where the aquifer is up to 20 m deep.

Due to the pedo-climatic conditions characteristic of this area, the floristic oscillation is that of the steppe, characterised by the lack of spontaneous arboreal vegetation. Among the cultivated plants we mention in particular wheat, barley, corn, sunflower, alfalfa, sugar beet and as fruit trees peaches, apricots, pears, apples, walnuts and quince.

The current Saligny commune, established after the administrative-territorial division in 2004, covers an area of 3340 ha, between the Mircea Vodă commune and the city of Cernavodă and is made up of three villages:

- Saligny - commune seat;
- Faclia - 1 km from the residence;
- Stefan the Great - 1.5 km from the residence.

Relief

The general appearance is of a calcareous plain covered with thick loess deposits. The maximum heights do not exceed 50 m above sea level. The commune is arranged in 2 portions, one of hills with heights up to the maximum and the valley portion. These two are arranged transversely along the three villages.

Climate

The temperate climate is mostly specific to Dobrogea, of the continental-marine type. Despite the fact that in this western area the influence of the Black Sea on the thermal regime is felt to a lesser extent, the winters are short and mild and the summers are long and often dry. From a meteorological point of view, this area of Dobrogea is known for the lowest amounts of precipitation in the country (approx. 600–700 mm/year). As a result, during snowy winters, it does not persist for long precisely because of the not very low temperatures, and during summers this area records the periods with the most sunny days and often scorching temperatures. Also, despite the high temperatures, during the few rainy days of summer, approximately half of the total annual precipitation falls, which ultimately produces floods due to the large amount of water falling during a torrential rain.

Agriculture

The population is mainly engaged in cultivating the land and raising animals:

- cereal crops (wheat, corn, barley, oats, rye) and vines;
- especially the breeding of farm animals (pigs, horses), domestic poultry but also pasture animals (sheep, cattle).

Population

On January 1, 2017, the population of Saligny commune was 2,312 inhabitants, registering a continuous growth trend since 2007, when it had 2,091 inhabitants, which represents an increase of 221 people by the beginning of 2017. The majority of inhabitants are Romanian (96.01%).

Economy

The economic activity is not very representative, on the territory of the commune there is a bread factory with a small production capacity, a fish farm located on the southern bank of the Danube-Black Sea Canal near the Făclia locality, called "Balta Făclia", known for important catches of perch, crucian carp, pike, etc. Also, a close connection is ensured between the village of Ștefan cel Mare and the Nuclear Power Plant due to the very close

distance but also the fact that in 2007 the issue of creating a radioactive waste deposit from the nuclear power plant on the territory of the Ștefan cel Mare locality was discussed. One of the reasons for this decision was the degree of economic development of the area but also the increase in the number of jobs.

Doicești commune

location

The commune of Doicești in Dâmbovița County, located approximately 7-8 km from Târgoviște municipality, is located on the meadow of the Ialomița River, bordering:

– to the east – Aninoasa commune;

– to the west – Vulcana Pandele commune;

– to the south – the Ialomița River;

– to the north – Glodeni commune;

Surface

The area of Doicești commune is 11.5 km² and extends along the middle course of the Ialomița River, at its exit from the Subcarpathian sector.

The area of the territory is 1098 ha, of which: 199 ha within the city and 899 ha outside the city (of which: arable = 299 ha, pastures = 230 ha, hayfields = 49 ha, vineyards = 9 ha, orchards = 61 ha, forests = 111 ha, waters = 47 ha, roads = 88 ha, unproductive = 5 ha).

Administrative organisation

Doicești commune has no component villages (the locality of residence being Doicești commune).

The relief aspects within the Doicești administrative perimeter, diverse in form and origin, are a consequence of the concurrent existence of two main factors:

- the Ialomița River which delimits the perimeter to the southwest;
- the hilly area in the eastern half of the perimeter.

The existence of these two main factors constitutes the natural framework that allowed the shaping factors to carry out their activity, generating a great diversity of relief microforms.

Forms specific to the plain area:

- the major bed of the Ialomița River;
- plain (middle terrace on the left of Ialomița);
- piedmont terrace (hills-plain contact);

Forms specific to the hilly area:

- steep slopes (slopes) – with medium (20-25°) and excessive (40-45°) slopes;
- erosion levels (water erosion);
- micro contact depressions and erosion (buttonholes).

Climate

The location of the area at the southern edge of the Subcarpathian hills creates a framework in which, from a climatic point of view, the area is sheltered from cold atmospheric currents from the north, which is marked by relatively mild winters; at the same time, the location near important massifs to the north allows for greater accumulation of precipitation and an increase in the percentage of humidity.

The large opening that the Ialomița valley acquires at the entrance to the Doicești area creates the framework in which the microclimate elements specific to the valley are attenuated in their mixture with those specific to the southern climate zone (plain climate).

Economy

The average number of employees in Doicești in 2023 is 649 employees.

The commune is located in a reconverted industrial area, with available labour force after the decommissioning of the thermal power plant. The population of 4612 inhabitants is mixed, with an average level of technical education. The SMR project has potential for local economic revitalisation and the creation of qualified jobs.

The locality of Doicești, through its location, has a direct connection with the county seat - the municipality of Târgoviște - as well as with the localities in the industrial hub that extends from Fieni to Târgoviște.

Mioveni

Location

Mioveni is a city in Argeș County, Romania, consisting of the component locality Mioveni and the villages Clucereasa, Colibași, Făgetu and Racoviță. It is located approximately 15 km northeast of the municipality of Pitești.

The locality occupies an area of 5,097 ha and includes the neighbourhoods of Mioveni, Colibaşi and Racoviță, Clucereasa and Făget. Of the total area, 1,523.25 ha is urban land and 1,934.00 ha is agricultural land.

The city's urban area occupied 790.25 ha at the end of 2009. In April 2010, with the approval of the new General Urban Plan of Mioveni (PUG), another 733 ha were added to the urban area. Thus, currently, the city's urban area occupies an area of 1,523.25 ha.

The city of Mioveni is located in the large Subcarpathian unit Getic Plateau or Getic Piedmont (which continues the Argeș Muscles), more precisely in a subunit thereof, the Cândești Piedmont.

Climate

Argeș County falls within the perimeter of the continental climate sector. The area of the city of Mioveni belongs to the central climatic district of the Roman Plain. The climate is generally mild, with not too cold winters (the average temperature is between - 10 0 C and - 15 0 C) and not too hot summers (the average temperature is between + 18 ^{0} C and +20 0 C). The average temperature in July is 22 0 C, and the average temperature in January is -3 ^{0} C.

Economy

Currently, the local and county economy relies and depends largely on the activity of the Dacia Plant, the latter generating in 2012 - 7.70% of Romania's exports, ranking first in the top of exporters at the national level.

Of the total of 19,752 active people in Mioveni, employed in the labour force, the largest share is occupied by employees in the manufacturing industry (78.65%) and those in the professional, scientific and technical fields (5.35%), their number being closely linked to the two major employers in the city (Dacia Automobiles and the Nuclear Research Institute).

Măgurele Commune

Location

The commune of Măgurele is made up of three localities, including the village of Măgurele, as the commune seat, and the villages of Iazu and Coada Malului.

The commune is crossed by the national road DN 1A Ploiești - Brașov, being located 20 km from the municipality of Ploiești and 8 km from the town of Vălenii de Munte.

In terms of its surroundings, the commune of Măgurele borders the communes of Gornet and Bălteşti to the east, the commune of Gura Vitioarei to the north, the commune of Lipănești to the south, and the commune of Dumbrăvești to the west, the border being marked by the Teleajen River.

The villages of the commune have generally experienced a linear and dispersed development, mainly along DN 1A and the access roads to this main road. Geographically, the commune's territory is located in a depression that includes both gentle hilly areas and medium-height hills.

Climate

The analysed territory falls within the continental-temperate climate domain, characterised by average annual temperatures of approximately 7–8°C, cold winters and warm summers. The rainfall regime indicates average values of 600–700 mm/year, of which approximately 485 mm are recorded in the vegetation season. From an anemometric point of view, the dominant winds are northwesterly, with a frequency of approximately 30%.

Economy

The demographic evolution of the Măgurele commune indicates a downward trend between 2011 and 2021, according to data from the National Institute of Statistics. In 2021, the commune's population was 4,570 inhabitants, which corresponds to a decrease of 5.75% compared to the level recorded in 2011.

Regarding the labour market, the average number of employees was 406 in 2014, 441 in 2015, 415 in 2016, 434 in 2017, 470 in 2018, 460 in 2019 and 477 in 2020, highlighting a general growth trend, with interannual fluctuations.

The commune's economic potential is based mainly on endogenous resources, namely arable land, pastures, hayfields and forests, as well as on plant and animal production. Agricultural land represents the main natural resource of the territory, and the dominant function in the commune's economic and social profile is agriculture, structured on two main branches: plant cultivation and animal husbandry.

Population health

Human health is an environmental component of major importance within the strategic assessment process, being directly linked to the quality of the physical, social and economic environment in which the population lives.

In the context of the development of the nuclear sector, population health must be analysed under two main dimensions:

- the physical and biological dimension, relating to potential exposure to risk factors (radiation, noise, air, water, soil pollution);

- the psychosocial dimension, related to risk perception, associated stress and public trust in regulatory and control institutions.

Nuclear energy, strictly regulated at national and European level, is based on the principle of maximum protection of humans and the environment, applied through standards and exposure dose limits imposed by specific legislation (CNCAN, EURATOM, IAEA).

Romania is facing, at the national level, a demographic decline and public health challenges, but there are no direct correlations between these trends and nuclear activities.

In areas where nuclear infrastructure exists (Cernavodă, Măgurele, Pitești, Băița, Doicești), the health status of the population is comparable to or superior to the regional average.

According to data from the National Institute of Public Health (INSP) and the Public Health Directorates (DSP), there were no exceedances of biological, radiological or epidemiological indicators that could be associated with nuclear activities.

3.8. CULTURAL HERITAGE

Cultural heritage is a testimony and expression of the values, beliefs, knowledge and traditions that have resulted over time from the interaction of human and natural factors. It is in a state of continuous evolution and fundamentally contributes to human development and the improvement of the quality of collective life. After all, cultural heritage delights us and inspires old and new generations in their journey towards knowledge. Therefore, it is a treasure that must be protected as such.

This area is an essential resource for Romania's identity and for the development of a peaceful and stable society, based on respect for human rights, democracy and the rule of law. Active participation and modern management of this strategic resource add economic, social and cultural value to the community.

Tangible cultural heritage includes:

- Archaeology (sites, vestiges, movable property discovered following specialised or accidental archaeological research);
- Built/immovable heritage (monuments, ensembles, sites);
- Movable heritage (museums, archives, collections, etc.);
- Intangible/immaterial heritage (crafts, games, rituals, forms of verbal expression, etc.). (https://www.cultura.ro/directia-patrimoniu/)

*Archaeological heritag*e includes sites, vestiges, structures, complexes and movable goods (artifacts) resulting from past human activities, discovered through systematic or accidental archaeological research.

Areas with known archaeological potential are sensitive to excavation works, foundations, technical-urban networks or resource exploitation. The environmental assessment identifies archaeological sites, delimits protection areas and establishes measures to avoid or minimise impact (relocation of routes, archaeological surveillance, in situ conservation).

*Built / immovable heritage (mo*numents, ensembles, built sites) includes buildings, constructions, architectural ensembles, historical sites and other fixed facilities (bridges,

fortifications, etc.) of cultural, artistic, historical or urban value, whether or not listed in the list of historical monuments.

Monuments and protected built areas condition the location and form of interventions (new constructions, infrastructure, municipal works), taking into account the compatibility of the project with protected areas (height regime, volume, type of interventions) and integration into the existing cultural landscape.

*Movable heritage (m*useums, archives, collections, movable cultural goods)

Movable heritage includes objects considered valuable, as testimonies of the way of life of various human communities and of the transformation of the natural environment, from ancient times to the present, cultural goods held by museums, archives, libraries or public and private collections (objects of art, documents, artifacts, ethnographic pieces, etc.), characterised by the fact that they can be moved without losing their cultural value.

Although not directly linked to the site, movable heritage is influenced by environmental conditions (humidity, vibrations, pollution, risk of flooding or fire) in the buildings and areas that house it.

Intangible/intangible heritage (crafts, games, rituals, forms of verbal expression, etc.)

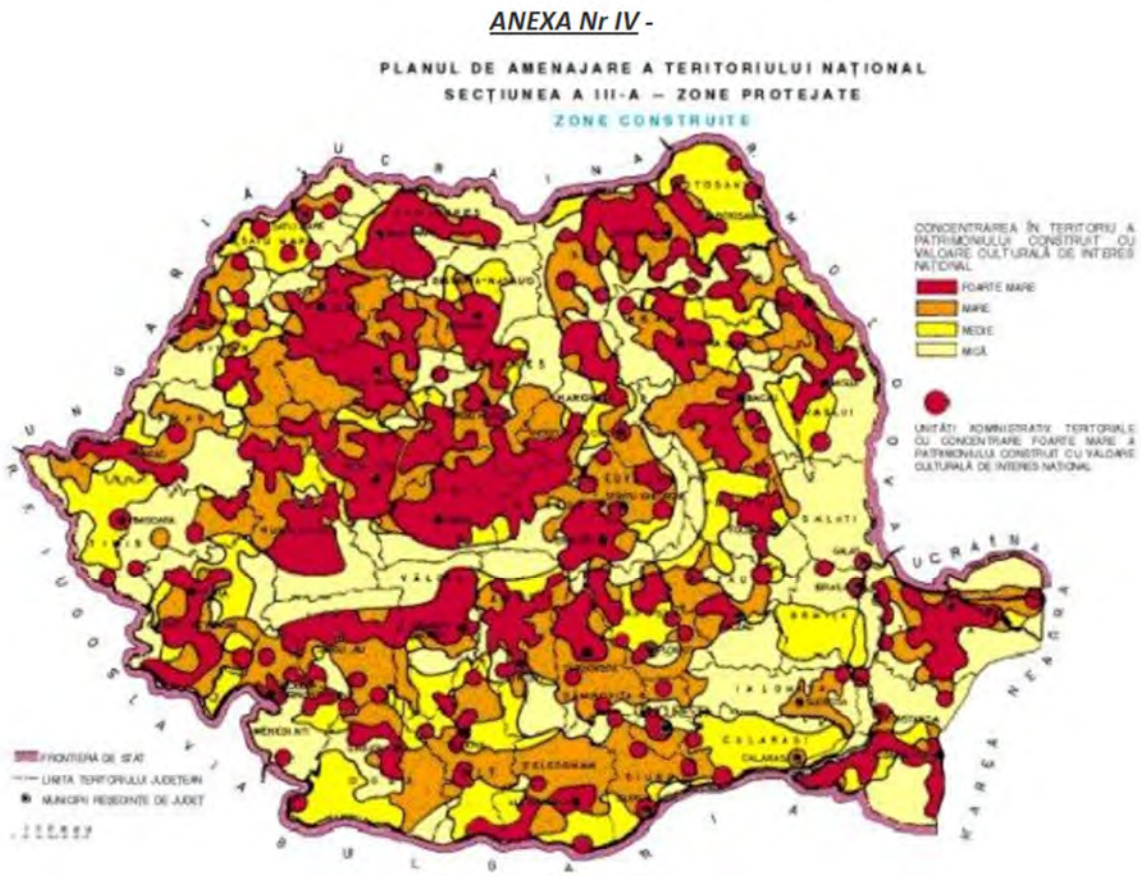
Intangible heritage represents the totality of practices, expressions, knowledge, crafts, traditions, rituals and forms of verbal or artistic expression transmitted from generation to generation and associated with a community or an area, which people recognise as part of their cultural heritage.

Digital cultural heritage

With the ever-increasing development of digital activities – whether for work or entertainment – new materials are constantly emerging that could be valuable resources for future generations. Digital books, films, archives, databases, photo galleries, digital exhibitions or various forms of virtual or augmented reality experiences, all have the potential to be part of cultural heritage.

The positioning of heritage areas is found in Annex IV of the National Spatial Planning Plan, Section III of Protected Areas – Built Areas (Law 2/2000).

FIGURE 59 - LOCATION OF HERITAGE AREAS IN ROMANIA, SECTION III - PROTECTED BUILT-UP AREAS



Natural resources

The proposed nuclear strategy is part of the overall objective of transitioning to an energy system with low greenhouse gas emissions, reducing the pressure on non-renewable natural resources and ecosystems. The use of nuclear energy, as a base source with very low CO_2 emissions over the entire life cycle, has the potential to contribute to:

- reducing dependence on fossil fuels (coal, oil, natural gas);
- conserving domestic energy resources for higher value-added uses;
- reducing the impact on water, soil and biodiversity resources compared to fossil fuel-based scenarios, under responsible planning and exploitation.

At the same time, the nuclear sector involves the use of specific natural resources (uranium, cooling water, land, construction materials) and generates radioactive waste that requires long-term management. The strategy considers a balance between resource needs, the conservation of natural capital and the protection of population health.

Uranium resources are limited domestic reserves, with exploitation declining in recent decades, thus a significant part of the nuclear fuel requirement is covered by imports, based on commercial contracts and international partnerships. Uranium ore mining and processing activities can generate impacts on soil, groundwater and surface water, air quality and landscape, if modern exploitation and rehabilitation techniques are not applied.

Other raw materials (cement, aggregates, steel, copper, aluminium, etc.) used in the construction and modernisation of nuclear facilities come mainly from mining and quarrying operations on the national territory, with cumulative impact on the environment (landscape, soil, water, biodiversity) and are already subject to specific legislation on environmental protection and the rehabilitation of affected lands.

Nuclear power plants use large volumes of water for cooling, and are usually located close to major watercourses or coastal areas. Water resources are subject to multiple pressures (drinking water supply, irrigation, industry, aquatic biodiversity), so any increase in cooling demand must be carefully sized and assessed.

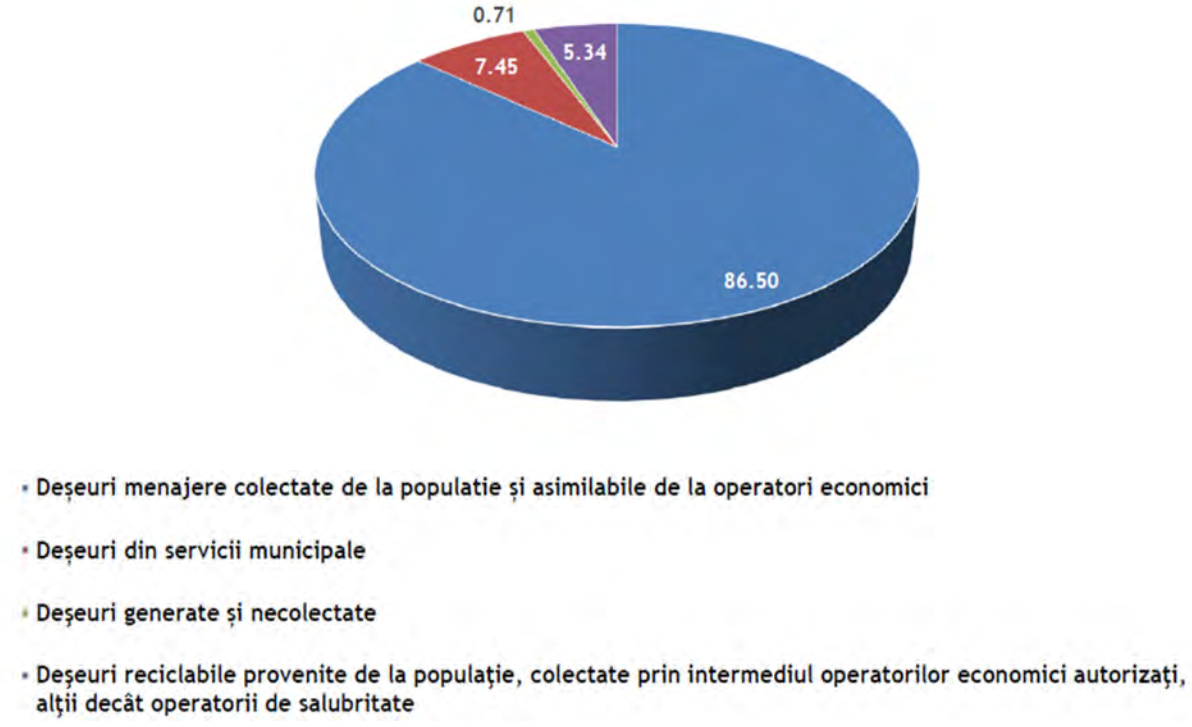
Another resource is land. The land footprint of nuclear installations is relatively small compared to other forms of energy production (especially fossil fuels or some forms of large-scale renewable energy). The land occupied is usually already anthropogenically modified (industrial areas, existing energy infrastructure, etc.).

3.9. WASTE GENERATION AND MANAGEMENT

The main types of waste generated:

- *Municipal waste:* of the total amount of municipal waste generated, the largest share is household and assimilable waste collected from the population and economic operators - 86.5% in 2023

FIGURE 60 - MAIN CATEGORIES OF MUNICIPAL WASTE GENERATED IN 2023 (%)



Source: RSM 2024- ANMAP (National Agency for Environment and Protected Areas - 2025)

- *Industrial waste*

The evolution of the quantities of non-hazardous waste generated by the main economic activities, reported by the economic operators generating waste, who report data through the PRODDES questionnaires during the period 2019 - 2023, is presented in the following Table:

TABLE 25 - NON-HAZARDOUS WASTE GENERATED BY THE MAIN ECONOMIC ACTIVITIES, EXCLUDING THE EXTRACTIVE INDUSTRY, 2019-2023 (THOUSAND TONNES)

Activitatea economică	2019	2020	2021	2022	2023
Industria prelucrătoare (Secțiunile CAEN: C10-C33)	6560,92	5496,67	5388,69	6339,19	5656,99
Producția, transportul și distribuția de energie electrică și termică, gaze și apă (CAEN: D)	5948,65	4278,36	5285,02	5503,62	4629,02
Captarea, tratarea și distribuția apei (Secțiunile CAEN: E36, E37, E39), cu excepția stațiilor de epurare a apelor uzate orășenești	66,54	47,214	36,83	49,576	51,84
Alte activități (Secțiunile CAEN: E38, F, G-U si G4677)	1718,09	1433,66	806,88	1306,58	2298,31

Source: RSM 2024- ANMAP

The evolution of the quantities of hazardous waste generated by the main economic activities, reported by economic operators generating waste during the period 2018 - 2022, is presented in the following table:

TABLE 26 - HAZARDOUS WASTE GENERATED BY THE MAIN ECONOMIC ACTIVITIES, EXCLUDING THE EXTRACTIVE INDUSTRY, 2019-2023 (THOUSAND TONNES)

Activitate economică	2019	2020	2021	2022	2023
Industria prelucrătoare (Secțiunile CAEN: C10-C33)	206,42	168,70	183,61	253,23	244,06
Producția, transportul și distribuția de energie electrică și termică, gaze și apă (CAEN D)	2,57	0,995	2,29	1,85	2,11
Captarea, tratarea și distribuția apei (CAEN E36, E37, E39), cu excepția stațiilor de epurare a apelor uzate orășenești	4,37	1,10	0,7	1.87	0,17
Alte activități (Secțiunile CAEN: E38, F, G-U si G4677)	52,76	184,054	242,24	271,99	243,45

The hazardous and non-hazardous waste landfills currently in operation are compliant.

Non-compliant industrial waste landfills have stopped storing waste according to the legal provisions in force.

TABLE 27 - INDUSTRIAL LANDFILLS FOR HAZARDOUS AND NON-HAZARDOUS INDUSTRIAL WASTE IN OPERATION DURING 2019-2023 (NUMBER)

	2019	2020	2021	2022	2023
Depozite conforme pentru deșeuri industriale periculoase	11	11	11	9	9
Depozite conforme pentru deșeuri industriale nepericuloase	40	37	36	37	36

Management of spent nuclear fuel and radioactive waste, from generation to final disposal

a) Short-lived low- and intermediate-level radioactive waste (LILW-SL) generated by the operation, refurbishment and decommissioning of the nuclear units at Cernavodă NPP will be disposed of in the DFDSMA. Siting and construction activities for this repository will be planned so that the facility becomes operational in 2028. Until the DFDSMA is commissioned, LILW-SL radioactive waste will be stored on an interim basis in dedicated facilities at the Cernavodă NPP site;

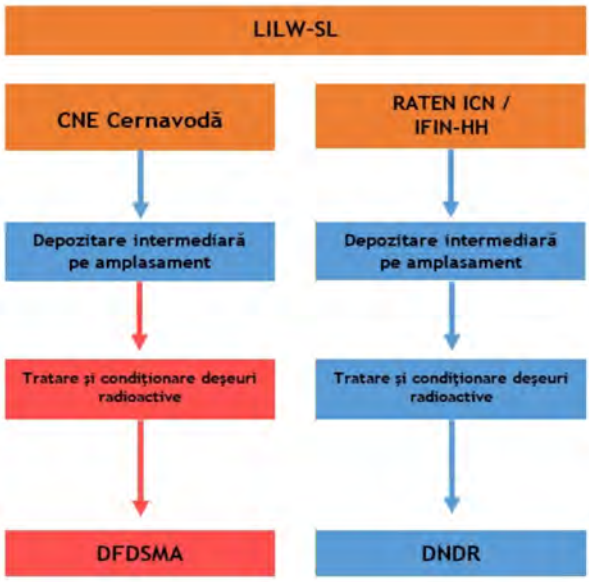
b) Spent nuclear fuel is currently classified as waste and will be disposed of in a deep geological repository together with long-lived low- and intermediate-level radioactive waste (LILW-LL). Siting and construction activities for the repository will be planned so that the facility becomes operational in 2055. Until the deep geological repository is commissioned, both spent nuclear fuel and LILW-LL radioactive waste will be stored on an interim basis in dedicated facilities.

c) LILW-SL radioactive waste generated by the operation and decommissioning of nuclear and radiological facilities outside the nuclear fuel cycle (research, medicine, industry, agriculture and other fields of socio-economic interest) will be disposed of at the IFIN-HH National Radioactive Waste Repository at Băița, Bihor County, until its closure. After the closure of that repository, institutional LILW-SL radioactive waste meeting the acceptance requirements for near-surface disposal will be disposed of at the DFDSMA;

d) LILW-LL radioactive waste and problematic radioactive waste generated by the operation and decommissioning of research reactors, as well as disused sealed sources containing long-lived radionuclides from activities outside the nuclear fuel cycle, will be disposed of in the deep geological repository. Until that repository becomes operational, this waste will be stored on an interim basis at the IFIN-HH and RATEN ICN sites;

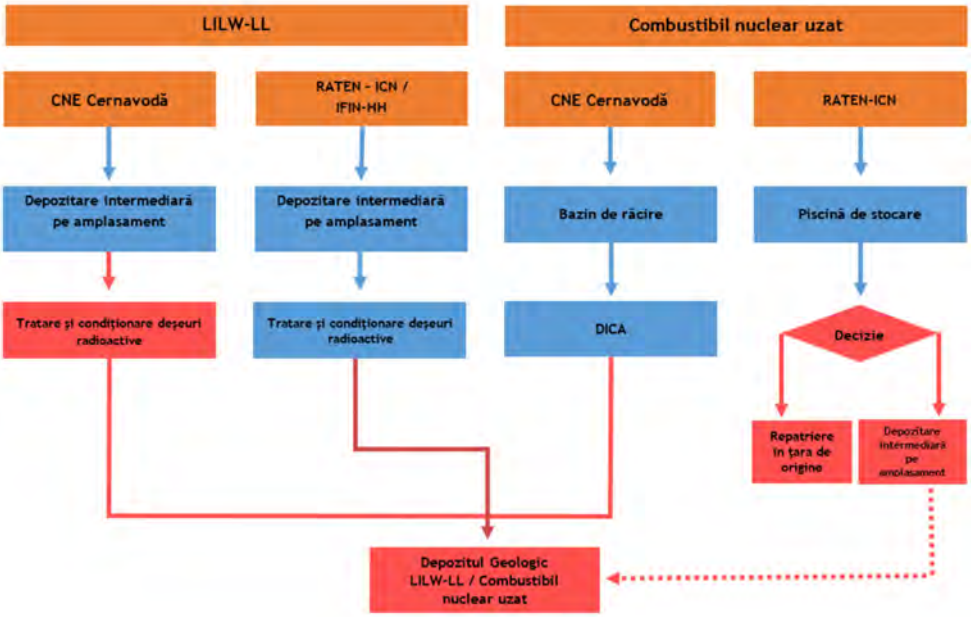
e) Spent nuclear fuel generated by the TRIGA reactor will be returned to its country of origin or disposed of in the deep geological repository. Until that repository becomes operational, the fuel will be stored on an interim basis at the RATEN ICN site.

FIGURE 61 - MANAGEMENT OF SHORT-LIVED LOW- AND INTERMEDIATE-LEVEL RADIOACTIVE WASTE



Source: ENVIRONMENTAL REPORT FOR THE MEDIUM AND LONG TERM NATIONAL STRATEGY ON THE SAFE MANAGEMENT OF SPENT NUCLEAR FUEL AND RADIOACTIVE WASTE

FIGURE 62 - MANAGEMENT OF SPENT NUCLEAR FUEL AND LONG-LIVED LOW- AND INTERMEDIATE-LEVEL RADIOACTIVE WASTE (LILW-LL)



Source: ENVIRONMENTAL REPORT FOR THE MEDIUM AND LONG TERM NATIONAL STRATEGY ON THE SAFE MANAGEMENT OF SPENT NUCLEAR FUEL AND RADIOACTIVE WASTE

3.10. LIKELY EVOLUTION OF THE ENVIRONMENT WITHOUT IMPLEMENTATION OF THE NATIONAL STRATEGY

This section analyses the scenario in which the National Strategy for the Development of the Nuclear Sector (SNDDN) is not implemented and the current trends of relevant environmental aspects, presented in the previous subchapter, are maintained.

The analysis is necessary to assess how the Strategy responds to environmental protection needs and requirements, as well as its evolution trends, providing a basis for comparing the potential effects of implementation versus the non-implementation scenario.

For Romania, accepting the doctrine of sustainable development in the nuclear sector represents the only responsible way to design medium and long-term development, in accordance with the national interest and the requirements of international collaboration.

The analysis of the scenario of non-implementation of the SNDDN is based on the current level of knowledge, available data and assessment methods regarding the state of the environment and anticipated developments in environmental components.

In the scenario of non-implementation of the National Strategy for the Development of the Nuclear Sector, the current situation is maintained, without significant progress towards decarbonisation, energy security and sustainable management of spent nuclear fuel.

In the short term, environmental impacts would be limited, but in the medium and long term, considerable adverse effects would occur, such as:

- significant delays in the development and commissioning of radioactive waste disposal infrastructure, particularly the Final Repository for Short-Lived Low- and Intermediate-Level Radioactive Waste (DFDSMA) and the Deep Geological Repository (DGA);
- the indefinite interim storage of low and medium-level radioactive waste leads to non-compliance with Romania's commitments to European legislation, to major investment efforts by operators of these types of radioactive waste, and may require additional long-term environmental protection measures;
- overloading of interim storage facilities and prolonged interim storage;
- additional investment needs to prevent the risk of radionuclides migration from existing repositories, following prolonged interim storage;
- increasing the risk of non-compliance with the commitments and obligations assumed by Romania within the framework of international legal instruments and the community acquis in the nuclear and environmental protection fields;
- maintaining increased vulnerability to the effects of climate change, by prolonging dependence on conventional energy sources with high greenhouse gas emission intensity;
- increased risk of radiological incidents at waste facilities, following prolonged interim storage;
- loss of opportunities for "cleaner" technologies and nuclear safety.

Without full implementation of the Strategy (especially the geological disposal programme), it is likely that successive expansions of the interim storage capacities (e.g. new MACSTOR modules) will be needed, increasing the effective storage duration in these facilities beyond the design lifetime, with structural ageing issues and additional monitoring

and maintenance requirements that may lead to operational constraints on the plant (possible power limitations or shutdown periods if storage space becomes critical).

Even if the regulator (CNCAN) continues to impose strict standards, the context of undersized and underfunded infrastructure increases the likelihood of non-compliance and incidents in the long term.

Without visible progress in the management of radioactive waste and spent fuel and waste, public trust in the state's ability to responsibly manage nuclear risks is eroding, any project to expand the Cernavodă power plant or any additional nuclear development (new units, SMRs, etc.) will face stronger social opposition, based precisely on the lack of a clear final disposal solution.

Failure to develop technologies for fundamental and applied nuclear-physics research using the ELI-NP high-power laser system would not cause a major increase in radioactive-contamination risks compared with the baseline, because ELI-NP is a research infrastructure handling small quantities of radioactive materials under CNCAN regulation. However, Romania would lose essential scientific and technological tools for optimising radioactive-waste management, developing environmental monitoring and diagnostic methods, and modelling and assessing the long-term impacts of nuclear facilities. In the long term, this would increase environmental vulnerability because ELI-NP would not be used as a research and innovation platform for environmental-protection solutions in the nuclear sector.

In addition, the lack of research development will delay new technology; Romania remains more dependent on external research networks for experimental data, with indirect impact on the environment through slower adoption of design solutions with passive safety advantage, delay in optimising LFR-specific waste treatment, lower capacity for innovation in reactor technologies with higher safety and sustainability potential and loss of domestic production and research capacities, dependence on imports and lack of innovation in new isotopes/techniques may indirectly lead to greater impact on public health and missed opportunities to reduce waste and doses.

Therefore, the failure to implement the Strategy would represent a loss of strategic opportunity for Romania, limiting the country's capacity to ensure a sustainable energy transition and to maintain a high level of nuclear safety and environmental protection. In addition, it would lead to the failure to meet the energy and environmental development objectives assumed by Romania through the European Green Deal, the Paris Agreement and the National Integrated Energy-Climate Change Plan (PNIESC) and would mean non-compliance with the provisions of art. 14 of Ordinance no. 11/2003 on the safe management of radioactive waste and spent nuclear fuel, which provides for the periodic review of the national strategy in the medium and long term, taking into account technical and scientific progress.

In the event of non-implementation of the National Strategy for the Development of the Nuclear Sector, the following developments are anticipated:

TABLE 28- LIKELY EVOLUTION OF THE ENVIRONMENT IF THE NATIONAL STRATEGY FOR THE DEVELOPMENT OF THE NUCLEAR SECTOR IS NOT IMPLEMENTED

Environmental aspect relevant to the National Strategy	**Probable evolution of the environment in the event of non-implementation of the National Strategy**
SOIL AND SUBSOIL	In the scenario of non-implementation of the Strategy, the current interim storage capacities for radioactive waste risk becoming insufficient, especially during periods of refurbishment of the units at Cernavodă NPP, which may lead to overloading of existing facilities and the need to build additional interim storage capacities to avoid difficulties in complying with nuclear and radiological safety requirements, The NPP will not operate if it does not have sufficient interim storage capacity for radioactive waste, according to the law. The delay in the development of the final repository for low- and intermediate-level waste (DFDSMA) and the deep geological repository (DGA) amplifies the risk of point contamination of the soil and subsoil, generating additional constraints.
WATER	Without the implementation of the Strategy and, implicitly, without the expansion of low-carbon nuclear capacities, pressure on water resources is maintained through the prolonged operation of classic thermal power plants with high water consumption for cooling. In the medium and long term, the risk of local and regional imbalances in the quantitative regime of water resources increases, especially in the context of climate change, as well as the risk of non-compliance with the quality and quantity objectives established by European water legislation. Indirectly, maintaining an energy mix based on fossil fuels can lead to degradation of the quality of water bodies through atmospheric deposition of pollutants and discharges associated with industrial processes.
CLIMATE AND AIR QUALITY	Failure to implement the Strategy would lead to Romania's continued dependence on fossil fuels for the production of electricity and heat, which would generate an increase or maintenance at high levels of greenhouse gas emissions (CO_2, CH_4, N_2O), as well as of classic air pollutants (SO_2, NO_x, particulate matter). This scenario significantly reduces the ability to achieve the climate targets assumed at European and international level and amplifies the risk of non-compliance with climate and air quality policies,

	including by exceeding limit values for pollutants. The consequences are reflected in the deterioration of air quality in urban agglomerations and industrial areas, with an indirect impact on the health of the population and ecosystems.
Climate change	Without the implementation of the Strategy, Romania would continue to maintain an energy mix dominated by fossil sources, which would lead to an increase in greenhouse gas emissions and a delay in the decarbonisation process of the energy sector. This may compromise the achievement of national and European emission reduction targets and may generate increased risks of non-compliance with the commitments assumed under the Paris Agreement and the European climate framework. In the long term, increased vulnerability to the effects of climate change (extreme weather events, drought, floods) is anticipated, with significant implications for economic sectors dependent on climate conditions and critical infrastructure.
BIODIVERSITY	In the scenario of non-implementation of the Strategy, no major changes in biodiversity are anticipated in the short term directly as a result of the non-expansion of nuclear capacities. However, maintaining and possibly expanding the use of conventional energy sources, especially based on fossil fuels, would contribute, in the medium and long term, to the degradation of habitats through air pollution, atmospheric deposition of pollutants and the expansion of extractive activities (mining, quarries). In addition, accelerating climate change, as a result of high greenhouse gas (GHG) emissions, may reduce the resilience of ecosystems, promoting biodiversity loss, changing species distribution and increasing the risk of invasive species.”
LANDSCAPE	Failure to implement the Strategy would maintain the existing industrial landscape, characterised by conventional energy infrastructure. In the long term, meeting energy demand without expanding nuclear capacity would probably require increased investment in fossil-fuel infrastructure (mining operations, thermal power plants and fuel depots), potentially causing further landscape fragmentation and artificialisation. The creation

	of waste-rock dumps and raw-material storage areas and the expansion of industrial areas would degrade landscape quality and identity, with possible adverse effects on tourist attractiveness and public perceptions of the living environment.
Human settlements and public health	In the absence of the Strategy, the continued intensive use of coal and gas-fired power plants would perpetuate high levels of air pollution, which may lead to an increase in the incidence of respiratory and cardiovascular diseases and to the general deterioration of the health of the population, especially in communities located in the vicinity of energy and industrial platforms. In addition, the lack of a coherent strategic framework for the development of the nuclear sector may increase energy vulnerability and the risk of energy poverty, through increased costs and volatility of energy prices, with an impact on the quality of life in urban and rural settlements. In the long term, this situation may generate socio-economic tensions and regional disparities in access to safe, affordable and environmentally friendly energy. In the long term, a disproportionate burden may be transferred to future generations, both in terms of environmental risks and economic costs.
WASTE	Failure to implement the Strategy would lead to major delays in achieving the strategic objectives for radioactive waste management, particularly commissioning of the DFDSMA at Saligny and development of the future Deep Geological Repository (DGA). In these circumstances, interim storage facilities would be used beyond their design horizons, and existing capacities would have to be expanded and/or new capacity constructed to avoid increasing long-term safety risks. However, use beyond the design lifetime is not, in itself, an exclusively negative element: it may reflect the robustness of the technical solution and the efficiency of the initial investment. However, such an extension must be substantiated by technical and safety analyses (including ageing assessments, equipment qualification, updating of deterministic and probabilistic analyses, re-evaluation of barriers and long-term performance), as well as by an investment programme for modernisation/replacement, capacity increase and lifetime extension, where appropriate.

	In the absence of final disposal solutions, it is difficult to demonstrate compliance with European directives and international conventions applicable to the management of spent nuclear fuel and radioactive waste. The accumulation of waste may also generate additional pressures on competent authorities and operators, including in the form of increased costs, the need for ad hoc interim measures and the risk of litigation or infringement proceedings.

4. ENVIRONMENTAL CHARACTERISTICS OF AREAS LIKELY TO BE SIGNIFICANTLY AFFECTED

The areas that may be significantly influenced by the implementation of the National Strategy for the Development of the Nuclear Sector (SNDDN) are mainly associated with the following categories of locations:

- existing and future sites for nuclear energy production (nuclear power plants and possible new units or technologies);
- nuclear fuel cycle facilities;
- sites for nuclear research, development and application facilities (including scientific platforms, pilot facilities);
- existing and potential sites for the storage and management of radioactive waste (surface repositories, geological repositories, interim storage facilities).

Land use in these areas is mixed:

- industrial and energy lands (industrial platforms, technological areas);
- agricultural land with a significant share in low-lying areas;
- forested lands and natural habitats, especially in hilly and mountainous areas;
- built-up areas – urban and rural localities, residential neighbourhoods, service areas.

Climatic, hydrological and geological conditions

The areas are characterised by:

- temperate climate with marked seasonal variations, episodes of drought and intense precipitation;
- the presence of surface water courses and underground aquifers used for water supply, technological processes and/or cooling;
- varied geological conditions, from alluvial deposits in the plains to sedimentary/crystalline formations in hilly and mountainous areas;
- Seismicity specific to the analysed areas, relevant for the design and safe operation of the facilities.

In certain areas there are natural risks (floods, landslides, erosion), which must be taken into account in the planning and implementation of the strategy measures.

Quality of environmental components (air, water, soil)

Air quality is influenced by the regional pollution background and other industrial and traffic sources, mainly by the use of fossil fuels in energy production, by the current electricity production systems which are outdated and highly polluting. In general, the values are within the legal limits, with the possibility of local exceedances in urban-industrial areas.

Surface and groundwater are subject to pressures generated by: urban and industrial discharges, diffuse pollution from agriculture, possible historical pollution.

The quantity and quality of groundwater and surface water depend on the transformation of climatic factors, with climate change influencing flows, physicochemical and hydromorphological characteristics.

The soils present areas of good quality, used in agriculture and forestry, areas with historical contamination or increased vulnerability to erosion and compaction.

These characteristics require increased attention in the design and operation of nuclear facilities, to prevent additional pollution and cumulative effects.

Socio-economic environment and population health

The areas analysed include: urban and rural localities with different levels of development, various economic activities (industry, services, agriculture, tourism), transport infrastructures (main roads, railways, river or sea ports, as appropriate).

In the vicinity of nuclear sites are found: residential areas and sensitive objectives (educational institutions, medical facilities, recreational areas), communities with a different degree of information and acceptance of technological risk.

The health status of the population is influenced by both socio-economic factors and environmental quality (air, water, soil, noise, biodiversity), as well as by the perception of risks associated with the nuclear sector.

Landscape and cultural heritage

The potentially affected territories combine: industrial-energy landscapes, dominated by large-scale infrastructures, rural and natural landscapes, with aesthetic and recreational value, elements of cultural and historical heritage (monuments, archaeological sites, urban protected areas).

The expansion or construction of new nuclear infrastructure can change the perception of the landscape and generate potential land use conflicts, which must be analysed and managed appropriately.

biodiversity

In the potentially affected areas are present: natural and semi-natural habitats (forests, meadows, wetlands), flora and fauna species of national and community importance, protected natural areas and Natura 2000 sites, located in the vicinity or in the areas of influence of the sites.

The main environmental aspects are related to: avoiding direct impacts on habitats and species, limiting fragmentation and loss of ecological connectivity, and assessing cumulative effects with other plans and projects in the same regions.

Conservation of natural resources

The potentially affected areas are characterised by the presence of valuable natural resources – surface and groundwater, fertile soils, agricultural lands, forested areas and associated biodiversity elements. Maintaining the regeneration capacity of these resources, preventing their degradation (pollution, erosion, overexploitation) and their rational use represent an essential characteristic of the environment in these areas, which conditions the location, design and exploitation of the activities provided for by the strategy.

For the operation of Units 1, 2, 3 and 4 at Cernavodă NPP, the main natural resource used is uranium. According to the Action Plan for implementing Romania's Energy Strategy 2025-2035, with a perspective to 2050, approved by Government Decision No. 1491/2024,

Romania has an open nuclear fuel cycle based on Canadian CANDU technology. Uranium dioxide (UO_2), used to manufacture the nuclear fuel required for the Cernavodă reactors, is produced by processing and refining uranium of domestic or imported origin.

In order to increase the security of supply of raw materials necessary for the manufacture of nuclear fuel at the Nuclear Fuel Factory (FCN) Pitești and reduce import dependence on the nuclear fuel production chain, the Nuclearelectrica S.A. (SNN) acquired the Uranium Concentrate Processing Plant from the National Uranium Company (CNU) in order to consolidate the nuclear cycle and streamline the cost of raw materials necessary for the manufacture of nuclear fuel for the Cernavodă NPP.

Also, in order to consolidate the nuclear fuel cycle, in 2021 SNN S.A. took over, free of charge, the concession licence for uranium-ore mining in the Tulgheș-Grințieș perimeter, Neamț County. Bringing this deposit into production will create the conditions for using domestically extracted uranium ore.

Unlike the CANDU reactors at Cernavodă NPP, which use natural, unenriched uranium, the new NuScale small modular reactors (SMRs) planned for implementation in Romania will use low-enriched uranium. The fuel will be uranium oxide enriched to a maximum of 4.95% U-235. This enables an SMR to achieve a higher energy density, use a compact design and require less frequent refuelling while maintaining a high level of nuclear safety. The source of uranium supply is not known at this stage and will be determined subsequently.

Another important resource, necessary for the implementation of the Strategy, is water. Water, a fundamental natural resource, plays a critical role in the operation of nuclear power plants, being used as a coolant to evacuate the residual heat generated in the reactor. In the case of the CANDU units at the Cernavodă NPP, the coolant is provided by taking water from the Danube River, with its passage through open cooling circuits. For the future small modular reactors (SMRs), the configuration of the cooling systems will be established later, the cooling-water supply source not yet being established.

Other natural resources used in the execution stage of the strategy's objectives are: soil (resulting from excavations and reused for fillings), stone, ballast, natural aggregates for the preparation of concrete (sand, gravel, etc.)

The materials that will be used to carry out the investments (natural aggregates - ballast, crushed stone, rough stone, gravel, sand) will be brought to the site by the contractors (including construction materials) and will not undergo technological processes, and will only be put into operation according to the construction and assembly technologies approved for each project. The materials will be purchased from authorised sources, being gradually transported to the installation site. Large stocks will not be formed in the area of the work fronts.

The soil, the lands on which the strategy is implemented, represents a non-renewable natural resource. The soil resulting from the excavation will be used for backfilling.

The resources necessary for the implementation of the projects of the National Nuclear Strategy and Programme will be made available by the companies that will carry out the construction works and by the suppliers of construction materials.

It is recommended to avoid the exploitation of natural resources within protected natural areas in order to implement the proposals of the National Nuclear Strategy and Programme.

Waste

The potentially affected areas are characterised by the generation of significant quantities of municipal and industrial waste, to which may be added, depending on the specifics of the activities, hazardous waste and waste resulting from the use of radioactive materials. The collection, treatment and disposal infrastructure (collection platforms, transfer stations, treatment stations, controlled deposits) is sometimes limited or unevenly developed, and there are also areas with historical or improvised deposits. These aspects, together with the need to comply with the legislation on the waste hierarchy (prevention, reuse, recycling, recovery, safe disposal), represent an essential characteristic of the environment in these areas and condition the way in which the activities proposed by the strategy can be located and operated, representing an important constraint for the development and operation of the proposed activities.

These environmental characteristics constitute the basis for the formulation, within the SNDDN, of objectives and measures aimed at ensuring:

- minimising negative impacts on the environment and human health;
- avoiding location in areas with critical vulnerabilities, when reasonable alternatives exist;
- early integration of environmental protection and sustainable development requirements into nuclear sector planning from the strategy phase and subsequently continuing with the plan and project phases, taking into account the potential impact on environmental components throughout all regulatory phases.

Vulnerabilities relevant to SNDDN implementation

The main vulnerabilities identified are:

- natural: seismic risk, floods, landslides, extreme weather phenomena, protected areas;
- of environmental components: water bodies with unsatisfactory ecological status, contaminated or sensitive soils, habitats and species already under pressure;
- socio-economic: communities with reduced adaptive capacity, dependence on certain economic activities, variable level of trust in authorities;
- of image and social acceptance, related to the perception of nuclear risk and radioactive waste management.

Identification of protected natural areas within the project's area of influence

Following the analysis, none of the projects foreseen within the SNDDN, whose location is known, is located inside protected natural areas of Community interest. The only protected natural areas likely to be affected by the implementation of the strategy are located in the area of influence of the Cernavodă NPP and, respectively, of the DFDSMA repository. In the area of influence of the Mioveni platform, only the Lacul lui Barca Nature Reserve is found.

Regarding the Deep Geological Repository project, since its exact location has not yet been established, it is not possible to identify the protected natural areas likely to be affected.

TABLE 29 - PROTECTED NATURAL AREAS OF COMMUNITY INTEREST WITHIN THE AREA OF INFLUENCE OF THE PROJECTS

Platform	10 km	20 km	30 km
CERNAVODA NPP	ROSCI0022 Canaralele Dunării ROSCI0412 Ivrinezu ROSPA0039 Dunăre-Ostroave ROSPA0002 Alah Bair-Capidava	ROSPA0001 Aliman Adamclisi ROSPA0007 Balta Vederoasa ROSCI0071 Dumbrăveni – Urluia Valley – Vederoasa Lake ROSPA0012 Brațul Borcea ROSCI0319 Mlaștina de la Fetești ROSCI0353 Peștera Deleni ROSCI0278 Bordușani-Borcea	ROSCI0053 Alah-Bair Hill ROSCI0172 The Forest and Valley of the Canaraua Fetii-Iortmac ROSPA0054 Lacul Dunăreni
DFDSMA Platform	ROSPA0039 Dunăre-Ostroave	-	-

TABLE 30 - NUMBER OF NATURA 2000 SITES WITHIN THE AREA OF INFLUENCE OF THE SNDDN OBJECTIVES

Natura 2000 site type	*Total number of Natura 2000 sites located in the area of influence of the SNDDN objectives*
SPA	6
SCI/SAC	8

At the analysed sites, in their vicinity and, where applicable, in the Protected Natural Areas of interest, anthropogenic pressures such as those below are manifested, with the mention that these are not common to all sites:

- replacing pasture with arable land;
- mixed non-intensive grazing;
- fertilisation with fertilisers;
- removal of hedges and groves or bushes;
- other agricultural activities;
- sand extraction;
- roads, motorways;
- power lines;
- discontinuous urbanisation;
- household waste storage;
- recreational fishing;
- the use of wind energy.

Analysis of the impact of the implementation of the National Strategy for the Development of the **N**uclear Sector in Romania on protected natural areas was limited for the Cernavodă NPP platform to a perimeter of 30 km around it, as this is considered, according to the regulations in force, the area of direct influence for nuclear energy objectives.

The locations of the analysed objectives are NOT located inside protected natural areas and most of the objectives have regulatory acts, and the environmental studies and periodic reports carried out did not highlight the existence of adverse effects on biodiversity elements.

In the case of the DGA, its location has not yet been proposed, the impact on biodiversity will be analysed in detail when completing the environmental procedures that are mandatory for obtaining regulatory acts issued by the environmental protection authorities.

Regarding DFDSMA, it can be stated that there are no highly sensitive areas on the site that could be significantly affected by the construction and operation of the facility, the location being chosen also from the perspective of the absence of protected natural areas, the closest being approximately 2.5 km away (ROSPA0039 Dunăre-Ostroave). The DFDSMA site is located in the exclusion zone of the Cernavodă NPP, approximately 350 m from the NPP Platform and can be characterised by the presence of land areas with habitats strongly affected by anthropogenic impact as well as the absence of important feeding, breeding and shelter areas for vertebrates of Community interest.

5. EXISTING ENVIRONMENTAL ISSUES RELEVANT TO THE NATIONAL STRATEGY

Chapter 3 presented the relevant aspects of the current state of the environment.

The environmental analysis related to the National Strategy for the Development of the Nuclear Sector (SNDDN) identifies and analyses potential existing environmental problems, with direct or indirect relevance to the implementation and sustainability of the proposed strategic objectives.

The issues presented in this section derive from the conduct of current nuclear activities, the operation and maintenance of existing infrastructure, as well as from the national and international context of energy transition and environmental protection. The following summarises the main environmental issues relevant to the National Strategy, for each environmental component analysed, taking into account potential interactions with environmental components and applicable compliance requirements.

Based on the analysis of the available information, the environmental assessment indicates that there are no environmental issues associated with the National Strategy for the Development of the Nuclear Sector (SNDDN).

5.1. SOIL AND SUBSOIL

The current state of the soil in areas associated with nuclear activities (Cernavodă NPP, IFIN-HH Măgurele, temporary radioactive waste repositories) is determined by the specifics of technological processes, the handling of radioactive materials and potential operational incidents, including controlled emissions within the limits of applicable regulations.

An important aspect is the prevention of radiological contamination of the soil and subsoil in areas where nuclear installations or facilities for the management of spent nuclear fuel and radioactive waste are located. Nuclear activities are strictly regulated, and the operation of nuclear installations requires the implementation of protection and monitoring systems designed to prevent any impact on the environment, including the soil and subsoil.

In this context, the protection of the soil and subsoil is ensured by complying with strict nuclear and radiological safety requirements, permanent monitoring of environmental components and the implementation of measures to prevent and control potential contamination. These measures are established in accordance with national and European legislation in the field of environmental protection and nuclear safety.

However, a potential risk of soil and subsoil contamination may arise during the implementation and operation of the Strategy objectives:

- in the area of temporary radioactive waste deposits;
- in the areas related to the handling and storage of spent nuclear fuel;
- during the construction, decommissioning or modernisation phases of nuclear facilities, when site works and related operations may generate additional pressures on the soil: earthmoving, excavation, storage and transportation of materials may contribute to the degradation of the soil structure and the loss of soil fertility.

In industrial areas, partial soil waterproofing is associated with infrastructure development and functional site organisation. This allows for the controlled management of

rainwater through drainage and collection systems, contributing to the stability and security of existing infrastructure.

To ensure soil/subsoil protection and prevent the occurrence of any environmental problems, a series of management and monitoring measures and mechanisms are implemented, of which the most relevant are:

- Radiological monitoring systems for soil and subsoil are maintained and operated on the site, correlated with monitoring programmes for the physico-chemical parameters of the environment;
- radioactive waste management is carried out safely, in accordance with applicable rules, by using appropriate temporary storage solutions and, where appropriate, final disposal;
- for nuclear installations, measures and procedures are provided for the restoration of land at the end of their life cycle, by applying ecological reconstruction works and returning, as far as possible, the land to uses compatible with their previous functions;

land use is achieved by prioritising the use of already anthropised areas, contributing to limiting the additional occupation of agricultural lands and those with protection status;

- The quality of the soil and subsoil is monitored through continuous monitoring programmes, which allow the evaluation of the evolution of environmental parameters and the maintenance of an adequate level of environmental protection.

According *to the Report on the results of monitoring the effects on the environment following the implementation of the National Medium and Long-Term Strategy on the safe management of spent nuclear fuel and radioactive waste, in the year 2023,* Natural radionuclides such as Pb-214, Bi-214, Ra-226 (from the U-238 series), Ac-228, Pb-212, Bi-212 (from the Th-232 series), U-235, K-40 and the artificial radionuclide Cs-137 were identified in the soil samples. The concentrations of K-40 vary between 263.58 Bq/kg (SSRM Sf. Gheorghe) and 469.79 Bq/kg (SSRM Cernavodă).

In the samples analysed by gamma spectrometry, natural radionuclides from the natural radioactive series, K-40 and Cs-137, were identified. The concentration level of the natural radionuclide K-40, the one that has the greatest contribution to external irradiation, was between 457.85 – 628.84 Bq/kg, with uncertainties associated with the measurement process of 3%. In all the analysed samples, the artificial radionuclide Cs-137 was identified, whose presence in the soil is due to the Chernobyl accident.

5.2. WATER

Nuclear energy is heavily dependent on water resources, which play an essential role in cooling processes, the safe operation of facilities and emergency management.

In Romania, the Cernavodă NPP uses the Danube as the main source of water for cooling the secondary circuit, which implies a pronounced interdependence between the river's hydrological regime and the safe operation of the plant.

The main risks identified for this environmental component include:

- changing the thermal regime of the water discharged into the receiver, generating the so-called "thermal effect", with potential consequences on aquatic ecosystems and the dissolved oxygen regime;

- the risk of accidental radioactive contamination of surface or groundwater, associated with operational incidents, uncontrolled leaks or system failures, even if the probability of occurrence is low;
- reduction of water flows during dry periods and in the context of heat waves, which may limit cooling capacity and impose operational restrictions or adaptations of the operating regime.

According *to the Report on the results of monitoring the effects on the environment following the implementation of the National Medium and Long-Term Strategy on the safe management of spent nuclear fuel and radioactive waste, I***n** 2023, surface water radioactivity monitoring was carried out within the Standard Programme and surveillance programmes in areas with anthropogenically modified natural background, covering the main water bodies in the area of influence of the Cernavodă NPP, such as the Danube, the spillways, the Danube–Black Sea Canal, lakes and other watercourses of interest. Samples were taken with daily, weekly or monthly frequencies, depending on the location, and were subjected to global beta, gamma spectrometric and tritium determinations.

The results of global beta measurements for surface water were, throughout the year, well below the warning limit of 2 Bq/l provided by OM no. 1978/2010. The maximum values recorded were of the order of 0.6 Bq/l, both in samples collected from the Danube and in those from the discharge channels, without exceeding the regulated thresholds.

Gamma spectrometric analyses mainly revealed the presence of natural radionuclides, especially K-40, which had a significant contribution to the total radioactivity of the samples, with variable values depending on the type of water body and season. The presence of the artificial radionuclide Cs-137 was identified sporadically, in very low concentrations, being attributed to the remanence in soil and sediments of radionuclides originating from the Chernobyl accident, without indicating current sources of contamination.

Tritium determinations showed higher variability, especially in the Cernavodă area, the spillways and the Danube–Black Sea Canal. Maximum values of the volumetric concentration were recorded punctually, especially at Seimeni and Saligny, but their interpretation is made in the context of the hydrological regime, controlled discharges and intensive monitoring carried out in 2023. In Baciu and Domneasca lakes, tritium concentrations were moderate and comparable to the values observed in other surface water bodies in the area.

Overall, the data obtained in 2023 indicate that surface water radioactivity is maintained at low levels, comparable to those in previous years, without exceeding the warning limits and without highlighting significant impacts on the aquatic environment. The monitoring data provided by the competent authorities currently indicate radioactivity values in the Danube waters within the regulated/allowed limits, which attests to compliance with radiological safety conditions. However, the increase in the frequency and intensity of droughts and heat waves, in the context of climate change, requires the updating and strengthening of water resource management plans for nuclear facilities, including operating scenarios under reduced flow conditions.

To reduce and adequately manage the risks associated with the environmental component "water", a series of measures are implemented, mainly:

- implementing and maintaining continuous monitoring programmes for surface and groundwater quality, correlated with radiological and chemical monitoring programmes;
- adoption and use of modern cooling technologies, with high efficiency and low specific water consumption, including solutions that reduce the thermal impact on the receiver;
- rehabilitating, modernising and maintaining wastewater collection, treatment and disposal systems in optimal parameters, so that effluents comply with applicable quality standards;
- strict compliance with the provisions of the Water Framework Directive 2000/60/EC and of the Water Law No. 107/1996, as subsequently amended and supplemented, including with regard to quality objectives, the authorisation regime and protection measures for water bodies potentially affected by nuclear activities.

5.3. CLIMATE AND AIR QUALITY

From a climatic point of view, Romania is facing a gradual increase in average annual temperatures, the intensification and increase in frequency of extreme weather phenomena (prolonged droughts, violent storms, episodes of torrential rainfall and floods), as well as increased pressures on water resources. These trends, associated with climate change, have direct implications for the operation of nuclear facilities, especially on cooling systems, safety and emergency management.

Nuclear power generation contributes significantly to reducing greenhouse gas emissions, representing a low-carbon energy option compared to fossil fuel sources. However, the life cycle of nuclear facilities involves indirect GHG emissions, associated with the stages of uranium extraction and processing, fuel fabrication, transportation, construction, maintenance and decommissioning of facilities, and radioactive waste management.

The main risks associated with this factor include:

- dust and atmospheric pollutant emissions during the construction, modernisation and decommissioning phases of nuclear infrastructures (construction sites, transport of materials, demolition activities), with local impact on air quality;
- the risk of release of radioactive substances into the atmosphere in the event of incidents or malfunctions, even if the probability of occurrence is low, requiring the maintenance of high standards of nuclear and radiological safety;
- the vulnerability of nuclear infrastructure to the effects of climate change and extreme phenomena (heat waves, increased cooling water temperatures, floods, severe storms), which can affect both the continuity of operation and the level of safety.
- To reduce and adequately manage these risks, a series of measures are being considered (this is an area subject to challenges and changes in the evolving European and national legislative framework), mainly:
- systematic assessment of climate risks and integration of climate change adaptation measures in the design, siting, operation and decommissioning of nuclear facilities (including operating scenarios under extreme conditions and reduced cooling water flows);

- compliance with and implementation of the principles set out in ESRS E1 – "Climate Change" and Regulation (EU) 2020/852 on the establishment of a framework to facilitate sustainable investment (EU Taxonomy), so that nuclear projects contribute effectively to climate-change mitigation and do not significantly harm other environmental objectives;
- implementation and maintenance of an integrated system for monitoring air quality and atmospheric radioactivity in areas influenced by nuclear facilities, in accordance with the requirements of Directive 2008/50/EC on ambient air quality and the national regulatory framework, with periodic reporting of the results to the competent authorities;
- correlating nuclear infrastructure development and operation plans with national strategies and plans on climate change adaptation, air quality and greenhouse gas emission reduction, so that the role of nuclear energy in the transition to a decarbonised energy system is harnessed in a coherent and responsible manner.

According *to the Report on the results of monitoring the effects on the environment following the implementation of the National Medium and Long-Term Strategy on the safe management of spent nuclear fuel and radioactive* **w**aste, In 2023, monitoring
The gamma dose rate was within the variation limit of the natural background. At SSRM Constanţa, the gamma dose rate values varied in the range of 0.080 - 0.150 μSv/h, the annual average being 0.096 μSv/h, and at SSRM Cernavodă the variation range was 0.050-0.170 μSv/h, the annual average being 0.098 μSv/h. The average value of the external gamma dose in the environment, obtained in 2023, for locations outside the Cernavodă NPP site was 877.68 μSv/year.

In 2023, Radon concentrations varied in the range of 0.470 – 22.118 Bq/mc at SSRM Constanţa and 0.364 – 51.709 Bq/mc at SSRM Cernavodă, the maxima were recorded on 01.04.2023, on the aspiration interval 02-07 at SSRM Constanţa, respectively on 03.01.2023, on the interval 20-01 at SSRM Cernavodă. Thoron concentrations varied in the range of 0.0097 – 0.871 Bq/mc at SSRM Constanţa and 0.008 – 7.680 Bq/mc at SSRM Cernavodă; the maxima were recorded on 20.08.2023, during the aspiration period 20-01 in Constanţa, respectively on 20.09.2023, during the interval 20-01 in Cernavodă.

The global specific alpha activity had values that fall within the range of 2.39E-05 Bq/m³ ÷ 5.56E-04 Bq/m³ (in the specialised literature, for the global specific alpha activity due to natural radioactivity the values are between 1.0E-05 and 4.0E-02 according to "Monitoring Radioactivity in the Environment Under Routine and Emergency Conditions" – De Cort Marc European Commission, JRC, Institute for Transuranium Elements, Ispra, Italy).

5.4. BIODIVERSITY

Nuclear sites and their adjacent areas may exert influences on natural ecosystems, especially in situations where they are located in the proximity of Natura 2000 sites, functional ecological corridors or wetlands of Community interest. In these circumstances, the design, construction and operation of nuclear facilities must be correlated with the requirements of the conservation of habitats and species of Community interest, as well as with the maintenance of ecological connectivity at landscape level.

Directly, pressures on biodiversity can manifest themselves through:

- land occupation and conversion of natural or semi-natural habitats into built surfaces or technical infrastructures in the case of DFDSMA and DGA;
- disturbance of fauna through noise, vibrations, artificial light and construction site activities, especially during the construction, modernisation and decommissioning phases;
- modification of hydrological conditions in aquatic habitats, as a result of works to capture or discharge water used for cooling.

Indirectly, activities associated with nuclear infrastructure may contribute to land use change, increased anthropogenic pressures (traffic, related developments, extension of utility networks) and long-term alteration of landscape characteristics, with cumulative effects on local and regional biodiversity. Although, under normal operating conditions, the radiological impact on biocenoses is limited and strictly regulated, the potential impact in incident or accident scenarios requires the maintenance of high safety standards and careful planning of land uses around the sites.

According *to the Report on the results of monitoring the effects on the environment following the implementation of the National Medium and Long-Term Strategy on the safe management of spent nuclear fuel and radioactive waste, I*n 2023, radioactivity monitoring in spontaneous vegetation was carried out within the Standard Programme, the Special Monitoring Programmes and the Cernavodă NPP Operation Supervision Programme, through sampling carried out with weekly, semi-annual or annual frequencies, depending on the location. The samples were analysed by global beta measurements, gamma spectrometric analyses and, for some locations, tritium and C-14 determinations, the results being reported in Bq/kg green mass.

The values of the specific global beta activity in the spontaneous vegetation samples were generally significant and varied within a wide range, reflecting the natural processes of radionuclide accumulation in the soil and atmosphere. In the Constanța and Cernavodă areas, the values were predominantly between approximately 110 and 445 Bq/kg green mass, with annual maxima recorded in the summer period, without indicating anomalies compared to the known distributions at regional level. In the area of influence of the Cernavodă NPP, the global beta activities presented higher values at specific points, the maxima being correlated with the local characteristics of the soil, the type of vegetation and the meteorological conditions.

Gamma spectrometric analyses consistently revealed the presence of the natural radionuclides K-40 and Be-7, which made the major contribution to the total radioactivity of the samples. K-40, of terrestrial origin, was identified in all samples, with variable concentrations, determined by its migration from the soil to plants through root absorption. Be-

7, of cosmogenic origin, was present in all analysed samples, its accumulation being attributed to direct deposition on the aerial surface of plants. The values recorded for these radionuclides fall within the variation ranges considered normal for spontaneous vegetation.

Artificial radionuclides were only sporadically identified. Cs-137 was detected punctually, in very low concentrations, both within special programmes and in some locations in the coastal area, its presence being attributed to the persistence in the soil of long-lived radionuclides from historical contaminations (the Chernobyl accident), without indicating current sources of contamination. Artificial radionuclides were not identified in most of the analysed samples.

Tritium and C-14 determinations carried out within the Cernavodă NPP laboratory revealed values comparable to those reported internationally for similar vegetation samples, without significant deviations from the natural background.

Overall, the results obtained in 2023 indicate that the radioactivity of spontaneous vegetation is dominated by natural radionuclides, and the measured levels are comparable to those in previous years and to background values, with no significant radiological impacts on the terrestrial environment being highlighted.

Regarding aquatic biota, 8 fish samples taken from the Danube, lakes and fish farms (Domneasca and Baciu) were analysed in 2023. The natural radionuclide K-40 was identified in all fish samples, confirming the dominant contribution of the natural background. The average gross beta activity as well as tritium determinations indicated low average values. Variable values were recorded for C-14, but within ranges reported internationally for similar samples, without signals indicating unusual accumulations.

5.5. LANDSCAPE

Although nuclear facilities have a relatively concentrated visual impact, they can change the character of the landscape in the areas where they are located, especially in the vicinity of the Cernavodă NPP, where massive industrial structures contrast with the natural landscape of the Danube and the Dobrudja relief.

The sites targeted for the development or expansion of nuclear capacities (Units 3 and 4, respectively SMR type facilities) are located in areas of predominantly industrial or technical-functional character, already marked by the presence of existing energy infrastructure, auxiliary facilities and transport networks. In this context, the local aesthetic value of the landscape is reduced, being defined mainly by the industrial functionality of the area, and not by natural or landscape elements of recreational or tourist interest.

In the area of the city of Cernavodă, the landscape alternates from floodplain to steep canals, agricultural lands dotted with ravines formed by the flow of torrents, hills and valleys covered with steppe meadows, bushes and forest plantations, and the landscape in the area is characterised by a flat morphology and vegetation specific to the steppe area, with bushes.

During the construction or expansion phases, temporary changes to the existing industrial landscape may occur, generated by excavation works, temporary storage of construction materials and increased site-specific traffic. These changes may lead to a temporary reduction in local visual coherence, without affecting landscapes of high aesthetic value or protected landscape areas.

5.6. HUMAN SETTLEMENTS AND PUBLIC HEALTH

Nuclear energy brings significant benefits in terms of energy security, as well as in the field of health and research (medical diagnosis and treatment, isotopic applications, fundamental and applied research). However, the development and operation of nuclear facilities are associated with concerns about the potential impact on public health, mainly in relation to exposure to ionising radiation, as well as the perception of radiological risk and the level of social acceptability of nuclear activities.

However, these benefits are accompanied by persistent concerns regarding potential impacts on public health, perceived radiological risk and the social acceptability of nuclear activities; such concerns may be amplified by the current geopolitical instability and the armed conflict at Romania's border. The current regional security context, marked by geopolitical instability and an armed conflict in the vicinity of Romania's borders, may amplify public concerns regarding potential risks associated with nuclear infrastructure. In extreme circumstances, events affecting the integrity or safe operation of nuclear facilities could result in releases of radioactive substances to the environment, with possible consequences for public health and ecosystems.

In this context, the implementation of the nuclear strategy involves maintaining and strengthening nuclear safety measures, radiation protection, environmental monitoring and preparedness for radiological emergencies, in order to prevent and limit any potential impact on population health and human settlements.

The implementation of the National Strategy for the Development of the Nuclear Sector can influence the health of the population through positive indirect effects, associated with the increase of energy security and the continuity of essential services (including for the medical infrastructure) and direct effects, through the maintenance/development of peaceful uses in health (isotopes, diagnosis and treatment). At the same time, the Strategy involves the development/operation of nuclear and related activities, which introduces a potential impact on health mainly through the radiological exposure of the population (under normal conditions, controlled by radiation protection requirements; in accidental scenarios, with potentially significant consequences, although with low probability) and through psychosocial effects associated with the perception of risk and social acceptability.

The main environmental and health risks identified include:

- high perception of radiological risk among local communities in the vicinity of nuclear facilities, influenced by the level of information, trust in authorities and the regional geopolitical context;
- psychological stress and feelings of insecurity associated with proximity to nuclear facilities, including fear of major accidents, radiological contamination or emergency situations;
- potential risks of exposure in the event of technological incidents or events, including scenarios of uncontrolled release of radioactive substances, which require the maintenance of a high level of nuclear and radiological safety;
- additional risks associated with the geopolitical context and armed conflicts in the proximity of Romania's borders (border war), including possible hybrid threats (cyber, disinformation, sabotage), which may affect public perception,

amplify population anxiety and require the strengthening of physical and cyber security measures, as well as emergency response plans;

- the impact of noise, vibrations and increased traffic (road, rail, naval) during the construction, modernisation and decommissioning phases of nuclear infrastructure, with local effects on the quality of life and comfort of the population.

The monitoring carried out to date indicates levels of environmental radioactivity within the limits allowed by national and international regulations, without highlighting any significant adverse effects on the health of the population. The exposure of the population to ionising radiation in areas under the influence of nuclear facilities is, under normal operating conditions, well below the levels associated with relevant health risks and comparable to the variations in the natural radiation background.

Maintaining public trust and properly managing risk perception requires a high degree of institutional transparency, access to information and public participation, in accordance with the Aarhus Convention and Directive 2003/4/EC on public access to environmental information.

To improve the relationship with the community and reduce the existing or perceived risks mentioned above, appropriate measures are implemented at local or national level, mainly:

- conducting coherent communication, information and education programmes regarding nuclear activities, associated risks and safety measures, including "risk communication" components adapted to local communities;
- active involvement of the public in the decision-making process, through public consultations, debates, access to environmental documentation and monitoring reports, so that the legitimate concerns of communities are integrated into the planning and authorisation process;
- implementing integrated monitoring of radiological exposures and public health indicators (including epidemiological surveillance in areas in the vicinity of nuclear facilities), with periodic reporting of results in a form accessible to the public;
- development, updating and periodic testing of external emergency plans, with the participation of competent authorities, nuclear facility operators, civil protection structures, as well as the population, including scenarios that take into account the possible effects of the regional security context and armed conflicts in the vicinity;
- strengthening physical-security and cybersecurity measures at nuclear facilities, in close cooperation with security and civil-protection authorities, so that risks associated with deliberate threats are kept as low as reasonably achievable and, should such threats materialise, they can be managed without significant consequences for the public or the environment.

The additional exposure of the population in the area as a result of the operation of the Cernavodă NPP is insignificant compared to natural exposure and complies with national and international regulations regarding population exposure as a result of nuclear practices.

From a radioactive point of view, for the entire period of 2023, there were no exceedances of the warning/attention limits for the environmental components monitored by RNSRM. The recorded values were within the normal limits of radioactivity and did not present a risk to the environment or the population.

Management of radioactive waste and spent nuclear fuel

The safe and sustainable management of radioactive waste is one of the most important and sensitive environmental issues associated with the use of nuclear energy, with implications for the entire life cycle of facilities – from operation and maintenance to decommissioning. In Romania, responsibilities in this area lie with the AGENȚIA NUCLEARĂ ȘI PENTRU DEȘEURI RADIOACTIVE (ANDR), which contributes to sustainable development by promoting and developing exclusively peaceful applications of nuclear energy and by ensuring the final safe disposal of radioactive waste at national level.

Low- and intermediate-level radioactive waste is currently stored on an interim basis in authorised facilities at the Cernavodă NPP and IFIN-HH Măgurele sites, in compliance with nuclear and radiological safety requirements. In the medium term, construction and commissioning of the National Radioactive Waste Repository at Saligny are planned as the final disposal solution for this waste category, in accordance with applicable international standards.

This issue has long-term environmental implications, mainly through the potential risk of soil and groundwater contamination in the event of improper management or loss of integrity of technical and engineering barriers. In this context, it is necessary to maintain and strengthen a rigorous framework for radiological monitoring, transparency towards the public and compliance with the standards of the International Atomic Energy Agency (IAEA) and the requirements of Directive 2011/70/EURATOM on the management of spent fuel and radioactive waste, so that long-term risks are kept at a minimum acceptable level from the point of view of environmental protection and public health.

5.7. POTENTIAL RISKS

The development of the nuclear sector in Romania, within the framework of the National Strategy for the period 2026–2030, with a perspective to 2050, as well as the implementation of the National Nuclear Programme, involves a complex set of strategic, operational and systemic risks. These risks are generated by the specific nature of nuclear activities, the long implementation horizon, the high safety and security requirements, as well as the constantly evolving geopolitical, economic and technological context.

Risk management constitutes a cross-cutting element of the Strategy, with the role of ensuring the continuity, security and sustainability of the national nuclear programme, in accordance with the standards of the International Atomic Energy Agency (IAEA), the European Union acquis and the international commitments assumed by Romania.

Risk type management involves identifying risk types and associated risks, establishing responsible authorities by risk type, establishing the areas of action of responsible authorities for prevention, preparation and response to the event and recovery/rehabilitation of the situation, as well as assigning support functions.

According to Emergency Ordinance No. 21/2004 on the National Emergency Management System, the types of risks identified are: fires, earthquakes, floods, accidents, explosions, damage, landslides or land collapses, mass illnesses, collapses of buildings, installations or facilities, stranding or sinking of ships, falling objects from the atmosphere or from space, tornadoes, avalanches, failure of public utility services and other natural disasters, serious disasters or large-scale public events determined or favoured by specific risk factors.

The legal basis for the management of emergency situations regarding nuclear and radiological risk is contained in the provisions of the National Nuclear or Radiological Emergency Response Plan (PNRUNR).

Decision No. 557 of August 3, 2016 on risk management regulates the national management of risk types and the conditions for the appointment and competences of the action commander and the intervention commander.

Risk type management involves identifying risk types and associated risks, establishing responsible authorities by risk type, establishing the areas of action of responsible authorities for prevention, preparation and response to the event and recovery/rehabilitation of the situation, as well as assigning support functions.

In accordance with the provisions of the National Nuclear or Radiological Emergency Response Plan, the National Commission for the Control of Nuclear Activities (CNCAN) is the responsible authority with the main role in preparing for and responding to a nuclear or radiological emergency.

At the same time, according to Government Decision No. 557/2016 on the management of risk types, CNCAN is designated as the responsible authority with the main role for managing nuclear or radiological risk.

The development of the nuclear sector in Romania, within the framework of the National Strategy for the period 2026–2030, with a perspective to 2050, as well as the implementation of the National Nuclear Programme, involves a series of risks and vulnerabilities that must be adequately managed. These are generated by the specific nature of nuclear and radiological activities, the long duration of projects in the nuclear sector, the high safety and security requirements, as well as technological, economic and geopolitical developments.

In accordance with Government Decision No. 557/2016 on the management of risk types, as well as with the Regulation on the management of emergency situations specific to nuclear or radiological risk, the National Commission for the Control of Nuclear Activities (CNCAN) is the responsible authority with the main role for managing the following risk types:

- accidents, breakdowns, explosions, fires or other events occurring in nuclear or radiological activities;
- radiological risk.

The management of these types of risk is carried out within the National Emergency Management System, in cooperation with the competent public authorities and institutions.

Accidents, breakdowns, explosions, fires or other events occurring in nuclear or radiological activities

Nuclear and radiological activities involve the use, handling, transport, storage and management of radioactive materials, as well as the operation of nuclear installations or other

installations using sources of ionising radiation. In these conditions, there is the possibility of accidental events, such as technical failures, operational incidents, explosions, fires or other unforeseen events that may lead to the release of radioactive substances into the environment.

Such events can occur as a result of factors such as:

- *Failures of equipment or safety systems*:

Equipment or safety system failures can occur as a result of component wear, technical defects, inadequate maintenance or unforeseen operating conditions. Such situations can affect systems essential to the safety of nuclear or radiological facilities, such as cooling systems, power supply, radiological monitoring systems or containment barriers. In the event of a degradation in the functioning of these systems, conditions may arise that, under certain circumstances, could lead to uncontrolled releases of radioactive substances or radiological exposures. Redundant safety systems, preventive maintenance programmes and rigorous monitoring procedures are implemented to prevent these risks.

- *Human errors in the operation of facilities or in the handling of radioactive materials*:

Human errors can occur in the operation of nuclear or radiological facilities or in the handling, transport and storage of radioactive materials. These can be caused by misinterpretation of operating parameters, failure to comply with technical procedures, insufficient training or organisational factors. Such situations can lead to deviations from normal operating conditions or improper handling of radioactive materials. The risk associated with the human factor is reduced through continuous training programmes, standardised operational procedures and automatic control and monitoring systems.

- *Extreme natural phenomena (earthquakes, floods, severe weather conditions):*

Extreme natural phenomena, such as earthquakes, floods, storms or other severe weather conditions, can affect the infrastructure and operation of nuclear or radiological facilities. These events can affect the power supply, cooling systems or other systems important for safety. As part of the design and operation of nuclear facilities, site-specific natural hazards are assessed and facilities are designed to withstand high-intensity natural events to ensure that nuclear and radiological safety conditions are maintained.

- *Fires or explosions generated by technological processes or other industrial installations*:

Fires or explosions can be generated by internal technological processes or industrial activities carried out in the vicinity of nuclear or radiological facilities. Such events can affect equipment, safety systems or technological infrastructure and can lead to disruption of normal operating conditions. To prevent the consequences of such situations, fire detection and extinguishing systems, measures for separating safety-critical equipment and emergency intervention procedures are implemented.

- *Acts of external interference or emergency situations affecting the integrity of nuclear or radiological facilities:*

Acts of external interference include deliberate actions or external events that may affect the safe operation of nuclear or radiological facilities. These may include unauthorised access, sabotage, theft of radioactive materials, incidents in the transport of radioactive materials, problems in the management of radioactive waste, abnormal operational events or other actions that may compromise physical protection systems. The integrity of facilities

may also be affected by external emergencies, such as major industrial accidents or other events that may disrupt critical infrastructure. Physical protection systems, access control, permanent monitoring and emergency response plans are implemented to manage these risks.

The consequences of such events may include radioactive contamination of air, water and soil, exposure of the population and personnel to ionising radiation, damage to ecosystems and significant socio-economic impacts on communities in the vicinity of nuclear facilities or on the transport routes of radioactive materials.

In the context of the nuclear strategy, the assessment of the risk associated with these events takes into account the measures for prevention, control and response to emergency situations, including the application of the principles of defence in depth, the existence of redundant safety systems, civil protection plans and mechanisms for radiological monitoring of the environment.

Radiological risk

The radiological risk associated with implementation of the nuclear development strategy is considered low and is managed through stringent nuclear and radiological safety measures in accordance with national and European regulations. Under normal operating conditions, radioactive releases are maintained at levels well below legal limits and do not generate significant effects on protected natural areas of Community interest. Potential impacts are considered for accident scenarios in which radionuclides could be released to the environment. Effects in such a case could include contamination of soil and surface water or groundwater; bioaccumulation of radionuclides in food chains (the process whereby radionuclides - radioactive substances present in the environment - are absorbed and retained by living organisms, including plants, animals and microorganisms, at a rate exceeding their elimination, potentially increasing radioactive concentrations in tissues and organs and transferring them to higher trophic levels, for example from phytoplankton to fish and then to aquatic birds or mammals); and effects on sensitive species and priority habitats through reduced reproductive, migratory or feeding capacity.

In addition to these types of risk established by the legal framework, the development of the nuclear sector may also be influenced by a series of risk factors and specific vulnerabilities, which may affect the implementation of the Strategy's objectives and the long-term functioning of the national nuclear programme. The main specific vulnerabilities are:

Cyber vulnerabilities associated with nuclear infrastructures

The progressive digitalisation of nuclear command, control and monitoring systems introduces important benefits, but also introduces cyber risks. Cyber attacks or vulnerabilities in digital systems can affect the operation of nuclear facilities and can have an impact on both nuclear safety and security.

Accidental events have a very low probability but may have severe consequences and associated effects.

Economic, financial and investment risks

Nuclear projects are characterised by very large investments and long implementation periods. For this reason, they can be affected by cost overruns, implementation delays or difficulties in securing financing.

Such risks may influence the pace of development of the nuclear programme and the ability to achieve the established strategic objectives.

Institutional, legislative and human resources risks

The sustainable development of the nuclear sector also depends on the stability of the legislative and institutional framework, as well as on the existence of a well-trained human resource. The shortage of nuclear specialists, the ageing workforce and limited institutional capacity may affect the effective implementation of the nuclear programme in the long term.

TABLE 31 - ENVIRONMENTAL RISK MATRIX

No.	Strategic objective / Measure	environmental component	Source of impact	Environmental impact/risk description	Impact type (direct/indirect, cumulative)	Probability	Impact magnitude	Prevention/reduction/compensation measures	Monitoring indicators / Responsible entity
1	Radioactive waste management	Soil / Groundwater	Radioactive waste storage	Soil and groundwater contamination through loss of integrity of storage barriers	Direct, long-term, cumulative	Low–Medium	High	Multiple barrier storage, EU/IAEA standards, periodic audits	Radiological monitoring results – CNCAN / environmental authority
2	Spent nuclear fuel management	Groundwater / Soil	Long-term storage	Migration of radionuclides to the geological environment over time	Indirect, very long-term	Low	Very high	Robust technical solutions, geological and hydrogeological assessments	Long-term monitoring – operator / competent authority
3	Operation of nuclear facilities	Surface water	Cooling and controlled evacuations	Accidental thermal or radiological impact on aquatic ecosystems	Direct, temporary	Medium	Medium	Strict discharge limits, integrated water management	Physico-chemical parameters – operator / ANPM
4	Transport of radioactive materials	Air / Ground	Transportation accidents	Accidental release of radioactive substances into the environment	Direct, accidental	Very low	High	Strict regulations, emergency plans, staff training	Reported incidents – competent authorities
5	Nuclear infrastructure development	Biodiversity	Construction and operation works	Habitat fragmentation and cumulative effects on ecosystems	Indirect, cumulative	Low	Medium	EA assessments, EIA, compensatory measures	Habitat status – environmental authorities

6	Population protection	Human health	Accidental contaminations	Indirect exposure through air, water, soil or food chain	Indirect, medium-term	Very low	Very high	Civil protection plans, public information	Population doses – DSP / CNCAN

6. ENVIRONMENTAL PROTECTION OBJECTIVES ESTABLISHED AT NATIONAL, EU OR INTERNATIONAL LEVEL THAT ARE RELEVANT TO THE STRATEGY, AND HOW THESE OBJECTIVES AND OTHER ENVIRONMENTAL CONSIDERATIONS WERE TAKEN INTO ACCOUNT DURING PREPARATION OF THE STRATEGY

6.1. General considerations

The elaboration of the National Strategy for the Development of the Nuclear Sector (SNDDN) was carried out in full correlation with the objectives and principles of environmental policies adopted at international, European and national levels. The integration of these objectives ensured the compatibility between the development of the nuclear sector and the requirements of environmental protection, climate change and public health, according to the provisions of GD no. 1076/2004, which transposes Directive 2001/42/EC on strategic environmental assessment (SEA).

6.2. International environmental protection objectives

The IAEA is the world's central intergovernmental forum for scientific and technical cooperation in the nuclear sector. It works for the safe and peaceful uses of nuclear science and technology, contributing to international peace and security and achieving the United Nations Sustainable Development Goals.

The IAEA was created in 1957 in response to the deep fears and expectations generated by the discoveries and diverse uses of nuclear technology, after in October 1956, the IAEA Statute was unanimously approved by 81 states. The IAEA currently has 180 member states (15 November 2024, https://www.iaea.org/), and is headquartered in Vienna.

Romania has been a member state of the IAEA since 1957, and during this period it has received support, expertise and technical assistance in the areas of regulation, authorisation and control of nuclear activities through the Technical Cooperation Programme. ANDR collaborates permanently with the IAEA. Between Romania and the IAEA there are agreements of the t*ype " Practical Arrangeme*nts " regarding scientific and technical cooperation in the field of nuclear safety.

Since 2007, Romania has been implementing the integrated safeguards (verification) system, which allows for real-time monitoring of nuclear material management. Starting with 1 May 2010, Romania has been applying the Comprehensive Safeguards Agreement and its Additional Protoc*ol. (https://www.mae.ro/node/55124)*

The policy set out in the National Strategy is aligned with Article 8 of Government Ordinance No 7/2003 on the promotion, development and monitoring of nuclear activities, republished, as subsequently amended and supplemented, in conjunction with Article 3(1)(a) and Article 4(2)(a) of Annex 1 to Government Decision No 1437/2009 approving the Regulation on the organisation and operation and the organisational structure of the AGENȚIA NUCLEARĂ ȘI PENTRU DEȘEURI RADIOACTIVE, as subsequently amended and supplemented. It was developed in consultation with the principal institutional

stakeholders in the sector, namely ministries, public-administration institutions and authorities, relevant organisations, economic operators and professional associations.

The International Atomic Energy Agency plays an essential role in promoting nuclear non-proliferation, through its technical component, as well as in the peaceful use of nuclear energy, including in the field of ensuring the security of radioactive materials and the safety of nuclear facilities.

The International Atomic Energy Agency (IAEA) develops Safety Standards that establish the fundamental principles, requirements and recommendations intended to ensure the protection of people and the environment against the risks associated with ionising radiation. These standards constitute a global reference and contribute to maintaining a high and harmonised level of nuclear safety worldwide. (https://www-pub.iaea.org/MTCD/publications/ PDF/Pub1578_web-57265295.pdf- IAEA Safety Standards for protecting people and the environment, Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards).

Security fundamentals present the fundamental security objective and the principles of protection and safety, providing the basis for security requirements. An integrated and coherent set of Security Requirements establishes the requirements that must be met to ensure the protection of people and the environment, both now and in the future. These requirements are governed by the objective and principles of the security fundamentals.

Nuclear safety requirements are fundamental for the safe and sustainable operation of nuclear installations. They are divided into two categories: general (system) requirements and specific (technical) requirements, which apply directly to nuclear installations and activities.

TABLE 32 - NUCLEAR SAFETY REQUIREMENTS

General Security Requirements	Specific Security Requirements
Part 1. Governmental, Legal and Regulatory Framework for Security	1. Site assessment for nuclear installations
Part 2. Leadership and management for security	2. Nuclear power plant safety 2.1 Design 2.2 Commissioning and operation
Part 3. Radiation protection and safety of radiation sources	3. Safety of research reactors
Part 4. Security assessment for installations and activities	4. Safety of nuclear fuel cycle facilities
Part 5. Management of radioactive waste before final disposal	5. Security of radioactive waste storage facilities
Part 6. Decommissioning and cessation of activities	6. Safe transport of radioactive materials
Part 7. Emergency Preparedness and Response	

Source: IAEA SAFETY STANDARDS FOR PROTECTING PEOPLE AND THE ENVIRONMENT

6.3. EU environmental protection objectives

European environmental policy is based on the principles of precaution, prevention, correction of pollution at source and "the polluter pays".

Multiannual environmental action programmes set the framework for future action in all areas of environmental policy. They are integrated into horizontal strategies and are taken into account in international environmental negotiations. Last but not least, implementation is fundamental. (ENVIRONMENTAL POLICY: GENERAL PRINCIPLES AND BASIC FRAMEWORK- https://www.europarl.europa.eu/RegData/etudes/ fiches_techniques/ 2013/050401/04A_FT(2013)050401_EN.pdf)

Through its policies, the EU protects the environment and seeks to minimise risks to the climate, human health and biodiversity. The European Green Deal aims to make Europe the first climate-neutral continent.

Some of the environmental objectives at European level that were also taken into account in the development of the strategy:

- Ensuring a high level of nuclear safety and radiological protection throughout the life of nuclear installations: construction, operation, closure, waste. (https://energy.ec.europa.eu/news/focus-eu-nuclear-energy-policy-why-it-matters-us-all-2024-03-13_en);
- Strengthening the contribution of nuclear energy to the decarbonisation of the European energy system, so that low/zero emission sources generate over 90% of electricity by around 2040. (https://energy.ec.europa.eu/topics/nuclear-energy/nuclear-investment-needs_en);
- Increasing the security of energy supply and reducing external energy dependence by diversifying the energy mix, including nuclear energy. (https://www.europeanfiles.eu/energy/current-and-future-contributions-of-nuclear-energy-to-energy-security);
- Supporting innovation, research and technological development in the nuclear sector - small modular reactors (SMRs), waste management technologies, fusion, etc. (https://snetp.eu/2025/06/05/nuclear-energy-a-strategic-driver-of-europes-economic-growth-and-sustainable-transition);
- Ensuring an appropriate investment framework for the European nuclear sector — both for extending the life of existing installations and for new capacities. (https://energy.ec.europa.eu/topics/nuclear-energy/nuclear-investment-needs_en);
- Integrating the principles of the circular economy and responsible management of spent fuel and radioactive waste, with the objective of minimising the impact on the environment. (https://www.europarl.europa.eu/factsheets/en/sheet/62/nuclear-energy);
- Maintaining and increasing European industrial leadership in the nuclear sector, so that the EU remains globally competitive. (Deloitte, Economic and Social Impact Report Nucleareurope, 5th June 2025 https://snetp.eu/2025/06/05/nuclear-energy-a-strategic-driver-of-europes-economic-growth-and-sustainable-transition);
- Encouraging civil society participation, transparency and public health, including through public involvement in nuclear decisions. (https://www.europarl.europa.eu/factsheets/en/sheet/62/nuclear-energy);

- Ensuring the integration of nuclear energy into a broader just and sustainable transition strategy, in line with European environment, energy and climate principles (https://energy.ec.europa.eu/topics/nuclear-energy/nuclear-investment-needs_en);
- Support for international and European cooperation in the nuclear sector, including the secure supply of nuclear raw materials, technologies and infrastructures. (***Nuclear energy in the European Union https://www.europarl.europa.eu/RegData/etudes/BRIE/2023/751456/EPRS_BRI%28 2023%29751456_EN.pdf);
- Achieving environmental objectives.

The Council of the European Union, through the Regulation on net zero industry, aims to achieve a global leadership in the green transition, using the technologies of the future to boost the competitiveness of our industry, create quality jobs and strengthen our open strategic sovereignty. The Council's position increases the number of strategic net zero technologies on the list from 8 to 10, by including nuclear technologies and sustainable alternative fuels.

At the community level, the aim is to improve the living conditions of the resident population by complying with nuclear safety standards:

- Council Directive 2013/59/Euratom of 5 December 2013 laying down basic safety standards for protection against the dangers arising from exposure to ionising radiation and repealing Directives 89/618/Euratom, 90/641/Euratom, 96/29/Euratom, 97/43/Euratom and 2003/122/Euratom – establishes uniform and mandatory rules for the protection of the health of persons exposed to ionising radiation: occupational, medical, public and environmental exposures.
- 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” – requires Member States to develop and implement a national policy and a national programme for the management of spent fuel and radioactive material/radioactive waste throughout their entire life cycle.

6.4. National environmental protection objectives

Currently, national sectoral policies prioritise the energy and non-power applications of nuclear energy, which represents one of the most reliable and sustainable energy sources in terms of environmental impact. The current global energy debate is dominated by finding the most acceptable solutions to meet the increasing demand and which, equally, guarantee the security, safety and accessibility of these energy sources, as well as minimising the impact on the environment.

Romania is a member state of the EU and the European Atomic Energy Community (EURATOM), of the IAEA and a member of the OECD-NEA and participates in specific activities in the field, complying with the EU Directives specific to the nuclear sector that it has transposed into national legislation.

Romania has been a founding member of the International Atomic Energy Agency since 1957. Starting with 2017, Romania joined the NEA (Nuclear Energy Agency), through

this accession the continuous efforts to implement high standards in the nuclear sector are once again recognised.

Under the auspices of the IAEA, Romania adopted the legal instruments to which it adhered:

- Vienna Convention on Civil Liability for Nuclear Damage;
- Joint Protocol on the Application of the Vienna and Paris Conventions on Liability for Nuclear Damage;
- Convention on the Physical Protection of Nuclear Material;
- Convention on Nuclear Safety;
- Convention on Notification of Nuclear Accidents and Radiological Emergencies;
- Convention on the provision of assistance in the event of a nuclear accident and radiological emergency;
- Convention on the Safety Management of Radioactive Waste and Spent Nuclear Fuel.

Since 2007, Romania has been implementing the integrated nuclear safeguards system, which allows for real-time monitoring of the management of nuclear material. Starting with 1 May 2010, Romania has been applying the Comprehensive Safeguards Agreement and its Additional Protocol.

Therefore, Romania establishes and maintains a well-established national legislative, regulatory and organisational framework for the nuclear security of nuclear and radiological facilities, in accordance with international conventions and treaties (NPT – Treaty on the Non-Proliferation of Nuclear Weapons; CPPNM – Convention on the Physical Protection of Nuclear Material; ICSANT – International Convention for the Suppression of Acts of Nuclear Terrorism), with the provisions of European Union directives, with IAEA standards in the field of nuclear and radiological safety and security, as well as with the recommendations of IGCTN – Global Initiative to Combat Nuclear Terrorism."

Romania is among the 14 European Union member states that maintain their option to use nuclear energy within their national energy components.

At the national level, the Government Programme establishes the basic principles of Romania's environmental policy, in accordance with European and international provisions, ensuring the protection and conservation of nature, biological diversity and the sustainable use of its components.

The competent national authority in the field of promotion, development and monitoring of nuclear activities for exclusively peaceful purposes and of the safe management of radioactive waste, including their final disposal, is the AGENȚIA NUCLEARĂ ȘI PENTRU DEȘEURI RADIOACTIVE (ANDR) in accordance with the provisions of Government Decision No. 1437/2009 on the approval of the Regulation on the organisation and functioning and the organisational structure of ANDR.

ANDR's main activity is to provide specialised technical assistance to the Government in the process of elaborating and adopting policies for the promotion, development and monitoring of exclusively peaceful applications of nuclear energy, both energy and non-energy, the safe final disposal of radioactive waste and the national coordination of the radioactive waste management process and the decommissioning process of nuclear facilities.

All activities in the nuclear sector are carried out in accordance with the provisions of the National Strategy for the Development of the Nuclear Sector (SNDDN) and the National Nuclear Programme (PNN) approved by Government Decision No. 1259/2002 on the approval of the National Strategy for the Development of the Nuclear Sector in Romania and the Action Plan for the implementation of this strategy.

The Agency develops the National Strategy for the Development of the Nuclear Sector and the National Nuclear Programme, in consultation with ministries, other central and local public administration bodies, economic operators and professional associations active in the nuclear sector, as well as with representatives of civil society.

National strategic objectives

The national strategic objectives of the nuclear sector presented in the PNN are grouped into three distinct categories, namely *(https://andr.ro/despre-noi/misiune-si-obiective/obiective-strategice-nationale*):

Fundamental objective

Increasing the share of nuclear electricity in Romania's total electricity production.

It will be carried out in compliance with the principles of sustainable development of society, under competitive cost conditions and ensuring nuclear security at the level of international standards.

Derived objectives

- Ensuring and continuously increasing the level of nuclear safety in accordance with the evolving requirements of international standards;
- Ensuring a radiological level, in accordance with national norms, for both personnel involved in the nuclear sector and the public. Reducing the impact on the environment;
- Carrying out radioactive waste and spent fuel management in accordance with international requirements;
- Harnessing the benefits of advanced reactors;
- Harnessing the benefits of advanced fuel cycles;
- Supporting research and development activities in the nuclear sector;
- Ensuring human resources in the nuclear sector;
- Periodic analysis of nuclear power reactor solutions offered by the global market, in order to select candidate projects for the implementation of new NPP units in Romania;
- Opening up to competition services for consulting, construction, commissioning, operation and decommissioning of nuclear facilities, as well as services related to radioactive waste management;
- Ensuring appropriate management for all state-owned units in the nuclear sector;
- Promoting ethical principles in relations between entities in the Romanian nuclear sector;

- Promoting and supporting national participation in activities related to the PNN and in PNN-related infrastructure projects.

TABLE 33 - ENVIRONMENTAL OBJECTIVES RELEVANT TO THE NATIONAL STRATEGY

Environmental objective	Related measures	Indicators / Targets
O1 Air and climate protection	M1 Maintaining air quality M2 Preventing air pollution M3 Reducing GHG emissions M4 Selecting sites outside areas affected by extreme events M5 Application of the principle of radiation protection	Reducing GHG emissions by 55% by 2030 ("2030 climate targets" – European Commission); maintaining limit values for pollutants
O2 Water protection	M6 Compliance with pollutant limit values M7 Protection of groundwater and surface water M8 Protection of drinking water	Zero significant pollution incidents; compliance with national legislation
O3 Soil and subsoil protection	M9 Soil pollution prevention M10 Carrying out the management of radioactive waste and spent fuel in accordance with national requirements and in accordance with the recommendations of the standards M11 Restoring soil quality where necessary	Reduction of affected areas; restoration of degraded areas; Environmental restoration following the cessation of activities of nuclear power plants or facilities
O4 Biodiversity conservation	M12 Maintaining the favourable status of habitats and species	Favourable conservation status
O5 Population health and human settlements	M13 Monitoring exposure to risk factors and health status.	Reducing the level of population exposure to noise pollution and ionising radiation Ensuring monitoring of radiological exposure and health status in the nuclear sector, as well as for the public Ensuring proper nuclear accident management.
O6 Noise and vibration prevention	M16 Reduction and compensation of noise and vibration effects	Noise levels ≤ regulated limits in all inhabited areas. Compliance with the following provisions: - Law 121/2019 – assessment and management of environmental noise - STAS 10009 – limits for urban areas

		-Ministry of Health Order 119/2014 – public health norms - Law No. 292/2018 - environmental impact assessment
O7 Landscape protection	M17 Integrating the plan into the existing landscape	Carrying out approved visual assessments in major projects
O8 Public awareness	M18 Information campaigns on environmental issues M19 Appropriate public awareness and information for understanding the nuclear sector	Ensuring a minimum number of major public campaigns / year
O9 Resource conservation	M20 Protection and efficient use of natural resources	Increasing resource efficiency by a sustainable percentage

7. POTENTIAL SIGNIFICANT ENVIRONMENTAL EFFECTS

According to the requirements of Government Decision No. 1076/2004, in the case of the analysis of a plan or programme, the Environmental Report identifies, describes and evaluates the possible significant effects on the environment, of their application as well as their rational alternatives, taking into account the objectives and the related geographical area.

The environmental report identifies, describes and assesses the possible significant effects on the environment, the mitigation measures and the conditions for their application, their rational alternatives, taking into account the fact that some elements (for example, future locations for certain objectives) will be defined in the later stages of design and authorisation.

This report takes into account that implementation of the National Strategy for the Development of the Nuclear Sector involves the construction, operation and expansion of nuclear and research facilities, as well as the development of infrastructure for the management of radioactive waste and spent nuclear fuel. All these activities may generate, directly or indirectly, two main categories of emissions/effluents - radioactive and non-radioactive - each subject to specific requirements for design, operational control, monitoring and compliance with the applicable regulatory instruments.

Consequently, the environmental assessment carried out at the strategic level:

- treats impacts in an integrated manner on environmental components (air, water, soil/subsoil, biodiversity, landscape, noise/vibrations) and on the human health component;
- uses the information available at the strategy level and, where technical detail is not yet available, applies a precautionary approach, based on the experience of similar projects and standard nuclear safety and environmental protection requirements;
- establishes framework measures and requirements for subsequent stages (EIA/Espoo, Natura 2000 Appropriate Assessment, CNCAN and environmental authorisations), so that risks and impacts are kept within acceptable limits, and the ALARA, prevention and precaution principles are consistently applied. The development of nuclear applications for monitoring emerging pollutants and ecosystems does not generate, at a strategic level, additional adverse effects on environmental components and can contribute to improving knowledge of the state of the environment, early identification of pollution sources and substantiation of measures to prevent and reduce impacts.

7.1. IMPACT ON SOIL AND SUBSOIL

During implementation of the National Strategy projects

During the implementation of the National Strategy, the impact on the soil-subsoil environmental component is related to the activities for the effective achievement of the objectives proposed by the strategy.

The execution of works related to the proposed objectives represents the main category of activities with direct impact on the soil and subsoil. Typically, these include: excavations and excavations for foundations, site organisation and operation, construction of buildings, tracing and construction of access roads, as well as the execution of technical and municipal

networks (water supply, wastewater collection, etc.). The precise technical details of these interventions are not available at this time.

Possible sources of pollution/damage during the execution period:

- domestic and industrial wastewater generated on site;
- accidental leaks of lubricants and fuels as a result of equipment or means of transport malfunctions;
- maintenance and repair operations for machinery and vehicles carried out on site;
- soil erosion processes induced by excavations, embankments or intense traffic;
- transport activities (internal and external to the construction site), including maneuvers and parking;
- operation of heavy machinery and vehicles (compaction, vibrations, leaks, noise);
- improper storage of construction/packaging/household waste;
- construction of internal roads;
- atmospheric emissions from machinery and means of transport.
- the risk of radionuclide pollution through accidental leaks due to leaks in the aquifer;
- the risk of pollution with radioactive liquid effluents from washing/decontamination;
- the transfer of radioactive pollutants from the air to the soil, through dry and/or wet deposition.

Regarding the specific impact of radioactive emissions - mechanisms and potential effects, in the case of nuclear-specific objectives (Cernavodă NPP, CTRF, facilities associated with radioactive waste management), radioactive emissions into the air (of tritium type in the form of HT/HTO, activated or contaminated aerosols/particles and, where appropriate, traces of radioactive iodine or other specific radionuclides) can lead to deposits on the soil surface, with the potential for local radiological contamination, generally at very low levels, in the vicinity of the discharge points/activity areas).

Radionuclides deposited on the soil can subsequently migrate into the soil profile through meteoric water infiltration and through transport processes in the porous medium, with the possibility of mobilisation to the vadose zone and, in unfavourable scenarios, to the aquifer, depending on local hydrogeological properties, soil sorption coefficients and drainage conditions.

Depending on the duration and magnitude of the deposition, effects on land uses may occur (temporary restrictions in immediately adjacent areas, if applicable, as well as transfer to biota through absorption by vegetation or through entrainment in the food chain), but these effects are usually prevented/limited by discharge control, monitoring and site management measures.

Effects on soil and subsoil are mainly temporary and confined to the construction phase, and can be remedied through land-restoration measures (reprofiling, stabilisation and restoration of soil fertility).

An exception is the areas permanently occupied by the achieved objectives (the footprint of constructions and associated infrastructures), for which the change in land use is permanent.

In these areas, interventions are made on the natural structure of the soil and its quality, by modifying or inhibiting pedogenetic processes, interrupting vegetation life cycles and altering the physicochemical and mechanical properties of the soil: texture, degree of

loosening, compaction, cohesion, as well as modifying hydrophysical, aeration and thermal properties.

The impact on the soil/subsoil will be predominantly local (limited in surface and volume), but may be long-term in areas affected by excavation, land improvement, filling, terracing and compaction works, by modifying the local geological stratification and structure, as well as by affecting the geological structure through excavation, improvement, filling, terracing and compaction works.

Overall, the impact associated with radioactive emissions into the air on the soil/subsoil is, under normal operating conditions and in compliance with the authorisation regime, predominantly local and of low intensity, being controlled by limiting discharges, filtration/purification on ventilation circuits, radiological monitoring of deposits and soil quality in areas of interest and intervention measures in exceptional situations, so as to prevent the occurrence of significant contamination and adverse effects on land uses.

During the implementation of the activities proposed by the National Strategy

During activities proposed under the National Strategy for the Development of the Nuclear Sector in Romania and the National Nuclear Programme, pollution of the soil and subsoil is not anticipated under normal operating conditions of the facilities. The design, construction and operation of the facilities are based on the defence-in-depth principle, including multi-barrier protection systems, impermeable surfaces in areas with contamination potential, leakage control and continuous monitoring of environmental parameters. Under these conditions, the risk of soil and subsoil contamination associated with the Strategy activities is assessed as very low.

Current exploitation is carried out in a controlled manner, in compliance with nuclear, radiological and environmental safety requirements. In abnormal or accidental circumstances, adverse effects on the soil and subsoil may occur, generated, for example, by:

- failure to comply with the conditions for storage, handling and disposal of waste from the site, including radioactive waste;
- failures of wastewater transport and treatment systems, with the possibility of uncontrolled discharges onto platforms, into unsealed areas or into rainwater networks;
- incidents in transfer operations of radioactive liquid waste (loading/unloading, hose coupling, container handling), with potential accidental leaks;
- accidental leaks of chemical substances and preparations used in technological or auxiliary processes;
- compromising protective barriers in the context of extreme external hazards (earthquakes, floods, severe weather phenomena) that exceed the design basis, or as a result of deliberate actions (physical or cyber security events);
- damage to liquid waste transfer lines (pumps, buried/partially buried pipes), including due to operating errors;
- inadequate operation of drainage systems (clogging, insufficient capacity or inadequate maintenance), which may promote ponding and infiltration into the soil.

The implementation of the Strategy can contribute to reducing the risk of soil and subsoil pollution by improving waste management, including: optimising transport routes and reducing distances between the generator and treatment/storage facilities, using modern

technologies with increased efficiency in waste treatment and optimising the use of existing and future storage facilities. These measures lead to a decrease in the quantities of non-compliant waste and to the prevention of situations with the potential for contamination of the geological environment.

For facilities located on the Cernavodă platform, the radiological impact on soil and subsoil under normal operating conditions is estimated to be very low and spatially limited to the immediate vicinity of the plant, as a result of the potential transfer of very small quantities of radionuclides from air to soil through atmospheric deposition. These contributions to environmental radioactivity are strictly monitored and kept below the limits established by national legislation and CNCAN regulations, and are not capable of causing significant effects on the integrity of Natura 2000 sites in the area.

The only radionuclide originating from the operation of the plant that can be detected outside the Cernavodă NPP site is tritium. Analyses have shown that the impact of the presence of tritium on the flora and fauna in the habitats present around the Cernavodă NPP, at the levels induced by the emissions from the plant, is insignificant, the estimated dose values being an order of magnitude lower than the reference levels.

Under normal operating conditions of the facilities covered by the SNDDN, impacts on soil and subsoil are considered insignificant because of the containment systems and other protection measures provided, together with programmes for monitoring, preventing and controlling emissions.

7.2. IMPACT ON WATER

During implementation of the National Strategy projects

During implementation of the National Strategy for the Development of the Nuclear Sector in Romania and the National Nuclear Programme, impacts on water are mainly associated with the works required to implement the strategic objectives: topsoil stripping and foundation excavations, construction-site organisation, decommissioning of existing facilities, construction of new facilities, access-road works, and installation of water-supply, wastewater and stormwater collection and drainage systems.

Such works may exert pressure on surface water and groundwater, particularly the water table, in the implementation areas. However, projects and facilities under the Strategy are or will be sited in locations selected on the basis of suitable hydrogeological conditions, so as to ensure high standards of aquatic-environment protection and prevent, through the overall design, the risk of contamination of surface-water and groundwater bodies.

For the deep geological repository, the location has not yet been established; consequently, at this stage, the water impact assessment only targets the potential effects of construction activities (excavation works, drilling, access infrastructure, site organisation), correlated with local meteorological and hydrological conditions, with the detailing of the effects on groundwater and surface water to be carried out within the specific impact studies and appropriate assessment, once the site is selected.

During the implementation stage, the main potential sources of water pollution are:

- domestic wastewater generated by construction site personnel, in the absence of adequate collection and treatment systems;

- leaks of lubricants, fuels and hydraulic oils, caused by the malfunction of machinery and means of transport used on the construction site, as well as by maintenance and fueling operations;
- soil erosion and entrainment of fine material into surface waters, as a result of excavations and earthworks, amplified by intense rainfall episodes;
- transport activities and the operation of machinery, which may lead to the dispersion of materials and accidental leakage of hazardous substances on access roads or near water bodies;
- improper storage of waste (including hazardous waste), with the risk of leaching and migration of pollutants to surface and groundwater;
- stormwater from industrial platforms and construction sites, loaded with suspensions, petroleum products or other polluting substances, in the absence of adequate collection and separation/treatment systems.

For nuclear-specific or radioactive waste management objectives, the above risks are added to:

- the risk of groundwater pollution through accidental leaks of radionuclides, as a result of leaks in installations, pipes or storage areas, followed by infiltration into the aquifer;
- the risk of water pollution with radioactive liquid effluents resulting from washing, decontamination or treatment operations, in the event of system failures or failure to comply with procedures.

For the DFDSMA Saligny site, simulation studies of the transport of radioactive contaminants in the underground environment have demonstrated that, due to the hydrogeological characteristics of the site (loess and clays acting as a natural barrier), radionuclides do not reach the main aquifer at concentrations higher than the accepted limits for drinking water, even in conservative scenarios. By analogy, for the deep geological repository, site selection criteria will be applied that ensure an effective natural barrier and, implicitly, the protection of groundwater bodies.

As regards Natura 2000 sites, the only protected natural areas of Community interest likely to be influenced by the implementation of the strategy are located in the area of influence of the Cernavodă NPP and the DFDSMA repository. During the construction phase, interactions with the aquatic environment may occur through accidental pollution of surface waters or temporary changes in their quality, but the Appropriate Assessment Study concludes that, by applying prevention and reduction measures (controlled site organisation, wastewater collection and treatment systems, retention and separation for stormwater, intervention plans in case of accidental pollution), the potential impact on water bodies and, implicitly, on the integrity of Natura 2000 sites is reduced, temporary and does not reach the threshold of a significant effect.

Overall, during implementation of the National Strategy, impacts on water are considered manageable at strategic level, provided that appropriate prevention, mitigation and monitoring measures are detailed and implemented during the subsequent design and authorisation stages. These measures must keep the risk of surface-water and groundwater pollution very low and prevent significant effects on Natura 2000 sites within the areas of influence.

During the implementation of the activities proposed by the National Strategy
Non-radioactive liquid effluent emissions

Cernavodă NPP

TABLE 34 - REGULATED NON-RADIOACTIVE LIQUID EFFLUENTS DISCHARGED FROM CERNAVODĂ NPP AND MAXIMUM PERMITTED VALUES

Category of discharged water	Quality indicator	Maximum permitted value (mg/L)
Domestic wastewater (not radioactively contaminated)	In accordance with Government Decision No. 188/2002 - NTPA 002/2002, as amended and supplemented by Government Decision No. 352/2005	
Process water	Temperature	*
	pH	6.5 – 9.0
	Suspended solids	25
	Total ionic iron	1.5
	Chlorides	250
	Sulphates	200
	Ammonium	3
	Phosphorus	1
	BOD_5	15
	Sodium	100
	Calcium	150
	Magnesium	50
	Petroleum product	5 (without iridescence)
	Free residual chlorine	0.2
	Hydrazine	0.1
	Morpholine	0.4
	Cyclohexylamine	0.1
	Lithium hydroxide	0.025
	Hydrazine + lithium hydroxide mixture	0.1 + 0.025
	Hydrazine + morpholine mixture	0.1 + 0.4
	Hydrazine + morpholine + cyclohexylamine mixture	0.1 + 0.4 + 0.1
	Rhodamine - discharged to the CDMN - discharged to the Danube	2.0 10.0
	Fluorescein - intermittent discharge	0.25
	RGCC-100	1.0 commercial product
	Biomate 5716	1.0
	ARQUAD MCB-50 biocide	5.2 active substance 0.01 mL/L commercial product
	Ethylene glycol	< 1.0
	Ultima Gold LLT scintillation fluid	0.01 active substance 0.00195 commercial product
	PRAESTOL A3040L	3
Stormwater, including water from underground drainage and water stored in the external drainage sump	In accordance with the reference objectives for the classification of surface-water quality.	

* With regard to thermal loading, the temperature of discharged process water:

- *in Reach II of the CDMN (in the stilling basin of the Recuperare Hydropower Plant) shall be no more than 10°C above the water temperature in Reach I of the CDMN, so that the water temperature in Reach II downstream of the discharge point does not exceed 25°C;*
- *when discharged to the Danube, shall be no more than 10°C above the Danube water temperature and no higher than 35°C after the mixing zone.*

Cernavodă Tritium Removal Facility

The main potential sources of pollution are:

- Domestic wastewater from the CTRF will be collected, conveyed and discharged through a separate system into the existing domestic sewerage network on the platform. The project will generate an estimated annual domestic wastewater volume of 1,060 m³.
- Stormwater from the CTRF will ultimately be discharged into the Cernavodă NPP distribution basin;
- Cooling water will not form part of the liquid effluents generated by the project. Continuous closed-circuit operation of the CTRF will be supported by refrigeration units;
- Potentially contaminated CTRF process effluents from the process area, including water used by the fire-extinguishing system and water resulting from equipment decontamination, will be collected by gravity in a sealed sump located in the basement of the CTRF building. From there, they will be pumped to the Unit 1 Radioactive Liquid Waste Management System (source: EIA Report for the CTRF).

The CTRF project will be connected to the domestic and storm sewer systems, respectively to the Radioactive Liquid Waste Management System at U1.

Under normal operating conditions, radioactive releases associated with the CTRF relate to the management of potentially contaminated liquid effluents, including those arising from decontamination operations. These effluents are received and treated in the Unit 1 Radioactive Liquid Waste Management System in accordance with operating procedures and applicable regulatory instruments.

Small Modular Reactors-SMR

Liquid effluent emissions result from the operation of the facility and will be regulated by regulatory acts:

- cooling waters (from cooling towers or auxiliary systems) - may contain dissolved salts, suspensions, biocide residues (chlorine, bromine, amine compounds) and anti-corrosive agents;
- domestic sanitary wastewater - treated before discharge;
- rainwater - can carry suspended particles, traces of oils/fuels from industrial areas;.
- non-radiological liquid effluents from the operation of auxiliary systems and support facilities, such as HVAC (heating, ventilation and air conditioning) systems, control laboratories and equipment washing and maintenance activities.

Under normal operating conditions, controlled quantities of liquid radioactive effluents may be generated by process and auxiliary systems. They will be collected, monitored, treated

and discharged in a controlled manner only in accordance with the limits and conditions established by regulatory instruments and operating procedures.

DFDSMA

Non-radioactive liquid emissions consist of:

- domestic wastewater resulting from the use of sanitary units and from condensation;
- wastewater (conventionally clean), accidentally resulting from breaks/cracks in pipes;
- rainwater.

Under normal operating conditions, liquid radioactive releases are prevented by the repository design (engineered and natural barriers), separate collection of any infiltration water and radiological monitoring. In unforeseen circumstances, potentially contaminated water will be collected and managed in accordance with regulatory procedures and requirements.

DGA

In the operating phase (normal operation) of a deep geological repository
when introducing and sealing waste, non-radiological emissions are mainly of a conventional, not nuclear, nature:

- infiltration waters (from rock or aquifer) pumped and drained from galleries which generally contain mineral salts, fine sediments, possibly dissolved construction additives;
- domestic wastewater from personnel activities;
- process water from equipment cooling or surface cleaning;
- minor oil/technical fluid leaks from machinery (prevented by strict procedures and retention basins).

Under normal conditions, radioactive releases to the aquatic environment are prevented by multiple barriers (encapsulation, backfill materials and host rock) and by management of infiltration water. Any potentially contaminated water will be monitored and managed separately in accordance with nuclear and radiological safety requirements.

ELI-NP research infrastructure

The resulting emissions consist of: domestic water, rainwater and wastewater resulting from the company's own car wash platform.

Under normal operating conditions, liquid radioactive releases are not anticipated. Where specific activities involve radioactive sources, any effluents will be managed in accordance with internal procedures and regulatory requirements, including collection and radiological monitoring, as appropriate.

During the operation of the facilities, under normal operating conditions, there is no pollution of surface and groundwater.

This is also due to the way in which the landfill sites are chosen, taking into account the hydrogeological stability of the site, the location of the site above the maximum flood level.

No significant adverse effects on the environment are predicted, except for small increases in the concentration of discharged substances.

There may, however, be potential pollution of groundwater and surface water under exceptional conditions, due to:

- failures/accidents occurring in the piping system for potentially contaminated water from the storage cells;
- failures of the facilities for collecting any infiltrations;
- failures of wastewater transportation and treatment systems;
- accidental destruction of repository waterproofing;
- accidents during the treatment and transfer of various types of radioactive liquid waste;
- destruction of protection systems in the event of cataclysms that exceed the level of protection provided by projects, or as a result of terrorist actions;
- failure to comply with the conditions for discharge into the outfall;
- malfunctions of liquid waste transportation systems;
- the risk of radionuclide pollution through accidental leaks due to leaks in installations with infiltration into the aquifer;
- the risk of pollution with radioactive liquid effluents from washing/decontamination;
- transfer of radioactive pollutants from air to the aquatic environment through dry or wet deposition.

In relation to the implementation of the SNDDN and PNN, the analysis of existing pressures indicates that

some of the projects derived from the SNDDN/PNN may interact with water resources (water needs, controlled discharges, works in the proximity of water bodies) and that the management plans already signal pressures on the aquatic environment (diffuse pollution, eutrophication, surface water abstractions, reduced connectivity and vulnerability to drought), the aquatic component remains the most sensitive receptor in the analysis. The cooling water from the Cernavodă NPP is discharged into the Old Danube branch, over 3 km from the plant, through the Seimeni Valley. This area of the branch is included in the ROSCI0022 Canaralele Dunării site.

Therefore, the only area where increased attention is required from the perspective of the potential for amplifying existing pressures is the aquatic environment, where any additional contribution must be prevented through avoidance and control measures from the planning phase, respectively through design and monitoring conditions, so as to maintain the integrity of aquatic ecosystems and water-dependent habitats.

7.3. IMPACT ON AIR

During implementation of the National Strategy projects

During the works required to implement the strategic objectives, effects on air quality will be associated with construction-site activities: topsoil stripping, foundation excavations, transport and handling of materials (which generate dust and exhaust emissions), site establishment and the operation of machinery.

Possible sources of pollution (non-radiological emissions) during the implementation stage:

- entrainment of dust particles and soil erosion phenomenon (diffuse dust emissions);

- road traffic related to the transport of materials and waste;
- operation of machinery and means of transport (emissions of NOx, CO, SO_2, VOC, dust);
- maintenance works and operations for machinery/vehicles (risk of accidental leaks);
- improper storage of waste on the construction site.

During the implementation phase, radioactive emissions to air are not normally associated with construction-site activities (topsoil stripping, excavation and transport). They may arise only where works are carried out near or within existing nuclear facilities, or during commissioning/testing of systems with radiological potential. In such cases, releases will be controlled through monitored ventilation systems and in accordance with the applicable regulatory documents.

Typology of gaseous radioactive effluents – The main categories of gaseous radioactive effluents/aerosols that may be relevant (depending on the objective and phase of the project) include: tritium (HT/HTO – tritiated water vapour), noble gases (Kr/Xe type) in the case of reactor facilities,
radioactive iodine and activated or contaminated aerosols/particles, carbon-14, as well as point-present activation products, all managed by containment, filtration and monitoring at exhaust stacks (IAEA – Safety Series No. 46 (1978), Monitoring of Airborne and Liquid Radioactive Releases from Nuclear Facilities).

Nature of the impact: the effects on air quality are temporary and limited to the execution period, with intensity and extent dependent on the technologies used, site organisation, weather conditions and compliance with environmental protection measures.

During the implementation of the activities proposed by the National Strategy

Sources of non-radioactive gaseous emissions

Cernavodă NPP

Non-radioactive gaseous emissions come from:

- vapour emissions from Diesel generators;
- starting heating plant;
- Diesel generators;
- auxiliary and support activities, transport activities and traffic within the premises – result in emissions of suspended particles.

Independent environmental assessments conducted for the Cernavodă NPP confirm that the impact of non-radioactive emissions is insignificant in the long term.

The technological process of producing electricity does not involve the use of volatile organic substances (VOCs) and does not lead to the formation of emissions of nitrogen oxides (NOx) or sulphur oxides (SOx).

tritium removal facility

The emissions of the CTRF facility during its operation period consist of:

- gaseous emissions resulting from periodic tests of backup generating sets;
- emissions generated by fuel combustion in transport vehicles and other on-site machinery (e.g. NO_x, SO_2, CO, PM_{10}, $PM_{2.5}$ and VOCs).

The calculation of annual greenhouse-gas emissions yields a maximum value of approximately 395 t CO_2/year, based on the operating hours required for operational testing of the two standby diesel generator sets.

NO_x, NO_2, SO_2, CO, PM_{10} and $PM_{2.5}$ will be present for short periods.

The estimated direct greenhouse-gas emissions generated by the two standby diesel generator sets are a maximum of 395.03 t CO_2/year.

TABLE 35 - ESTIMATED EMISSIONS FROM FOSSIL-FUEL COMBUSTION BY STATIONARY STANDBY DIESEL GENERATOR SETS (TESTING PERIODS - 2 HOURS/MONTH)

	NO_x kg/h	**SO_2 kg/h**	**CO kg/h**	**PM_{10} kg/h**	**$PM_{2.5}$ kg/h**
Flow	10,260	1,089	1,555	0.466	0.390

Source: (Environmental Impact Assessment Report for the project "Construction works of the Cernavodă Tritium Removal Facility")

Small Modular Reactors - SMR

Non-radioactive gaseous emissions from auxiliary equipment and support activities:

- Auxiliary equipment: emergency diesel generators may produce limited air emissions but these are not anticipated to lead to significant air quality impacts for sensitive receptors.
- Transportation of personnel and materials: Road traffic associated with personnel movement, material delivery, and equipment transportation contributes to minor, diffuse air emissions, similar to those encountered at other industrial sites.
- Nuclear fuel cycle emissions: Non-radioactive emissions generated by the nuclear fuel cycle occur primarily in the nuclear fuel cycle as a set of distinct activities, spatially and functionally separate from reactor operation. – namely in the processes of fuel fabrication, enrichment, transport and management of fuel and waste – occur predominantly off-site (Final Environmental Impact Statement for an Early Site Permit at the Clinch River Nuclear Site Reader's Guide, April 2019).

DFDSMA

During the operation of the facility, only gas emissions from transportation are expected. Pollutants generated: particulate emissions from diesel engines, NOx, SOx, CO, particles, VOCs and various other hazardous air pollutants, including benzene.

No radioactive gaseous and aerosol emissions into the atmosphere are expected under normal operating conditions.

Potential air pollution may also occur under exceptional, accidental conditions, due to: the destruction of protection systems in the event of natural disasters that exceed the level of protection provided by the projects or inadvertent actions on site, incidents during radioactive waste handling operations, the destruction of protection systems in the event of unauthorised interventions, sabotage or armed attacks.

DGA

In the operation of DGAs, there are normally non-radiological emissions of a conventional nature, in the form of gases or liquid effluents, similar to those generated in other underground industrial works:

- exhaust air that may contain dust (from handling sealants);
- CO_2 and water vapour from underground maintenance processes/human activities;
- exhaust gases from machinery and transport: nitrogen oxides (NO_x), carbon monoxide (CO), particulate matter (PM), carbon dioxide (CO_2).
- volatile organic compounds (VOC): from paints, solvents, construction materials resulting from maintenance activities;
- natural gas from rock: methane (CH_4) or other hydrocarbons that can be released from the geological formations traversed by galleries. These are not radioactive, but can generate an explosion risk if not ventilated.

The Alfred Project

Non-radioactive emissions are comparable to those of other complex industrial facilities (flue gases, dust, noise), and their impact is reduced by applying technical prevention and control measures.

During operation, non-radioactive emissions associated with auxiliary installations, such as flue gases from thermal power plants and generators, as well as dust and fumes resulting from secondary technological activities, may occur. Non-radioactive emission reduction systems are in place (low-NOx burners, periodic maintenance).

ELI-NP research infrastructure

The resulting emissions consist of: pollutant emissions (exhaust gases) from the combustion of fuels (gasoline, diesel) in various types of engines; acrolein emissions may result from the operation of the kitchen.

Sources of gaseous radioactive releases (gaseous radioactive effluents and aerosols) are specific to facilities carrying out nuclear activities. Under normal operating conditions, releases are controlled through monitored ventilation systems and stacks, with retention or filtration (e.g. HEPA filters and/or activated carbon, as appropriate), radiological monitoring and compliance with limits approved through regulatory instruments, so that impacts on air quality and sensitive receptors remain very low.

The potential sources of potentially polluting radioactive emissions into the air are the following:

Cernavodă NPP Platform

Radioactive emissions into the air associated with the Cernavodă NPP platform are mainly controlled discharges through the ventilation systems of the reactor building and the service building, as well as from other potential generation points (spent fuel storage pools, decontamination centre and heavy water facility). The main radionuclides potentially present in the discharged air are tritium, radioactive iodine, noble gases and radioactive particles. The impact on air quality is, under normal operating conditions, reduced and localised, being

limited by confinement, filtration/retention and radiological monitoring at the discharge points, respecting the authorised limits; in abnormal/accidental situations, a temporary increase in the release potential may occur, managed by the protection systems and response procedures.

Small Modular Reactors-SMR

No releases of radionuclides into air or water are anticipated under normal operating conditions.

Potential gaseous effluents are noble gases, iodine, tritium (HTO), radioactive particles, accidentally released.

The impact would be temporary and scenario-dependent, being limited by containment barriers, ventilation/filtration systems and radiological monitoring, in accordance with applicable regulatory requirements.

DFDSMA

In normal operation, the radioactive content is contained and the integrity of the seals and containment systems ensures the absence of radioactive emissions into the air, so that the impact on air quality is insignificant. The impact assessment becomes relevant mainly for postulated accident scenarios (e.g. handling incidents, unforeseen barrier degradations or unauthorised interventions), when point releases of contaminated aerosols/particles could occur; these situations are managed by safety procedures, local containment measures, monitoring and intervention.

DGA

Most disposal concepts cannot completely isolate the long-lived radionuclides present in the waste. Consequently, in the very long term, the main functions of the geological disposal system are to delay and limit the escape of radionuclides from the progressively degrading engineered barrier system into the geological environment and eventually into the biosphere.

Research activities

In the field of research activities, both the ALFRED project and the ELI-NP are designed so that, under normal operating conditions, radioactive emissions into the air are undetectable/negligible, and the impact on air quality remains very low.

Potential sources of air emissions: radionuclides generated by activation (especially in fuel, structures and liquid lead); potential for gas phase transition for certain species in accidental scenarios (e.g. Te, I, Cs) and air from experimental chambers with short-lived radionuclides, mainly with local potential; as a rule, experiments do not generate significant radioactive aerosols.

The predicted impact is low a**nd localised under** normal conditions, as emissions (tritium, noble gases, iodine, particles) are discharged i**n a controlled mann**er, w**ith monitorin**g and compliance with authorised limits. In abnormal/accidental situations, the impact may temporaril**y increas**e, but is managed through barriers and control procedures, with impact limitable through detection and intervention systems. The effects are temporary and dependent on the magnitude of the accident.

7.4. IMPACT ON BIODIVERSITY

During construction of the Strategy projects

The potential impact generated by the implementation of the projects may come during the construction phase from the construction works, namely the generation of air emissions of gases and dust, as well as noise and vibrations produced by machinery but also from waste through their improper management. All the projects proposed in the national strategy are located outside protected natural areas, except for the Deep Geological Repository, whose location has not yet been established.

During the construction phase, there will be mainly an impact on the soil and subsoil. The forms of impact on the soil during construction may be of the following nature: physical, mechanical, chemical (effects on the amount of nutrients in the soil), biological, and the reduction of soil volume. For the construction phase, the sources of soil pollution will be: occupation of land areas, changing their destination; handling and storage of construction materials; waste management (resulting from construction activities); fuel leaks from machinery and means of transport; activities of excavating foundations, construction of internal roads, construction of pipelines and surface drainage; deposits of construction material dust.

The excavations carried out will interfere with the natural structure of the soil, its quality. This impact is inevitable given the specific nature of the construction activity:

- Modification of pedogenetic processes, by interrupting the life cycles of vegetation, microfauna and mesofauna
- Modification of the physicochemical and mechanical properties of the soil: texture, looseness, compaction, cohesion
- Modification of hydrophysical, aeration and thermal properties.

All excavations will be carried out as close as possible to the surface area proposed by the regulatory documents, thus affecting a minimum volume of soil/subsoil.

The impact will be local, limited in surface area and volume, but long-lasting, due to: damage to the geological structure through excavation, improvement works, filling, terracing and compaction.

The sources of air pollutant emissions specific to the projects studied are ground-based, open (those involving the handling of construction materials and soil processing) and mobile (machinery and trucks – pollutant emissions and noise). All of these source categories are undirected, being considered surface sources.

Most machinery uses diesel fuel; therefore, exhaust gases released to the atmosphere contain heavy-metal-bearing particulates (Cd, Cu, Cr, Ni, Se and Zn), polycyclic aromatic hydrocarbons (PAHs), sulphur dioxide (SO_2), nitrogen oxides (NOx), non-methane volatile organic compounds (NMVOCs), methane (CH_4), carbon oxides (CO and CO_2), ammonia (NH_3), other particulates and hydrocarbons. These include respirable particulate pollutants. PM_{10} and total suspended particulates are the main air pollutants during construction. To reduce exhaust emissions, modern machinery and equipment with up-to-date technical inspections will be used in accordance with applicable legislation. Wind erosion of temporarily uncovered ground surfaces is an additional dust source associated with construction works. Dust generated

during handling of construction materials and excavated or fill soil is also an important pollutant.

Implementation of the Strategy will result in the occupation of certain land areas outside protected natural areas, mainly within anthropogenic industrial sites with no conservation value.

This loss of surface area, as a feeding and resting area for bird species, is insignificant compared to the land area in the studied area, so the residual impact will be insignificant.

Transport of construction materials and the works required to implement the projects may generate noise and atmospheric dust, with effects on nearby fauna and flora. However, because local conditions in the areas intended for implementation of the Strategy projects favour the dispersion of air pollutants, dust emissions during implementation are expected to be low and not to disrupt plant physiological or biochemical processes.

Given that no plant species of conservation interest have been identified on the project sites provided for in the SNDDN (where the location is known), the local flora being represented by ruderal and segetal plants, without conservation value, we assess an insignificant impact on the vegetation.

We conclude that the feeding, resting and breeding habitats of species of Community interest, for which protected natural areas in the vicinity of the sites have been declared, will not be affected by the achievement of the objectives set out in the strategy, given: the distance to the protected natur**al areas, the specific natu**re of the objectives, the local environmental characteristics and the fact that there will be no direct interventions on areas other than those provided for by the strategy.

In the case of fragmentation, two components can be discussed: the physical barrier (mainly built elements that prevent the free movement of individuals) and the "behavioural" barrier - determined by works that lead to the emergence of avoidance behaviour.

The barrier effect during the construction period for birds will be a behavioural one, due to the avoidance of the areas where the construction works will be carried out. The barrier effect will be felt in the proximity of the work points and will have the effect of temporarily moving the fauna specimens that use these anthropised lands for feeding, to neighbouring areas. The effect will be temporary, insignificant, the works being carried out in stages.

Regarding species of Community interest, it can be stated that the impact will be insignificant, exercised only at the local level.

During construction, the effect of noise and vibrations on biodiversity is limited to the effect on fauna. Thus, noise is mainly caused by the operation of the equipment necessary for the construction work, but also by other activities within the construction work. During the construction period and as a result of the noise and vibrations, a displacement of fauna from the initial area using the site as a feeding area is observed, which will be naturally repopulated/reused over time once the works have ceased and the land has been restored.

Due to the phasing of construction works, it is estimated that the noise effect will not manifest itself over the entire surface of the project sites, but locally at the level of each work point where interventions are carried out and at the level of the main access roads.

Regarding the impact of artificial light, during the construction period, we note that the works will not take place at night, so that an artificial light source would be required to carry out the construction works and would affect migratory species.

Given that nuclear energy activities are carried out outside protected natural areas, habitats and species of Community interest at considerable distances from them will not be affected. The implementation of energy objectives will not result in fragmentation or loss of Natura 2000 habitats.

The direct impact will be felt on flora and fauna during the construction phase. Sources of pollution that may affect fauna during construction works are noise, vibrations and dust emissions, however, these are temporary in nature and will disappear once the construction activities cease. Given that the analysed areas are located in anthropised areas (e.g. on the Cernavodă NPP platform, the Doicești platform, the Mioveni platform and the Măgurele platform), no plants of conservation interest will be affected, the local flora being represented by ruderal and segetal plant communities without conservation value. An insignificant impact on vegetation is thus assessed.

As for the flora, the dust carried by air currents, resulting from the operation of heavy machinery on the site, can reach the foliar apparatus of the vegetation in the vicinity of the site and affect the physiological processes characteristic of plant organisms (photosynthesis, respiration and transpiration). Considering the structure and composition of the vegetation on the site, the absence of elements of conservation interest and protected species, and the small scale of the construction works both on a spatial and temporal scale, the impact of the works on the flora and vegetation can be considered insignificant.

Regarding protected and unprotected fauna species, we specify that during the implementation of the strategy there will be a temporary removal of them from the directly affected areas in the immediate vicinity, following that upon completion of the works, they will reuse the project sites according to their food needs. We recall that the areas targeted by the implementation of the objectives proposed by the strategy are located outside protected natural areas, on lands with the use category - yards-constructions or agricultural.

During the execution of the investment works, the impact on environmental components is temporary, limited to the execution period and reversible (after restoring the site to its initial state, environmental components are no longer influenced). The impact will have a variable frequency, depending on the scheduling schedule and the type of works performed.

For DFDSMA, the location does not overlap with protected natural areas of Community interest, thus no areas of habitats of Community interest ROSCI0022 Canaralele Dunării or feeding, shelter or breeding habitats for bird species for which the protected natural area ROSPA0039 Dunăre-Ostroave was declared will be lost.

The impact on protected natural areas generated by the development of the deep geological repository will only be able to be properly established when its exact location is known. Until the site is identified and confirmed, a detailed assessment of the effects on habitats and species of Community interest cannot be carried out, but only a general analysis of the possible interactions. Following the selection of the location, specific environmental impact studies and an appropriate assessment for protected natural areas will be necessary, ensuring the integration of the objective in accordance with the requirements of national and European environmental legislation.

Regarding the impact of the research projects, the buildings necessary for the implementation of ELI-NP are already completed, being located on the Măgurele site. The ELI-NP project thus does not generate an impact on the environment or biodiversity during the construction period.

Regarding the ALFRED project, construction works are carried out only within the premises of RATEN ICN (Mioveni), an anthropised industrial site where the buildings and their related annexes will be located and which are the subject of the investment project. During the construction phase, it may have temporary and local effects on biodiversity. The main aspects refer to the loss and fragmentation of habitats determined by the occupation of the land and the elimination of spontaneous vegetation, as well as the disturbance of local fauna as a result of noise, vibrations and intense traffic associated with the construction site. There are also limited risks related to soil pollution through accidental leakage of fuels or oils, and a decrease in air quality through dust and exhaust gas emissions.

Population reduction

The risk of mortality of individuals belonging to fauna species may occur especially during the construction period, as a result of: construction site traffic (the so-called roadkill), earthworks, excavation works, accidental pollution, but also during the operation of landfills, as a result of the traffic necessary to transport radioactive waste.

Among the fauna species most at risk of mortality due to road traffic are amphibian and reptile species.

According to the literature (*Amphibian and reptile road-kills on tertiary roads in relation to landscape structure: using a citizen science approach with open-access land cover data, He*igl et al., 2017), the direct effect of road traffic on animal populations is through fatal collisions with moving vehicles. Roadkill does not affect all taxonomic groups in the same way. Amphibians and reptiles are mostly affected when crossing roads during migration between their breeding, feeding and hibernation sites; reptiles are also attracted by the favourable microclimate on roads. Amphibians and some reptile species are even more susceptible to road traffic, as they remain motionless in the face of an approaching vehicle.

There are very few studies on the effects of traffic on amphibian and reptile populations, despite the fact that amphibians and reptiles have significantly more species at risk than mammals or birds. Furthermore, available data on road kills of amphibians and reptiles for Europe are scarce and often not comparable due to different study designs and species-specific response patterns.

In temperate regions, many amphibian species and some reptile species require complex landscapes including wetlands for breeding and shrubland for feeding and hibernation. Therefore, the composition of the landscape around roads is an important factor influencing the number of road fatalities for both amphibian and reptile populations. Some reptile spe*cies (e.g. La*certa viridis, Laurenti, 1768) are more habitat-selective than others (e.*g. Natrix na*trix, Linnaeus, 1758), migrating long distances from summer to hibernation habitats.

Most adult frogs are sensitive to road traffic when migrating to breeding grounds, while road kills of young frogs are more dispersed in space and time when moving from hibernation sites.

Most studies investigate the impact of roads with high traffic volumes that are usually fenced and therefore represent a stronger barrier to amphibians and reptiles. However, there is increasing evidence that tertiary road networks particularly affect small species such as herpetofauna. However, the influences of tertiary roads on amphibian and reptile populations at the landscape level are often not studied.

The study by Heigl et al., 2017, aimed to monitor road traffic kills during two periods of amphibian and reptile activity from March 2014 to October 2015 on a 97.5 km road section in a rural region of eastern Austria. The term tertiary road network is used to summarise (I) agricultural roads (used by farmers, speed limit 30 km h−1), (II) cycle paths (used only by cyclists), (III) municipal roads (used mainly by residents, speed limit 50 km h−1) and (IV) interurban roads (used mainly by residents, speed limit 100 km h−1).

During the monitoring, 252 roadkills (180 amphibians and 72 reptiles) were identified, comprising eight species. The green toad (Bufo viridis*, Laurenti,* 1768), common toad (Bufo bufo, Linnae*us, 1758*) and grass snake (Natrix natrix) we*re the domi*nant amphibian and reptile species investigated. The majority of amphibians and reptiles were killed on agricultural roads. Data analysis led to the establishment of several hotspots, with the majority of these hotspots for amphibians being near arable and suburban land. Frogs accounted for 96% of all amphibian roadkills and snakes accounted for 83% of all reptile species killed on roads.

Road mortality of both amphibians and reptiles was recorded throughout the active season, mainly on agricultural roads. Bufo viridis and Bufo bufo accounted for 96% of all amphibian road mortality, with peaks in April, August and September.

Natrix natrix accounted for 83% of all reptile road mortality, with peaks in September and October. During these months, snakes and lizards frequently use roads for daytime basking, while farmers also use the roads more intensively during harvesting.

The risk of "road-kill" (fauna mortality on road infrastructure) will be assessed and quantified in the design phase of the DGA and DFDSMA, based on field studies (fauna inventory, crossing modelling) and traffic scenarios, with avoidance and reduction measures (fauna crossings, directional fences, signaling, speed management) to be established accordingly.

During operation of the Strategy projects

Activities in the field of nuclear energy production

The impact assessment of nuclear energy activities focuses on the two major objectives of the SNDDN: the Cernavodă NPP projects and the Doicești SMR project. The analysis takes into account both general technological aspects and elements of interaction with environmental components, with a focus on water consumption, cooling water discharge and associated influences on surface water bodies. At the same time, the potential effects on biodiversity are assessed, according to the methodological framework, by reporting to the four main categories of impact: habitat alteration, habitat loss, population reduction and species activity disruption. The approach has an integrated and cumulative character, taking into account the particularities of each objective, but also the strategic context of the development of the nuclear sector at national level.

The impact generated by CANDU reactors

- **Changing the flow/level of watercourses**

To carry out technological processes within the Cernavodă NPP, it is necessary to use water to cool the CANDU reactor, the water being taken from the Danube, through the Danube - Black Sea Canal, the hot water being subsequently discharged back into the river.

Since the Danube can provide the necessary cooling flow, the open-loop operation of the hydrotechnical circuit was envisaged, so the technological requirements cannot support a reduction in the amount of water used for cooling. Therefore, the amount of water taken is equivalent to that discharged, and water losses along the circuit are minimal.

The water is captured through a free-level intake located on a diversion channel of the Danube-Black Sea Canal - branch I, then reaches the NPP distribution basin, from where, after mechanical cleaning in the U1 and U2 Screen Houses and pumping through the U1 and U2 Pump Houses, it ensures the cooling of the turbine condenser in Unit 1 and Unit 2, respectively, as well as of some heat exchangers in the two nuclear units.

The water is returned to the Danube through the warm water channel via the Seimeni canal or, exceptionally, in the Danube - Black Sea Canal, section II. The water flow taken is equal to the discharged flow, the water losses on the circuit being negligible (under normal operating conditions 98% of the Danube water returns to the river). At high Danube levels, the effect of water withdrawal for Cernavodă is not felt.

The consumption of cold water for the technological water circuits is strictly metered. The volumes and water flows are authorised for the operation of the two units in permanent mode 365 days/year and 24 hours/day, according to the Water Management Authorisation in force:

Maximum daily flow = 9,331,200 m^3/day (equivalent to 108,000 l/s)

Maximum annual volume = 3,405,888 thousand m^3

According to the requirement of the Water Management Authorisation, a water requirement is issued annually for the following year. Thus, compared to the maximum volume of water taken provided for in the authorisation, the quantity of water per unit/month and total is estimated, depending on the cooling requirement of the plant.

In conclusion, implementation of the Cernavodă NPP projects provided for in the Strategy will not cause significant changes in the flow or level of the Danube that could affect the species and habitats within ROSCI0022 Canaralele Dunării.

- **Thermal influence of cooling water discharged into the aquatic receptor**

Cooling water from the Cernavodă NPP is discharged into the Old Danube branch, over 3 km from the power plant, through the Seimeni Valley but also exceptionally into the second branch of the Danube-Black Sea Canal.

During the winter, a fraction of the hot water flow (25% ÷ 70%) is discharged into the NPP distribution basin, to prevent the formation of ice (ice cap), with the notification of the National Romanian Waters Administration, the Dobrogea-Litoral Water Basin Administration, without thermally influencing the water in the Diversion Canal and, respectively, the first branch of the Danube - Black Sea Canal.

According to the issued regulatory acts, limits were imposed on the temperature of technological waters discharged into the second branch of the Danube - Black Sea Canal and

into the Danube, respectively into the stilling basin of the Recuperare HPP and into the Danube, in order to prevent an impact on local biodiversity components.

According to the Water Management Authorisation (WMA), the water temperature at the outlet of the power plant must meet the following conditions:

- in the second branch of the Danube - Black Sea Canal, it will be a maximum of 10°C above the water temperature of the first branch of the CDMN, so that the water temperature in this branch, downstream of the canal discharge point, does not exceed 25°C.
- in the Danube, it will be a maximum of 10°C above the water temperature of the Danube River, but not higher than 35°C, after passing through the mixing zone.

The National Institute for Research and Development "Danube Delta" (INCDD Tulcea) carried out in 2010-2011, for the preparation *of the Appropriate Assessment Study of the environmental impact of Units 3 and 4 of the Cern*avodă NPP, a complex study to assess the impact of the discharge of cooling water from the Cernavodă NPP (Units 1-2) on the conservation status of species and natural habitats of Community interest for whose conservation the Natura 2000 sites located in the cooling water discharge area were designated.

Laboratory measurements and analyses of hydrochemical and hydrobiological samples taken during the same periods from the cooling water channel at Cernavodă NPP and from various stations in the Rasova – Capidava sector, respectively field observations were carried out on the Călărași – Hârșova sector. The following conclusions resulted from the field investigations:

- during periods of high Danube levels at Cernavodă (over 200 cm, such as during summer and winter), the waters coming from the cooling water discharge channel of the Cernavodă NPP float on the Danube (without mixing with the river waters) over a distance of approximately 3 – 3.5 km
- during periods of low Danube water levels at Cernavodă (below 200 cm, as occurs in spring and autumn), stratification no longer occurs; the Cernavodă NPP cooling water mixes with Danube water within the first hundred metres downstream of the discharge, and the modified-temperature plume is only 1.5-2 km long;
- the water plume with modified temperatures has a width that varies from 300 m to about 400 m in the discharge area and is reduced to about 50 m near the Seimeni locality;
- Overall, the effect of the thermal gradient of the effluent from the Cernavodă NPP does not present a significant environmental impact, the operation of Units 1 and 2 complying with the Requirements of the Water Management Authorisation which provides, in terms of thermal load, that the temperature of the waters discharged into the Danube will be a maximum of 10°C above the temperature of the Danube River, but not higher than 35°C, after passing through the mixing zone.

The study also concluded that by commissioning Units 3 and 4 of the Cernavodă NPP, changes in the length and width of the water plume with modified temperatures may occur, as follows:

a) the length of the water plume with modified temperatures

- during periods of high Danube levels (summer and winter) the water layer with modified temperatures will probably extend over a length of approximately 4.5 – 6.5

km (depending primarily on the increase in the flow rate of discharged waters and to a lesser extent on the difference between the temperature of the waters coming from the cooling water discharge channel at Cernavodă NPP and the temperature of the Danube waters upstream of the mouth of the cooling water discharge channel at Cernavodă NPP);

- during periods of low Danube levels (autumn and spring) the water plume with modified temperatures will probably have a length of approximately 3 - 3.5 km (depending primarily on the increase in flow, discharged waters and the difference between the temperature of the waters coming from the cooling water discharge channel at Cernavodă NPP and the temperature of the Danube waters upstream of the mouth of the cooling water discharge channel at Cernavodă NPP);

b) the width of the water plume with modified temperatures in the area of the mouth of the cooling water discharge channel at Cernavodă NPP

Due to the doubling of the discharged cooling water flow (from approximately $1^{0}0$ m³ /s to approximately 200 m³ /s), with the entry into operation of Units 3 and 4, it is expected that the width of the hot water plume will increase to approximately 450 m. This phenomenon of expansion of hot water in the first phase of contact with the river water is described in the specialised literature relating to cooling waters from thermal and nuclear power plants.

To determine the effects of temperature on the aquatic biocenosis, toxicity tests were carried out, according to the additions to the Environmental Impact Assessment Report for the project "Continuation of construction and completion works of the Cernavodă NPP - Units 3 and 4", on some biological components that enter the trophic structure of the biocenosis of the aquatic ecological system in the Old Danube branch, represented by primary producers (green algae - *Scenedesmus quadricau*da L., *Chlorella vulgar*is L.) and consumers (fish - *Cyprinus carpio* L.).

Increasing temperature has an effect on primary productivity, in the sense of stimulating it up to a point, a process marked by high values of biomass and chlorophyll "a" followed by a decrease in them after prolonged exposure.

Analysis of the results of acute toxicity tests carried out on fish showed that regardless of whether they are acclimatised to a certain temperature or not, they are sensitive to an increase in temperature to high values, above 35°C. The manifestations generated by thermal shock are similar in the sense that the same manifestations appear for a short period, namely balance disorders, increased respiratory movements, agitation. When analysing the consequences of thermal pollution on fish, the acclimatisation process must be taken into account. The tolerance zone, the temperature range in which fish survive, moves to other values depending on the change in the acclimatisation temperature. It has been experimentally shown that, as the acclimatisation temperature increases, the preferred temperature also increases.

Data sets obtained in campaigns carried out during the operation of Unit 1 at Cernavodă NPP show that in all seasons, along the initial vertical mixing zone, the water temperature increase due to the effluent from a unit becomes less than 3°C in most situations, and the corresponding cross-sectional area is much smaller than a quarter of that of the arm.

The effluent from Units 3 and 4 is similar to that from Units 1 and 2, both in its temperature difference relative to the source water and in its chemical composition. During operation of Units 3 and 4, or simultaneous operation of Units 1, 2, 3 and 4, the temperature

difference between the NPP effluent and the source water is the same as for Unit 1. Following discharge to the Danube, the effluent from four NPP units forms a thermal plume adjacent to the right bank of the Old Danube branch. Temperature increases of 3°C relative to the receiving water extend several kilometres downstream and generally occupy no more than one quarter of the cross-section on the right side of the Old Danube branch. The affected area represents less than 0.5% of ROSCI0022 Canaralele Dunării. This is a small variation compared with natural monthly interannual temperature variations in the lower Danube. Across most of the Old Danube cross-section downstream of the effluent, the natural thermal regime remains unchanged, with temperature changes confined to a narrow strip adjacent to the right bank.

Disturbance of species activities – barrier effect

Regarding migration routes, in Romania, due to its geographical position and varied relief, there are four main migration corridors that cross it: Sarmatic, Pontic, East Elbic and Panono-Bulgar. Dobrogea brings together the East-Elbic, Pontic and Sarmatic corridors during migration periods under the generic name of VIA PONTICA.

To identify the migration routes in the area of influence of the strategy, the data and maps presented in reference works in the field were taken into account (such as "Bird Migration" - Rudescu L., Scientific Publishing House Bucharest; "Dynamics and Mig*ration" "B*irds" - Cioch*ia V., S*cientific and Encyclopedic Publishing House). In the Romanian specialised literature there are very few works that deal with the phenomenon of migration and the migration routes of birds, with strict references to the territory of Romania (Rudescu 1958; Munteanu 1969; Cătuneanu et al. 1978; Maties 1986).

Spring migration is often rapid and is influenced by weather conditions and the birds' pre-nuptial and nuptial activity. In addition to the main migration routes, there are numerous secondary routes, and more local or regional corridors are generally apparent in autumn. Large concentrations of birds occur in Dobrogea and the Danube Delta because the East-Elbian, Pontic and Sarmatian routes converge there. From this area, the East-Elbian routes fan out along a north-west to south-east axis, mainly following the Danube valley between Călărași and Brăila and, farther north, the Prut valley. The Carpathian route, a secondary branch of the East-Elbian route, follows the Siret and its main tributaries across the Eastern Carpathians. The Pontic route follows the longitudinal axis of central Dobrogea from north-north-east to south-south-west, while the Sarmatian and Maritime Sarmatian routes follow the Black Sea coast.

FIGURE 63 - MAIN SPRING MIGRATION ROUTES IN ROMANIA (INCDDD, 2012)

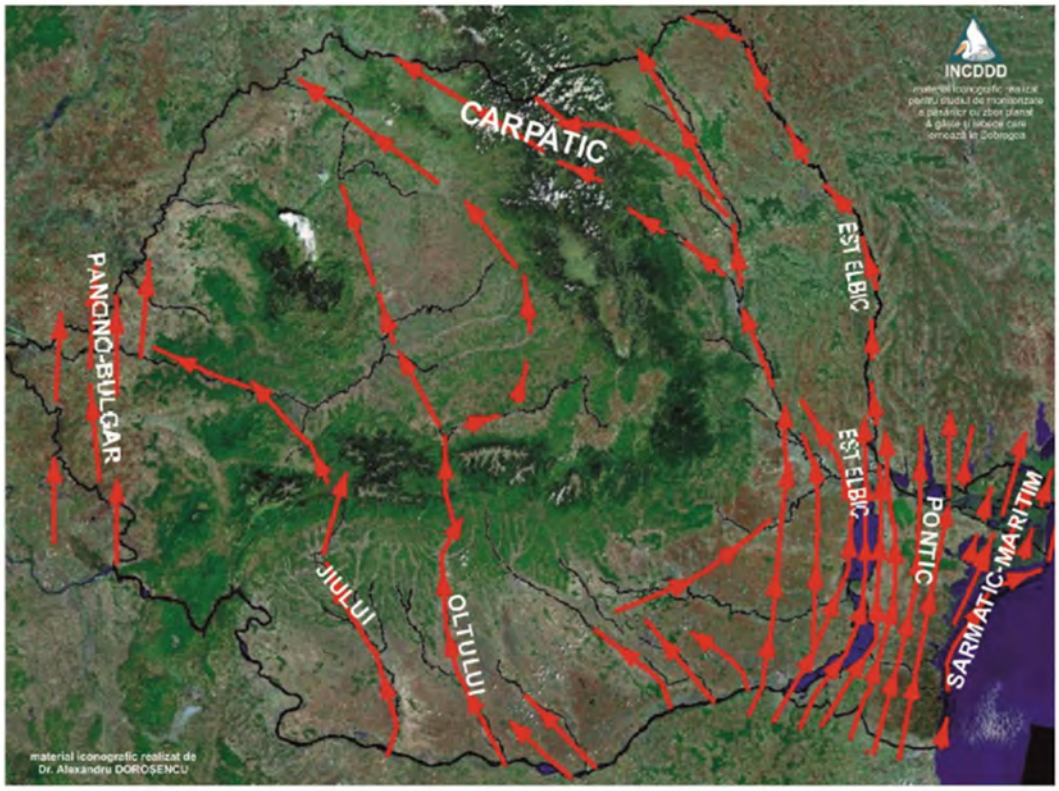
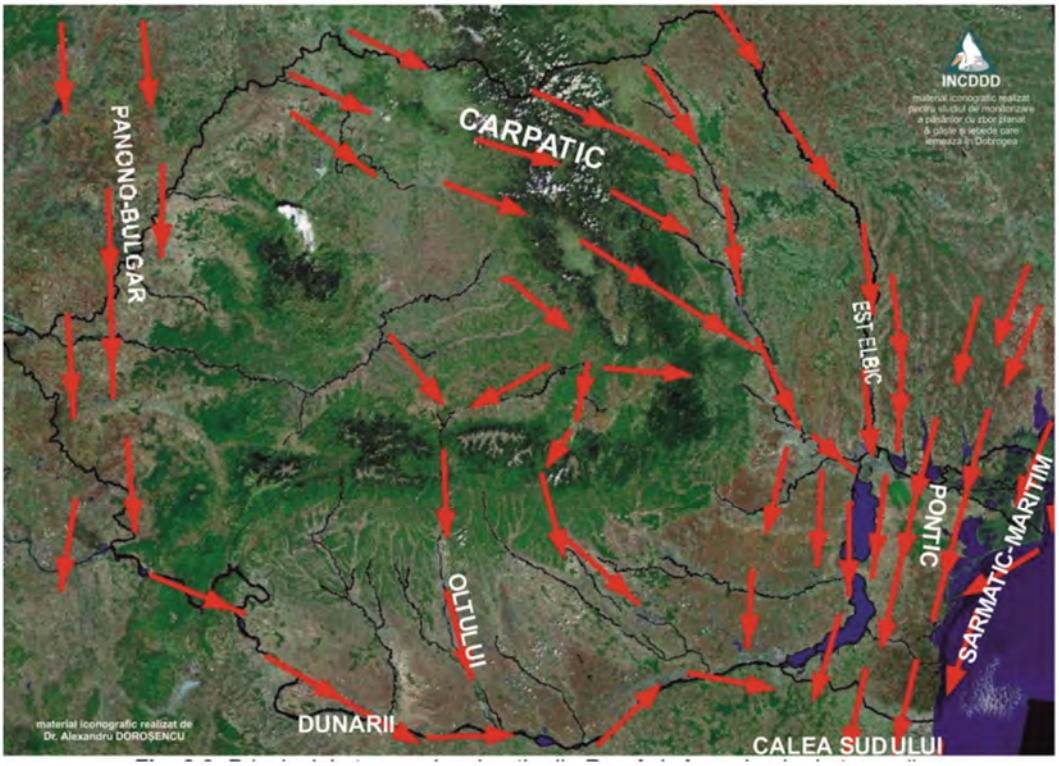


FIGURE 64 - MAIN AUTUMN MIGRATION ROUTES IN ROMANIA (INCDDD, 2012)



A secondary impact of the change in water temperature and local microclimate, due to the discharge of cooling water with a higher temperature than in the Danube, is manifested especially on bird species.

According to the Environmental Impact Assessment Report for the project "Refurbishment of Unit 1 of the Cernavodă NPP and Expansion of the Intermediate Spent Fuel Storage with MACSTOR400 modules" for the area in the vicinity of the effluent discharge into the Old Danube branch, an increase in the annual frequency of fog phenomenon by 10% in the hot water discharge area was estimated, due to one or more units of the NPP. The increase in water temperature occurs in a relatively small area on the right side of the river, so the influence of the effluent on the fog frequency is not significant. After the entry into operation of Units 3 and 4, the conditions for fog occurrence in the effluent discharge area and its frequency will be practically the same, but over a longer sector downstream.

The impact on bird species may consist of decreased visibility, modification of feeding conditions. However, this fog phenomenon is local, temporary, with a low frequency, without creating physical barriers (decreased visibility) and behavioural barriers for bird species.

- **Modification of the physicochemical and radiological parameters of the aquatic receptor**

According to the Environmental Impact Assessment Report for the project "Continuation of construction and completion of Units 3 and 4 at Cernavodă NPP", the discharge of hot effluent into the Old Danube branch does not cause changes in the physical, chemical and biological parameters of the river waters that would generate eutrophication phenomena. Under certain conditions during the warm season, in the second section of the CDMN, water "blooming" phenomena may occur, which are not caused by the presence of the NPP effluent. At the end of the warm season, the state of the waters in the second section of the CDMN returns to normal.

The water quality upstream and downstream of the NPP effluent discharge section is characterised based on the Normative on the classification of surface water quality for the purpose of establishing the ecological status of water bodies, approved by Order 161/2006. In addition to the thermal regime, indicators regarding acidification, oxygen regime, nutrients, salinity and other relevant substances were analysed in the RIM. The values of the physico-chemical indicators determined in campaigns from different periods in sections on the Old Danube branch downstream of Cernavodă are close to those determined in the upstream section (the section of the Danube from the CDMN intake, upstream of the NPP effluent). The values of the water quality indicators are within class II (for physico-chemical indicators) in most cases. Some temporary exceedances are determined by pollution sources in the Danube river basin and are not due to the NPP effluent.

Regarding the influence on the aquatic ecosystem, the analysis carried out within the RIM, which is also based on numerous field data, obtained during the operation of Unit 1, in the most diverse hydrological and meteorological conditions in all seasons of the year, shows that the impact of the Cernavodă NPP effluent manifests itself on a limited area, limited to the right bank of the Old Danube branch, and does not influence the conditions of the aquatic ecosystem as a whole. The influence of the effluent from four units at the Cernavodă NPP does not manifest itself on more than 25% of the cross-sectional area of the stream section and only on a distance of no more than 2-3 km downstream of the discharge section.

As stated in the Environmental Impact Assessment Report for the project "Continuation of construction and completion works of Units 3 and 4 at Cernavodă NPP", the values of chemical, microbiological and biological indicators, determined during the years of operation of Unit 1 under the most diverse seasonal hydrological and meteorological conditions, were located in the same intervals in sections downstream and upstream of the effluent discharge point, or inside and outside the thermal plume in the same cross-section.

The variations in these values are normal fluctuations in the water of the Danube and are not due to the nuclear power plant but to variable sources in the Danube basin. Natural fluctuations in the temperature of the Danube water are frequent, within a few degrees above or below the monthly average. The biocenosis is adapted to such variable conditions of water temperature and water quality.

From a radiological point of view, the water taken from the Danube never comes into contact with the primary circuit (the nuclear part of the power plant).

In general, in CANDU reactors, some of the tritium produced in the heavy water is removed from the heavy water systems to the containment systems and is generally recovered. However, a small proportion is removed outside the containment systems and is considered a routine radioactive release. Radioactive releases are regularly monitored and kept within regulatory limits and reduced to as low as reasonably achievable (ALARA).

According to the Environmental Impact Assessment Report for the project "Construction works of the Cernavodă Tritium Removal Facility", tritium releases in the form of liquid effluents from units 1 and 2 of the Cernavodă NPP do not significantly affect the quality of surface waters in the area of influence of the plant. Also, the results of monitoring of the radioactivity of drinking water and deep groundwater in the area of the Cernavodă NPP site show that they do not present radioactive contamination, which means that the impact of tritium releases from the plant on this type of water is neutral. The amount of liquid effluents produced in the CTRF and discharged into the active drainage system is much lower than the amount of liquid effluents produced in normal operation by the nuclear units and consequently the radiological impact is lower. By applying the detritiation process, it is anticipated that the tritium emissions in liquid effluents from the Cernavodă NPP site will gradually decrease, which will lead to a corresponding decrease in the radiological impact of the plant's activities on the water environment. Thus, it can be considered that the radiological impact on the water environment, due to the operation of the CTRF, as the ALARA measure to reduce tritium releases in the form of liquid effluents from units 1 and 2, is positive, direct, reversible, local and long-term.

According *to the Report on the results of monitoring the effects on the environment following the implementation of the National Medium and Long-Term Strategy on the safe management of spent nuclear fuel and radioactive waste, I***n** 2023, surface water radioactivity monitoring was carried out within the Standard Programme and surveillance programmes in areas with anthropogenically modified natural background, covering the main water bodies in the area of influence of the Cernavodă NPP, such as the Danube, the spillways, the Danube–Black Sea Canal, lakes and other watercourses of interest. Samples were taken with daily, weekly or monthly frequencies, depending on the location, and were subjected to global beta, gamma spectrometric and tritium determinations.

The results of global beta measurements for surface water were, throughout the year, well below the warning limit of 2 Bq/l provided by OM no. 1978/2010. The maximum values recorded were of the order of 0.6 Bq/l, both in samples collected from the Danube and in those from the discharge channels, without exceeding the regulated thresholds.

Gamma spectrometric analyses mainly revealed the presence of natural radionuclides, especially K-40, which had a significant contribution to the total radioactivity of the samples, with variable values depending on the type of water body and season. The presence of the artificial radionuclide Cs-137 was identified sporadically, in very low concentrations, being attributed to the remanence in soil and sediments of radionuclides originating from the Chernobyl accident, without indicating current sources of contamination.

Tritium determinations showed higher variability, especially in the Cernavodă area, the spillways and the Danube–Black Sea Canal. Maximum values of the volumetric concentration were recorded punctually, especially at Seimeni and Saligny, but their interpretation is made in the context of the hydrological regime, controlled discharges and intensive monitoring carried out in 2023. In Baciu and Domneasca lakes, tritium concentrations were moderate and comparable to the values observed in other surface water bodies in the area.

Overall, the data obtained in 2023 indicate that surface water radioactivity remains at low levels, comparable to those in previous years, without exceeding warning limits and without highlighting significant environmental impacts.

- **Radiological impact on flora and fauna**

From the point of view of assessing the radiological impact on biocenoses, studies carried out to monitor and assess the radiation exposure of some species of aquatic and terrestrial organisms have shown that the estimated doses for endemic fish species do not exceed 12 microGy/year, being mainly due to tritium and C-14, radionuclides originating from the operation of the Cernavodă NPP, but also K-40 and Cs-137, whose presence in the environment at the present concentration levels cannot be linked to the activity of the Cernavodă NPP. The terrestrial organisms for which exposure assessments were carried out were the field mouse and the deer, for which the estimated absorbed doses were lower than 10 microGy/year. Compared to the reference levels recommended by the Canadian Nuclear Safety Commission, the releases of radioactivity into the environment at the Cernavodă NPP are still far from producing detectable effects on the biocenoses in the area of influence.

Since the area surrounding the Cernavodă NPP site is heavily anthropised, biodiversity is monitored, especially regarding agricultural ecosystem elements. The only elements of natural ecosystems, susceptible to being affected by the Cernavodă NPP activities, that are systematically monitored are spontaneous vegetation and fish from the Danube.

The analyses for determining the activity concentration of gamma-emitting radionuclides did not reveal the presence of anthropogenic radionuclides specific to the Cernavodă NPP at the level of biodiversity in the area of influence, these being at the level of the natural background. The only radionuclide originating from the operation of the plant, which can be detected outside the Cernavodă NPP site, is tritium. The analyses showed that the impact of the presence of tritium on the flora and fauna in the habitats present around the Cernavodă NPP, at the levels induced by the emissions from the plant, is insignificant, the estimated dose values being an order of magnitude lower than the reference levels.

Considering the implementation of the CTRF project, whose objective is to reduce the tritium inventory in the active circuits of the plant and, implicitly, reduce radioactive emissions into the environment, the cumulative radiological impact of the operation of the nuclear units and the CTRF on biodiversity in the area of at least 30 km around the Cernavodă NPP is assessed as negligible.

According *to the Report on the results of monitoring the effects on the environment following the implementation of the National Medium and Long-Term Strategy on the safe management of spent nuclear fuel and radioactive waste, I*n 2023, radioactivity monitoring in spontaneous vegetation was carried out within the Standard Programme, the Special Monitoring Programmes and the Cernavodă NPP Operation Supervision Programme, through sampling carried out with weekly, semi-annual or annual frequencies, depending on the location. The samples were analysed by global beta measurements, gamma spectrometric analyses and, for some locations, tritium and C-14 determinations, the results being reported in Bq/kg green mass.

The values of the specific global beta activity in the spontaneous vegetation samples were generally significant and varied within a wide range, reflecting the natural processes of radionuclide accumulation in the soil and atmosphere. In the Constanța and Cernavodă areas, the values were predominantly between approximately 110 and 445 Bq/kg green mass, with annual maxima recorded in the summer period, without indicating anomalies compared to the known distributions at regional level. In the area of influence of the Cernavodă NPP, the global beta activities presented higher values at specific points, the maxima being correlated with the local characteristics of the soil, the type of vegetation and the meteorological conditions.

Gamma spectrometric analyses consistently revealed the presence of the natural radionuclides K-40 and Be-7, which made the major contribution to the total radioactivity of the samples. K-40, of terrestrial origin, was identified in all samples, with variable concentrations, determined by its migration from the soil to plants through root absorption. Be-7, of cosmogenic origin, was present in all analysed samples, its accumulation being attributed to direct deposition on the aerial surface of plants. The values recorded for these radionuclides fall within the variation ranges considered normal for spontaneous vegetation.

Artificial radionuclides were only sporadically identified. Cs-137 was detected punctually, in very low concentrations, both within special programmes and in some locations in the coastal area, its presence being attributed to the persistence in the soil of long-lived radionuclides from historical contaminations (the Chernobyl accident), without indicating current sources of contamination. Artificial radionuclides were not identified in most of the analysed samples.

Tritium and C-14 determinations carried out within the Cernavodă NPP laboratory revealed values comparable to those reported internationally for similar vegetation samples, without significant deviations from the natural background.

Overall, the results obtained in 2023 indicate that the radioactivity of spontaneous vegetation is dominated by natural radionuclides, and the measured levels are comparable to those in previous years and to background values, with no significant radiological impacts on the terrestrial environment being highlighted.

Regarding aquatic biota, 8 fish samples taken from the Danube, lakes and fish farms (Domneasca and Baciu) were analysed in 2023. The natural radionuclide K-40 was identified

in all fish samples, confirming the dominant contribution of the natural background. The average gross beta activity as well as tritium determinations indicated low average values. Variable values were recorded for C-14, but within ranges reported internationally for similar samples, without signals indicating unusual accumulations.

The impact generated by SMR reactors

Small Modular Reactors (SMRs) represent a promising advancement in nuclear power, offering a smaller footprint, enhanced safety features, and greater flexibility compared to traditional large nuclear power plants. One of the critical considerations for any power generation technology, including SMRs, is the implications for water consumption.

Water is essential to various aspects of the operation of a nuclear power plant. It is mainly used for cooling, a vital process for removing the heat generated by nuclear fission and preventing the core from overheating. The secondary circuit uses water to produce steam to drive turbines and generate electricity.

Water consumption of SMRs is a critical factor, especially in regions facing water scarcity and the effects of climate change. The amount of water consumed by SMRs can vary depending on the reactor design, cooling technology, and local environmental conditions. Some SMR designs use once-through cooling systems, which draw large volumes of water from a nearby source (such as a river or lake), use it for cooling, and then discharge it back to the same source, possibly at a higher temperature. Other designs use closed-loop cooling systems, which recirculate water and use cooling towers or air-cooled condensers to dissipate heat, resulting in lower overall water consumption but higher energy consumption for cooling.

In the case of the SMR Reactor, this will be a modular Pressurised Water Reactor (PWR) using light water as both a moderator and coolant. The project is in the FEED 2 phase, being at the early stages of engineering and planning. Details regarding the water supply source have not yet been determined.

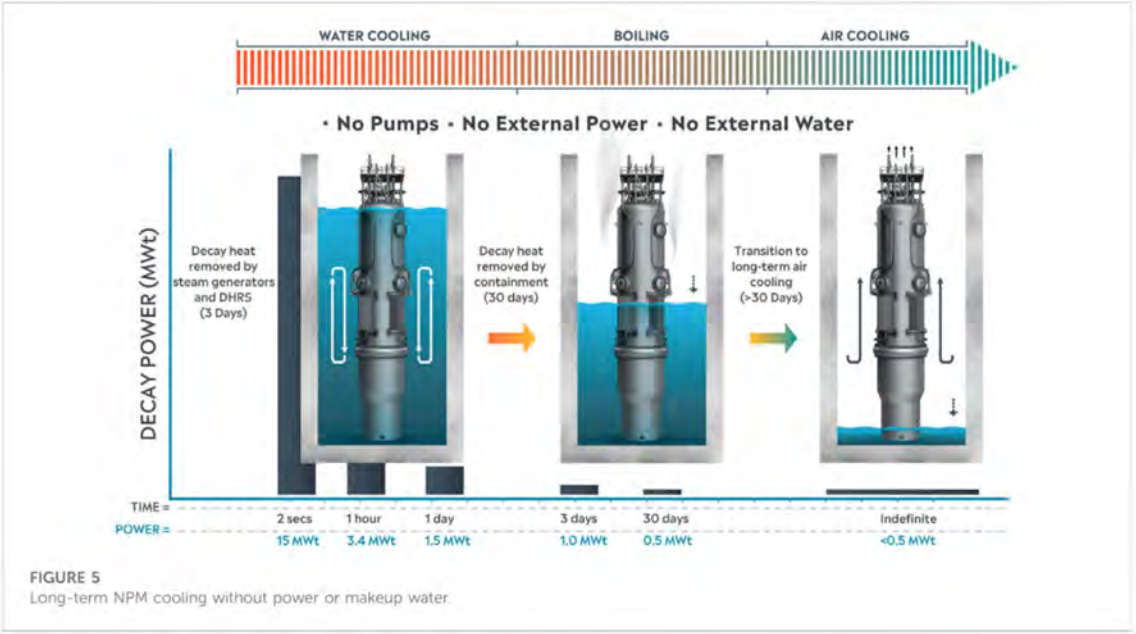
Given that the SMR plant uses a simplified small modular reactor (SMR), based on established light water reactor technology, but with substantial improvements in terms of nuclear safety, it is estimated that the impact on water bodies will be reduced, due to the possibility of optimising the cooling systems and control of the discharged water temperature, as well as the continuous monitoring of water quality parameters in accordance with the requirements of applicable environmental regulations.

The technology involves using water to cool the reactor through a passive system, in which an integrated pressure vessel submerged in a water cooling pool allows heat dissipation without relying on external pumps or large water sources on a continuous basis. The pool functions as a guaranteed source of cooling, with the capacity to absorb all the waste heat produced by all reactors for a period of over 30 days. The pool, together with auxiliary cooling and purification systems, prevents fuel failure, helps to evacuate heat from the primary system and represents the shielding environment for the spent fuel stored in it.

The circulation of the coolant is achieved through the physical principle of the density difference (natural convection) between the water that takes up the heat from the reactor core and releases it through the steam generator to the secondary circuit.

The potential impact on nearby water bodies will be assessed as part of environmental studies, to ensure compliance with thermal and chemical limits, as well as the protection of local ecosystems.

FIGURE 65- *EXAMPLE OF THE COOLING SYSTEM FOR SMALL MODULAR REACTORS (UNIQUE SAFETY FEATURES AND LICENSING REQUIREMENTS OF THE NUSCALE SMALL MODULAR REACTOR, WELTER ET AL., 2023)*



The impact on aquatic habitats and species is generally lower in SMRs than in a conventional CANDU reactor, as SMRs require a much lower water flow rate. Most reactors have closed cooling systems, which greatly reduces direct contact with natural ecosystems, and the volume of water and thermal energy transferred to the environment are much lower.

Thus, for small modular reactors (SMRs) the impact on water bodies is generated by the cooling activities necessary for the operation of the reactor.

Measures will be taken, both technical, through design and organisational, so that the legal requirements of the regulatory acts issued for the project are respected and there is no significant impact on water bodies, thus ensuring the protection of aquatic ecosystems and compliance with applicable environmental requirements. Any change in the physico-chemical properties of the water will be continuously monitored to prevent significant effects on aquatic ecosystems.

In the case of SMR reactors, the robust design, reduced fuel inventory and multiple barriers to fission product release contribute to a low probability and consequence of radionuclide release even under extreme accident conditions. This simplifies emergency preparedness and response requirements and creates the basis for reducing the exclusion zone (EPZ) at the site boundary.

The reduced radiological impact is an argument in favour of installing SMRs closer to populated areas or industrial agglomerations. The advantages of the SMR concept, such as the comprehensive use of passive safety elements, the desire to simplify the design and increase flexibility, combine naturally with the safety and economic objectives that the next generation of nuclear systems proposes.

Non-power nuclear activities (research)

During the operation period, the only environmental impact in the case of research activities is related to the management of radioactive waste and the generation of radiation.

Radioactive waste specific to research activities (activated components and targets associated with high-power laser radiation, or lead from the ALFRED demonstrator) will be collected, treated and temporarily stored in authorised areas within the research organisations, and subsequently disposed of at the IFIN-HH National Radioactive Waste Repository at Băița, Bihor County.

For research activities on the IFIN-HH platform, depending on the contact dose-equivalent rate and contamination potential, activated components and other active materials such as targets will be stored using radiation shielding and/or suitably shielded, sealed containers to prevent the spread of contamination. After prolonged operation, a certain level of radioactivity, mainly from short-lived radionuclides, is also induced in radiation shields and especially in high-energy particle-beam stopping systems (beam dumps). All materials classified as radioactive waste on the basis of their radionuclide concentrations will be managed by IFIN-HH in accordance with its own procedures.

ELI-NP is equipped with a special space for the storage of this waste, where it is temporarily stored until it reaches a level of activity that allows its processing at the Radioactive Waste Treatment Plant. The final disposal of low and medium-level waste resulting from ionising radiation applications is carried out in the National Radioactive Waste Repository, located in Băița Bihor, and managed by IFIN-HH, being an objective of national importance in the safe management of short-lived radioactive waste. Thus, the impact generated by the management of radioactive waste will be insignificant.

While in the projects associated with the ELI-NP objective the generation of radioactive waste is limited to small volumes, resulting from experimental activities and the use of radioactive isotopes for medical purposes, the Alfred project represents a special case in terms of radioactive waste management. The particularity derives from the use of liquid lead as a coolant, which in addition to ordinary radioactive waste, can itself become a radioactive contaminated material (it can retain radionuclides resulting from fission), requiring specific solutions for treatment, conditioning and long-term storage.

The lead-cooled fast reactor (the objective of the ALFRED project) is one of the most promising technologies, due to the favourable characteristics of lead as a coolant. However, the radiotoxicity of lead is high, due to the fission products and the retained activation products. The lead used as a coolant in the reactor is not radioactive in itself, but during operation it can be contaminated by exposure to neutrons and by contact with structural materials or fuel. Thus, at the end of the life of the facility or during maintenance operations, the resulting lead can become contaminated radioactive waste and is managed through a rigorous cycle of recovery, decontamination, conditioning and final disposal, according to the standards of the International Atomic Energy Agency (IAEA) and European legislation.

Radiation generation

In the ALFRED demonstrator, as in any nuclear system, a neutron field and a gamma radiation field are generated in the reactor during normal operation due to the stable fission

reaction. This radiation field, in addition to representing a potential source of radiation in itself, is responsible for the activation of materials such as fuel, structures and coolant, which in turn become secondary sources of radiation. Against all these sources of radiation, measures must be applied to protect the environment and the population in the vicinity of the facility. This need is reflected in national regulations regulating the maximum permissible doses for all categories of workers at a nuclear facility and for people in the surrounding areas.

For ALFRED, the main objective for radiation protection reflects one of the IAEA basic safety principles for nuclear power plants, the ALARA principle. The ALFRED objective, therefore, is based on the ALARA concept which aims to promote the application of all reasonable measures that can contribute to the reduction of radiation exposure, regardless of whether the regulatory limit has already been targeted and the minimum protection guaranteed. Therefore, the proper application of the ALARA concept, which is an integral part of all international best practices in the field of radiation protection, extends the protection of people and the environment.

Among the lines of protection included in the ALFRED design, there are several physical/mechanical and non-mechanical barriers to prevent the release of fission products. The engineered ones are passive physical solutions, which mechanically confine the radioactive material in successive locations, from the innermost to the outermost. The non-engineered barriers are inherent capabilities of the materials, which physically/chemically retain the radionuclides from further dispersion in the system.

All radiation generated by the ELI-NP research infrastructure is generated only as long as the generation systems are powered by electricity, which distinguishes this type of infrastructure from critical nuclear fission reactors. The induced radioactivity formed mainly by short-lived radionuclides is reduced to the minimum possible by the appropriate choice of materials from which the reaction chambers, beamdumps and protective screens are constructed.

The research activities carried out on site, inside the experimental chambers, will result in air loaded with short-lived radionuclides. The air from the experimental areas is directed only to the filtration areas and then to the exhaust stack. The air ventilation system in the experimental areas will include several stages of filtration (activated carbon filters and high-efficiency HEPA filters), before exhausting to the stack.

Through the operation of the research infrastructure, taking into account all emissions, it is estimated that the dose constraint level established by CNCAN for radiological and nuclear activities on the site will not be exceeded.

In the long term, the ALFRED (Advanced Lead Fast Reactor European Demonstrator) and ELI-NP (Extreme Light Infrastructure – Nuclear-Physics) projects are strategic initiatives for Romania and Europe, with long-term impact in energy, science and innovation.

ALFRED defines its mission as twofold: 1. to demonstrate LFR technology and 2. to serve as a prototype for a commercial lead-cooled fast neutron SMR reactor.

The ALFRED concept can help demonstrate the capabilities of LFRs to greatly reduce the need for natural resources, both by substantially extending their efficient use in the reactor (more energy produced per unit of fuel) and by implementing a closed fuel cycle in which all the feedstock with potential for energy generation (90% of the burned fuel) is recovered, thus saving an equal amount of resources. LFRs are also capable of operating with depleted or

recovered uranium, so the availability of the deposits accumulating in Europe represents an opportunity to eliminate the need for natural resources for tens of thousands of years, at the capacity of the current nuclear generation. Furthermore, LFRs are the most credible option for intensive burning of long-lived components from the waste resulting from the operation of nuclear reactors. There will be a major impact on reducing radiotoxicity, because with this approach it is possible to restore the level of ores in a few hundred years, instead of a few hundred thousand, as would be needed with current technology.

Among the fast-spectrum variants that could be put into operation in the SMR sector, which could take advantage of the benefits of a closed fuel cycle as an additional advantage, LFRs seem to be promising candidates. The possibilities offered by the inherent properties of lead used as a coolant allow for a very safe design (as required by any SMR to allow the grouping of several units and their location close to the end users) with simple technical solutions, therefore robust, safe and cheap: all of which are essential to allow the exploitation of the full potential of the SMR philosophy. In fact, the market opportunities for safe and competitive nuclear systems in the SMR segment have directed the efforts made at European level in the LFR field towards the idea of a lead-cooled SMR.

In this context, ALFRED is designed to meet all requirements for deploying a first wave of lead-cooled SMRs and to serve as an experimental platform for new solutions to be implemented in the subsequent fleet of new systems. Two key ALFRED demonstrator criteria are the representativeness of its power and size - ALFRED will be designed at a power level and with dimensions representative of a commercial fleet of lead-cooled SMRs - and, to the extent possible, the implementation of robust and highly available technical options, favouring alternatives that can be implemented or applied with minimal additional R&D and qualification effort where performance is not affected. In practical terms, this means aligning the principal design parameters and many plant-level choices with the strategic direction of the lead-cooled SMR concept.

In the long term, the ALFRED project is an opportunity for the nuclear industry to use existing experience and move forward in the field of innovative Generation IV systems. A success of the ALFRED project will be a success for the future nuclear industry. Moreover, addressing the objectives of achieving small modular systems (SMR), a secondary objective of the ALFRED demonstrator, will contribute in a broad way to the development of new approaches characterised by modularisation, standardisation, serial manufacturing of components, the realisation of large components in factories and their transportation to sites, updating and modernising industrial codes and standards, etc. An important impact will be produced by the technological transfer from research-development-innovation to industry, for example through new innovative materials and components, through high-performance manufacturing technologies.

As a nuclear facility intended to realise the Generation IV vision, safety is embedded in the ALFRED design and is intrinsic to the concept itself. This approach is common to Generation IV candidate systems; however, LFRs, including ALFRED, benefit greatly from the inherent properties of lead, which provide designers with new options and considerable flexibility in the design approach.

Pure lead as a coolant is chemically inert compared to sodium and, furthermore, is preferable in terms of safety due to substantially lower radiological considerations, particularly

with respect to Polonium-210. One of the advantages of using lead in a fast reactor is that lead retains radionuclides such as iodine and caesium, even in the event of a severe accident involving reactor vessel failure, reactor building failure, and exposure of coolant to the atmosphere.

Radioactive waste disposal activities

During the operation of the repositories, the activities that may constitute sources of pollution are mainly the transport activities of radioactive waste which may generate emissions of atmospheric pollutants and dust, accidental leaks of fuels, automotive lubricants. These can infiltrate into the soil, water bodies and the geological environment, leading to their loading with pollutants. Pollutants generated: particulate emissions from diesel engines, NOx, SOx, CO, particles, VOCs and various other hazardous atmospheric pollutants, including benzene.

No radioactive gaseous and aerosol emissions into the atmosphere are expected under normal operating conditions. During the operation of the repositories only gas emissions from transport are expected. On the site of the depots and in the surrounding areas, air monitoring will be carried out permanently based on radioactive emissions monitoring programmes.

Potential air pollution may also occur under exceptional, accidental conditions, due to: the destruction of protection systems in the event of natural disasters that exceed the level of protection provided by design or inadvertent actions on site; failure to comply with the environmental protection conditions imposed by the project; incidents during radioactive waste package handling operations; the occurrence of fires; the destruction of protection systems in the event of unauthorised interventions, sabotage or armed attacks.

During the operation of the radioactive waste repositories under normal operating conditions, there will be no pollution of the soil-subsoil environment, as multi-barrier protection systems are provided from the design stage. It is unlikely that there will be any pollution of the soil and subsoil due to the activities associated with the projects.

Potential pollution of groundwater and surface water may be due to the occurrence of exceptional, accidental operating conditions: malfunctions/accidents in the water pipeline system from the storage cells, potentially contaminated; malfunctions of the facilities for collecting possible infiltrations; malfunctions of the wastewater transport and treatment systems; accidental destruction of the storage waterproofing; destruction of protection systems in the event of cataclysms that exceed the level of protection provided by the projects, unauthorised human actions or inadvertent actions on the site; destruction of protection systems in the event of armed attacks or sabotage; malfunctions or improper operation of the facility for detecting radioactive water; leaks of potentially radioactively contaminated water from the collection tanks; accidents when transferring potentially radioactively contaminated water in specialised trucks and during transport to a liquid radioactive waste treatment station; exceptional hydrometeorological conditions.

As a result of the operation of the deposits, 3 types of wastewater will result: stormwater, domestic water and potentially contaminated stormwater. Wastewater discharges will mainly come from the collection and discharge basin. The potential pollution of the Danube River with radioactively loaded wastewater from the DFDSMA, a situation that would

also generate a transboundary impact on the riparian states of the Danube River, located downstream of the river's flow direction, can only occur as a result of accidents or serious damage to the foundations of the deposits.

The simulation of the transport of the main contaminants from the waste to be disposed of at DFDSMA in the geological layers below the repository demonstrates that, due to the hydrogeological characteristics of the Saligny site, the loess and clay layers act as a very effective natural barrier against the release of radionuclides into the main aquifer of the site. The radionuclides considered in this analysis do not reach the aquifer at concentrations higher than the accepted limits for drinking water.

Based on the results of simulation studies on the behaviour of radioactive contaminants in the waste to be disposed of at DFDSMA, it can be mentioned, by analogy, that for the deep geological repository – given the strict site selection criteria, in particular the geological ones regarding the effectiveness of the natural barrier – radionuclides will not migrate through the host rock to the aquifers at high concentrations. This conclusion is based on the operating principle of the multi-barrier system, which combines the geological barrier with the engineering barriers, ensuring long-term isolation of radioactive waste and limiting the risk of contamination of water resources and, implicitly, of natural habitats and species of Community interest.

The deep geological repository (DGA) is internationally recognised as the most robust and long-term technical solution for isolating radioactive waste from the environment and the population.

A deep geological repository may be described as a system of galleries located at depths of hundreds of metres in a stable geological environment, in which radioactive-waste packages are emplaced within an appropriate engineered-barrier system.

The geological formation in which the waste is stored, generally referred to as the "host rock", generally constitutes the most important containment barrier. The various barriers act in concert, initially to retain the radionuclides, then to ensure their safe decay, and finally to limit their release into the accessible environment. A combination of natural (geological) and engineered barriers constitutes the "multi-barrier" system of the DGA.

The final disposal of long-lived radioactive waste in a geological repository is the solution accepted by all countries facing this problem. Moreover, this solution is practically the only option according to the IAEA Fundamental Safety Principles and in line with the principle of sustainable development.

There is a broad consensus, however, that most disposal concepts cannot completely isolate the long-lived radionuclides present in the waste. Consequently, in the very long term, the main functions of the geological disposal system are to delay and limit the escape of radionuclides from the progressively degrading engineered barrier system into the geological environment and eventually into the biosphere.

The final disposal of long-lived radioactive waste in a geological repository is the solution accepted by all countries that have this problem.

Geological formations suitable for waste disposal exist throughout the world. They can vary greatly in nature and can therefore provide the desired characteristics in different combinations and to different extents.

Typically, corresponding formations can be found in:

a. rocks with very low permeability in which water flow is essentially excluded;

b. massive deposits of impermeable plastic rocks;

c. deep groundwater systems that have not exhibited advection flows for periods of hundreds of thousands of years or more.

d. groundwater systems that have combined flows with transport pathways from the storage area to accessible groundwater systems or to the biosphere.

Criteria for selecting candidate sites

Due to the local specificity of factors and processes, only general criteria can be established for choosing the location of a geological repository, taking into account long-term security, technical feasibility and social, economic and environmental requirements.

A. Geological environment

In the barrier system, the natural barrier is essential, and it is necessary to establish requirements for the geological environment: the site must be well characterised, with properties that limit the migration of radionuclides; the host rock must have sufficient depth and dimensions, preferably be homogeneous, with mechanical, thermal and gas migration properties adequate for the safety of the construction, operation and long-term stability of the repository.

B. Future geological changes. The host rock must not be affected by geodynamic or climatic phenomena (seismicity, volcanism, diapirism or glacial cycles) that could degrade the containment capability of the repository or alter groundwater flow rates and directions.

C. Hydrogeology

• The hydrogeological characteristics and geological environment must prevent groundwater flow into the repository and allow the waste to be isolated for the prescribed period of time.

• Evaluation of the groundwater movement mechanism and analysis of the direction and speed of

flow, will be important arguments for nuclear safety assessments in any site, the most plausible mode of transport of radionuclides being through the aquifer environment.

consequences, from a hydrogeological point of view, generated by the location of the final radioactive waste repository (thermal and radiation effects, increase in hydraulic conductivity due to mining activity, etc.) will be taken into account.

D. Geochemistry

• The geological and hydrogeological environment must prevent the release of radionuclides into the environment.

• Choosing a host rock with good geochemical properties and high retention capacity is essential for long-term security.

• The migration of radionuclides is controlled by processes such as dispersion, diffusion, precipitation, adsorption, ion exchange, and chemical reactions.

E. Events resulting from human activities

• The location must be chosen so that human activities do not affect the security of the repository.

• Avoid areas with resources (oil, gas, minerals, geothermal energy) to reduce the risk of human intrusion.
• Existing boreholes and excavations must be identified and sealed to prevent radionuclides migration.
• Flood risk must be carefully analysed, preferring areas with minimal flood impact.

F. Construction and technical conditions

• The location must allow for the safe design and construction of facilities, according to mining regulations.
• Excavation work must be planned so as not to interfere with waste disposal.
• Excavations must be carried out without creating migration paths; the extracted material can be reused or stored in a controlled manner.
• The landfill should be located at great depth, with minimal surface restrictions, avoiding areas at risk of landslides or flooding.

G. Waste transportation

• The site must be located so that the radiation exposure of the population and the environmental impact of transporting waste to the site are within acceptable limits.
• Transporting radioactive waste to geological disposal involves exposure of the population to ionising radiation, consumes fuel, and releases combustion products into the atmosphere. These impacts will increase with the distance over which the waste is transported.

H. Environmental protection

• The location must be chosen so that the environmental impact is minimal and acceptable.
• The landfill must comply with all environmental protection regulations.
• Possible adverse effects: environmental degradation through works, impact on the population, damage to water sources and flora and fauna.

I. Land use

• In choosing the appropriate location, land use and ownership must be considered in relation to the perspective of future development and regional projects in the area of interest.

J. Social impact

• The location must be chosen so that the social impact is acceptable, maximising benefits and minimising adverse effects.
• Areas with adequate infrastructure that can support economic development are preferred.
• Activities should avoid densely populated areas.

METHODOLOGY FOR SELECTING HOST FORMATIONS FOR DEEP GEOLOGICAL REPOSITORY

The selection criteria used in scientific studies in the ANDR database to inventory and rank favourable geological formations were:

1. Exclusion criteria

- Seismicity zones (where the formation is located in a major seismic zone, A, B or C, according to P100/92);
- Current accentuated vertical movements (if the massif is affected by major, active faults and is structurally inhomogeneous);
- Host-rock depth greater than 500 m and minimum area of <1.5 km² for salt and <50 km² for granite and crystalline rocks;
- Geological structure with risk of hazard, volcanic activity;
- Socio-economic reasons;

Environmental protection reasons (if the site is located in a National Park or is declared a Protected Area);

- Land ownership issues.

2. Selection criteria

✓ Identification of regions with favourable conditions; their ranking;

✓ Identification of smaller areas for future investigations and their prioritisation;

✓ Identification of surface geological conditions;

✓ Establishing areas for detailed research;

✓ Existence of favourable access conditions (CFR, roads) and distance from the Cernavodă NPP;

✓ Availability of human resources for the project.

3. Geological-geotechnical criteria for selecting DGA

• effectiveness of the geological barrier:
• the thickness of the rocks;
• rock homogeneity (degree of compaction, porosity, mechanical deformations);
• hydrogeology (conductivity, cracks-fractures-pores, karst circulation);

protective rocks in the roof;

• the self-sealing capacity of the host rocks;
• geochemical and mineralogical conditions.
• stability of the geological barrier over time:
• neotectonic movements, geodynamic processes;
• self-sealing capacity of rocks;
• karst;
• the extent of erosion over time.

4. Geotechnical conditions in underground works

• homogeneity, rock hardness, deformations, risk of gallery collapse.

5. Local and regional durability and sustainability

potential social, economic and cultural effects during the DGA implementation phase;

• local and regional development (improving the quality of life);

• adaptability of the physical and social infrastructure to changes resulting from implementation of the DGA.

Generic parameters include repository depth, porosity, low permeability, the geological environment above and below the repository site, tectonic stability and natural resources.

During decommissioning of the Strategy projects

Decommissioning of nuclear facilities represents the last stage of the life cycle of a nuclear facility, a process by which a facility is permanently decommissioned and the site is restored to a safe, stable and compatible state for subsequent conventional uses. This stage has as its main objective the elimination of any radiological risk for the population and the environment, through a set of technical, administrative and monitoring activities carried out under the control of the competent national authority – the National Commission for the Control of Nuclear Activities (CNCAN).

Under CNCAN Order No. 102/2022 approving the Regulation on Safety Requirements for the Decommissioning of Nuclear and Radiological Facilities, the decommissioning process must be planned, authorised and carried out so as to maintain nuclear safety, radiological protection and environmental protection throughout the relevant activities. The Order establishes the general authorisation requirements, the responsibilities of the licence holder and the basic principles for planning and implementing decommissioning measures.

The facility licence holder must prepare and keep up to date a Decommissioning Plan from the construction phase of the nuclear facility onwards. The document must describe the stages of the process, the technologies used for dismantling, the methods for managing radioactive and conventional waste, the measures for protecting workers and the public, and the actions required to restore the site after completion of the works. The Decommissioning Plan is reviewed at least every five years and whenever major changes occur in the facility configuration or regulatory requirements.

Throughout the decommissioning process, the licence holder must ensure continuous environmental monitoring, control of exposure doses, traceability of the resulting materials and waste, and implementation of measures to reduce effects on environmental components. Decommissioning is carried out in stages and only on the basis of prior CNCAN authorisation, after compliance with nuclear and radiological safety requirements has been demonstrated.

In the context of the implementation of the National Strategy for Sustainable Development of the nuclear sector (SNDDN), compliance with the provisions of CNCAN Order No. 102/2022 ensures a safe, controlled and sustainable transition from the operation of nuclear facilities to their closure and rehabilitation, thus contributing to environmental protection and strengthening institutional responsibility in the field of nuclear safety.

To date, SNN Cernavodă NPP has developed, in accordance with regulatory requirements, the Preliminary Decommissioning Plan for the facilities in operation, namely:

the two nuclear power units (U1 and U2), the Interim Spent Fuel Storage Facility (DICA) and the Interim Solid Radioactive Waste Storage Facility (DIDSR).

This plan presents, at strategic level, the selected options for decommissioning the nuclear facilities at the Cernavodă NPP site and the steps required for their implementation, depending on the availability of the two final disposal facilities to be developed by ANDR: the Final Repository for Short-Lived Low- and Intermediate-Level Radioactive Waste (DFDSMA) and the Deep Geological Repository (DGA) for spent nuclear fuel and long-lived radioactive waste.

Radioactive waste generated by decommissioning will be disposed of in the DFDSMA or, where it contains long-lived radionuclides, in the DGA. Materials arising from dismantling facilities and buildings in the nuclear area that are found, following radiological monitoring, to be free of radioactive contamination, or whose contamination is below clearance levels, will be recycled or disposed of as conventional waste after release from CNCAN regulatory control.

From the point of view of the radiological impact on the environment, the activities carried out during the implementation period of the decommissioning project will be carried out in compliance with the requirements established in the specific authorisations for this phase, and at the end of the activities, any radioactive contamination on the site of the former nuclear facilities will be reduced to a level that allows for release from its authorisation regime. In accordance with the provisions of the current law (Law No. 292/2018), the decommissioning of nuclear power plants requires the environmental impact assessment procedure, which is completed with the decision to issue the Environmental Agreement by the environmental authority.

CONCLUSIONS OF THE APPROPRIATE ASSESSMENT STUDY

The national strategy for the development of the nuclear sector in Romania is compatible with environmental protection objectives and with maintaining the integrity of protected natural areas, taking into account the implementation of the measures proposed when carrying out detailed assessments at plan/project level (RM/RIM/EA).

This strategic document, accompanied by the "National Nuclear Programme", establishes the framework for the development of the nuclear sector in Romania, including the modernisation of nuclear infrastructure, the expansion of capacities, the rehabilitation of existing facilities, and the responsible management of spent fuel and radioactive waste.

The SNDDN is therefore a policy framework comprising both immediate and medium-term operational objectives - modernisation, expansion of existing capacity and safety - and longer-term commitments concerning spent nuclear fuel and radioactive waste management and the development of new nuclear technologies. These elements are coordinated to maximise the benefits of the existing nuclear infrastructure.

The SNDDN is compatible with the objectives of environmental protection and with maintaining the integrity of protected natural areas, provided that the regulatory procedural stages and prevention and control measures, an integral part of the strategy's activities, are respected. The locations associated with nuclear activities and projects in the SNDDN and PNN are predominantly located in areas with a high degree of anthropisation, which limits direct

pressures on habitats and species of Community interest and allows for predictable risk management.

For energy objectives, especially the Cernavodă NPP and the SMR project, the most sensitive environmental vector is water. In normal operating conditions, cooling waters constitute a distinct flow from technological wastewater, the former having as its main effect the local thermal increase of the receiver, and the latter being treated and monitored before discharge. The potential impact on aquatic ecosystems is manifested by the warm waters discharged, possible local changes in turbidity and microclimate (short episodes of evaporation fog in specific meteorological conditions). These effects are, however, controllable by limiting the temperature at discharge, designing and operating the discharge points, continuous monitoring of water quality and respecting the conditions imposed by permits. Under these conditions, the influences remain local, do not affect the integrity of Natura 2000 sites and do not lead to structural changes in aquatic habitats.

The conclusions of the study "Appropriate Assessment of the Environmental Impact of Units 3 and 4 of Cernavodă NPP" state that the impact of the Units 3 and 4 project is insignificant and that the simultaneous operation of four nuclear units at the Cernavodă NPP site does not affect the favourable conservation status of habitats and species, including those of Community interest. It was also estimated that the operation of Units 3 and 4 does not have a significant impact on natural habitats or flora and fauna species within the project's area of influence, either directly or indirectly, in the short or long term, during the construction, operation or decommissioning phases, or cumulatively with the potential impact of other activities carried out at Cernavodă NPP. In the context of medium- and long-term climate change projections for Romania, specifically the Dobrogea region, considered together with the generally insignificant environmental impact assessed during the operation of Units 3 and 4, it is estimated that the discharge of heated effluent into the Danube from Cernavodă NPP operating with four nuclear units does not generate adverse effects on species and habitats of conservation interest, and the impact is assessed as insignificant.

Final radioactive waste repositories, namely the final repository for low- and intermediate-level waste and the deep geological repository, are essential components of a responsible nuclear policy. Their need is twofold: to reduce the cumulative risks associated with long-term temporary storage and activities associated with the final part of the nuclear fuel cycle. For the deep geological repository, the impact cannot be quantified before the site is established; however, the selection and exclusion criteria, together with the multi-barrier system (engineered barriers and geological barrier), are designed precisely to prevent the migration of radionuclides to aquifers at relevant concentrations and to avoid crossing sensitive habitats or ecological corridors. Similarly, for the DFDSMA, the heat-free inventory and engineered containment solutions ensure a low, local and manageable risk.

The strategic level analysis indicates that radiological risks in normal operation are low, and credible accident scenarios are of low probability and are covered by prevention, monitoring and response measures. At the project level, the assessments will detail the actual perimeters of influence based on specific modelling (air and hydrogeology), calibrate water resources protection measures and ensure compliance with the Conservation Requirements of Protected Natural Areas.

From the perspective of energy security and climate objectives, implementation of the Strategy is timely and recommended. Nuclear energy provides firm, low-carbon capacity, stabilises the energy system and reduces exposure to volatility in fossil-fuel markets. The strategic benefits outweigh the environmental risks, which under the proposed framework are clearly identifiable, localised and manageable through compliant design, operation and monitoring. Overall, the Strategy can be implemented without significant effects on protected natural areas where project locations are known, with priority given to sound water management at Cernavodă NPP and the SMR project and to responsible development of final radioactive-waste disposal infrastructure.

All the objectives set out in the National Strategy for the Development of the Nuclear Sector (with the exception of the deep geological repository – whose location is unknown) are located outside protected natural areas, in accordance with the provisions of national and European legislation on the conservation of biodiversity and the maintenance of the integrity of the natural heritage. This compliance is the result of the strategic planning process, which integrated criteria for environmental protection and sustainable use of resources, in correlation with energy security objectives. Thus, no areas of habitats of Community interest or of feeding/resting or breeding habitats for bird species for which sites of Community interest have been designated will be lost.

The research activities proposed on the Mioveni and Măgurele platforms are not intended for the production of electricity and do not involve technological flows with the potential for significant environmental impact. Their location on already anthropised platforms, the functional separation of the facilities, the reduced volumes of materials and the strict operating regime mean that any effects will be local, punctual and short-term, and insignificant. In conclusion, the research activities do not generate significant environmental impact and do not affect conservation objectives.

The radioactive waste management component is essential for the long-term credibility and security of the nuclear programme. The DFDSMA and, in the future, the deep geological repository close the management cycle, reduce the cumulative risks of temporary storage and ensure the protection of water resources and biodiversity through the multi-barrier system and strict site selection/exclusion criteria.

At the current stage, the impact of the DGA cannot be quantified before the location is established, but the selection methodology is designed precisely to avoid significant interactions with habitats and species of Community interest. The selection of the future location will be based on complex geological, technical and environmental studies, in accordance with the standards of the International Atomic Energy Agency (IAEA), applicable national legislation and European Union directives. The process will also include environmental impact assessment stages, to ensure compliance with the principles of environmental protection.

General guidelines for supporting project development

The appropriate assessment study establishes a set of general guidelines intended to support the development and implementation of subsequent projects derived from the SNDDN and PNN, so that they are compatible with the conservation objectives of the protected natural areas and do not generate significant effects on their integrity. The guidelines are intended to

guide the planning and design stages, ensuring a preventive approach through which potential risks to habitats and species of Community interest are identified in advance, and locations or technical solutions incompatible with the protected natural values are avoided.

In this regard, the study indicates as a priority principle the location of future projects outside protected natural areas and wetlands of international importance, including Ramsar sites, as well as the use, as far as possible, of already anthropised areas and existing infrastructure corridors. In situations where location in the vicinity of protected natural areas cannot be avoided, projects will be designed in such a way as to prevent direct or indirect damage to the elements that support the integrity of the sites (habitats, species, ecological structures and functional processes), including by maintaining ecological connectivity, limiting fragmentation and reducing associated anthropogenic pressures.

The study recommends that the development of subsequent projects take into account the sensitivity of environmental components, with an emphasis on rare, vulnerable or fragmented habitats and wetlands, by avoiding works or activities that may modify the hydrological regime, reduce water quality, affect the structure and functionality of natural habitats or significantly increase disturbance (noise, vibrations, lighting, traffic, works during sensitive periods). Technical solutions and site organisation will be selected so as to minimise land occupation, reduce the impact on soil and vegetation, control emissions and accidental pollution risks, as well as limit the cumulative effects generated by multiple projects or overlapping with existing pressures.

Furthermore, each subsequent project will need to be analysed at site level, through the applicable environmental assessment procedures (including appropriate assessment, if there is a possibility of affecting protected natural areas), to allow for the detailing of impacts and risks according to local conditions and for the establishment of specific avoidance, prevention, reduction and, where appropriate, compensation measures. It is also recommended to integrate monitoring measures from the design phase, so that potential adverse effects can be detected early and management measures can be adjusted adaptively.

By applying these general guidelines, subsequent projects can be developed in a manner consistent with the objectives of the SNDDN and PNN, while ensuring the protection of protected natural areas and compliance with the principle of preventing significant environmental impacts.

7.5. IMPACT ON LANDSCAPE

Landscape is understood as the set of natural and anthropogenic components (relief, water, vegetation, land uses, infrastructure, cultural values), as well as their visual perception by receptors.

The implem**entation of the Nati**onal Strategy will not have a significant impact on the landscape, except for the periods when the new objectives will be achieved, when an insignificant impact will be felt, for a limited period of time.

Sources of visual/landscape impact dur**ing the implementation period**:

- installation of construction site organisations, barracks, temporary platforms, material/scrap stocks;
- presence of machinery, cranes, road transport, temporary signage;

- topsoil stripping, excavation, slope grading and localised vegetation clearance;
- construction site dust (reduced local visibility);
- temporary night lighting and associated visual noise.

Nature of the impact: predominantly temporary and reversible, with local intensity in the immediate vicinity of the work fronts. The magnitude of change ranges from small to moderate in industrialised or visually degraded landscapes to moderate

During the operating period

Potential sources/elements of visual impact:

- volume and height of technical constructions (process buildings, halls, stacks/towers, ventilation structures);
- auxiliary infrastructure (internal roads, parking lots, fences, guard posts) and outdoor equipment (tanks, transformers, cooling systems);
- outdoor lighting and security signage installations;
- movement of vehicles on the platform (operational traffic) and the periodic presence of specialised convoys;
- any panels, antennas, above-ground utility routes or crown/elevation differences resulting from terrain modelling.

Impact nature (normal operation): low-medium magnitude, depending on architectural integration and natural distances/masking, long duration (throughout the life of the objectives), at local-area level (in the potential visibility area), partially reversible (reduced by decommissioning and restoration measures) and reduced in industrial areas, medium in sensitive contexts or with open lines of sight to the objective.

7.6. IMPACT ON HUMAN SETTLEMENTS, THE POPULATION (SOCIAL AND ECONOMIC ENVIRONMENT) AND HUMAN HEALTH

During implementation of the Strategy projects

The assessment aims at the potential effects of the Strategy's objectives on local communities, living conditions, employment and the health of the population, in correlation with temporary or permanent changes in environmental components (air, soil/subsoil, water, landscape, noise/vibrations) and with the radiological protection regime applicable to nuclear installations and related facilities.

Types of possible effects (mostly temporary):

- Environmental quality and land use: local increases in dust and emissions from construction site traffic; temporary occupation of areas for construction site organisation; changes to the landscape.
- Noise and vibrations: temporary intensification in the vicinity of construction sites and access roads.
- Traffic and road safety: additional machinery/freight traffic, with potential disruption to local mobility.
- Socio-economic aspects: positive impact through job creation during execution and activation of local supply chains and services (accommodation, transport, catering, maintenance).

General nature of the impact in implementation: temporary, local, minor–moderate without measures; minor with the application of measures.

During the implementation of the activities proposed by the National Strategy

Under normal conditions, no significant effects on the health of the population are anticipated; exposures are maintained well below limits and at as low levels as possible.

Nuclear or radiological emergencies may occur in the following situations:

a) industrial, medical, road incidents or fires involving radioactive sources, accidental releases, loss of sources or illicit trafficking of radioactive sources;

b) transport of nuclear fuel and radioactive materials by road, sea, river and air means of transport;

c) terrorist threats or attacks with nuclear materials or radioactive substances;

d) accidents at nuclear installations on the territory of the country.

In the event of abnormal operation of a nuclear power plant, it may emit radiation into the area.

surrounding radioactivity in the form of a mixture of products generated in the reactor, called "nuclear fission products". The main radionuclides that pose a risk to health hazards are radioactive cesium and radioactive iodine. The population may be exposed to these radionuclides either directly, from the air, or indirectly, through contaminated water and food.

Rescue teams, intervention teams and nuclear power plant workers may be exposed to higher doses of radiation, by the nature of their professional activities and directly, through exposure to radioactive materials inside the plant.

Planning of activities to protect the population and emergency personnel must be carried out taking into account the following exposure routes:

a) external exposure, due to unshielded radiation sources or entry into the radioactively contaminated area;

b) internal exposure, through inhalation and ingestion of contaminated water or food;

c) external radioactive contamination of intervention personnel.

During operation of the Strategy projects, the implementation of specific protection systems will significantly reduce the risks of affecting parameters with potential impact on human health. In addition, the NSR-01 FUNDAMENTAL RADIOLOGICAL SAFETY NORMS establish the requirements for ensuring the radiological safety of professionally exposed personnel, the population and the environment, according to the provisions of Law 111/1996 on the safe conduct of nuclear activities, republished.

The mentioned rules apply in the case of:

- practices involving the risk of exposure to ionising radiation from: artificial sources, natural sources (if radionuclides are or have been processed in order to use their properties as radioactive, fissile or fertile substances), electrical equipment which, operating at a potential difference of over 5 kV, generates such radiation;

- activities involving the presence of natural sources of radiation in situations other than those provided for in the previous paragraph;

- interventions in case of radiological emergencies, as well as in case of residual exposures following a radiological emergency, or a past professional practice or activity.

Specific measures to protect environmental components, including human settlements, the population (social and economic environment) and human health will ensure that the impact during the operation period is within acceptable limits on the health of the population and has positive socio-economic effects (employment, local income, services).

Thus:

- effluents, where they exist, are controlled and monitored;
- public exposures are kept well below legal limits, applying the ALARA principle (As Low As Reasonably Achievable);
- Noise and vibrations are generally low and stable, with short peaks during scheduled maintenance (communicated in advance).
- for all objectives, standardised radiation protection is carried out: zoning, protective screens, limitation of working time in controlled areas, individual dosimetry, medical surveillance;
- for the nearby population, exposures are negligible during normal operating conditions;
- the effective dose limit for the population is respected, which is according to NSR 01 1mSv per year and in special situations established by CNCAN an upper annual limit of up to 5 mSv per year, provided that the average value over 5 consecutive years of the effective dose does not exceed 1 mSv per year.

CNCAN will take all necessary measures to ensure that public exposure to radiation arising from nuclear practices is kept as low as reasonably achievable, taking economic and social factors into account. Provided that the approved designs and the recommendations set out in regulatory acts, endorsements and specialist studies are complied with, the activities to be carried out under the objectives of the Nuclear Strategy will not adversely affect the health of the local population, due to implementation of the prescribed measures.

According to national monitoring, no risks or causes for concern have been identified for the social environment or public health, and operation of the facilities has not been associated with adverse health effects.

Nature of impact: low–negligible on population health; positive socio-economic effects (employment, local income, services).

7.7. NOISE AND VIBRATION IMPACTS

During implementation of the National Strategy projects

The strategy's objectives are mainly located in industrial areas or at significant distances from inhabited areas, which provides a natural spatial attenuation of acoustic and vibrational impact.

Receptors sensitive to noise and vibrations are residential areas, educational/healthcare facilities, protected natural areas, and personnel on site (occupational exposure).

During the implementation of the activities proposed by the National Strategy

Ambient noise and vibrations are generated mainly by transport flows, decommissioning operations and the current exploitation of existing objectives. During the implementation of the Strategy, acoustic contributions and vibrations are associated with the

actual execution of the works (transport, construction site, equipment) and are temporary in nature, with limited impact in time on the "population" receptor.

The noise is predominantly stationary, low-medium level, controlled at the source (by housings, shock absorbers, bearings, etc.), with occasional increases during major maintenance and scheduled logistical activities.

Vibrations are limited to rotating equipment and there is little propagation outside technical buildings due to rigid foundations, anti-vibration mounts and protective distances.

During activities carried out under the National Strategy, given the industrial location and the control systems at the source/path/receptor, the impact on receptors outside the premises is low–negligible and specific occupational requirements apply to personnel on the premises.

7.8. IMPACT ON HISTORICAL AND CULTURAL HERITAGE

Based on the current location of known objectives, the implementation of the Strategy does not generate interactions with historical or cultural heritage assets in the targeted areas.

For future investments, the existence of potential impacts cannot be anticipated at this level; these will be clarified by completing the legal stages (screening, evaluation, consultation and approval), including checks in official heritage lists and registers and, where appropriate, preventive archaeology.

7.9. CLIMATE CHANGE

Climate variability, particularly through the frequency and intensity of extreme weather events, as well as climate change as a whole, represent fundamental challenges facing society at the beginning of the 21st century. Climate warming, reflected in increasing temperatures or more frequent and intense heat waves, changes in the precipitation regime, either by concentrating quantities in extreme events - floods, or their absence for long periods - droughts, and anomalies felt regarding the seasons in temperate regions, determine major changes in the interactions between society and the natural environment, both at a global level and at a regional or local level.

Scientific knowledge on the physical basis of global climate change is periodically summarised in the report of the Intergovernmental Panel on Climate Change (IPCC) within Working Group I (https://www.ipcc.*ch/report/sixth-assessment-report-working-group-i/) According t*o the summary of Working Group I (of the IPCC), the magnitude of recent changes in the climate system is unprecedented in the last thousands of years, and human influence is the main factor in these changes.

The main manifestations of climate change consist of:

- *Temperature and thermal extr*emes: Compared to 1850–1900, the global average surface temperature in the period 2081–2100 is very likely to be higher by 1.0°C to 1.8°C in the very low greenhouse gas (GHG) emissions scenario considered (SSP1-1.9), by 2.1°C to 3.5°C in the intermediate GHG emissions scenario (SSP2-4.5), and by 3.3°C to 5.7°C in the very high GHG emissions scenario (SSP5-8.5).

Extreme low temperatures (cold spells) could become less frequent in Europe. In addition, global warming affects the predictability of events and therefore our ability to react effectively. (https://clima*te.ec.europa.eu/climate-change/consequences-climate-change_ro*).

- *Average precipitation and rainfall extremes: Global* average annual continental precipitation is projected to increase by 0–5% under the very low GHG emissions scenario (SSP1-1.9), 1.5–8% under the intermediate GHG emissions scenario (SSP2-4.5), and 1–13% under the very high GHG emissions scenario (SSP5-8.5) by 2081–2100 compared to 1995–2014. There is increasing evidence compared to the IPCC AR5 (published in 2014) that the global water cycle will continue to intensify as global temperatures increase (high probability), with precipitation and surface water runoff projected to become more variable over most land regions within seasons (high probability) and from year to year (medium probability). (https://*www.ipcc.ch/report/ar6/wg1/chapter/technical-summary*).

  Many European regions are already experiencing more frequent, more severe and longer periods of drought due to climate change. The frequency and severity of droughts would also increase the length and severity of the forest fire season, particularly in the Mediterranean region. Climate change is also expanding the area at risk of forest fires.
- *Freshwater availability*: More frequent and severe droughts, rising water temperatures, and cloudbursts are expected to cause a decline in water quality. Changes in river flows due to drought may also affect inland waterway transport and energy production.
- *Biodiversity impact: D*irect effects include phenological changes (at the level of behaviour and life cycles of animal and plant species), changes related to species abundance and distribution, community composition, habitat structure and ecosystem processes.

  Climate change also has indirect effects on biodiversity through changes in land use and other resources. These can be more damaging than direct effects because of their magnitude, scope and speed. Indirect effects include: habitat fragmentation and loss; overexploitation; air, water and soil pollution; and the spread of invasive species. They will further reduce the resilience of ecosystems to climate change and their ability to provide essential services such as regulating climate, providing food, clean air and water, and controlling floods or erosion.
- *Changes in soil, inland waters and the marine envir*onment: serious soil erosion, decrease in organic matter, salinisation, loss of soil biodiversity, landslides, desertification and flooding, increase in river and lake water temperature and decrease in ice sheet, affecting water quality and freshwater ecosystems.
- *Health impact:* a significant threat not only to human health, but also to animal and plant health.
- *Impact on the social and economic environment: effects on labour availability and changes in sectoral production (https://climate.ec.europa.eu/climate-change/consequences-climate-change_ro). Human-caused carbon dioxide (CO_2) emissions are the main driver of global ocean acidification.*

This acidification has been observed in the surface layer.

Anthropogenic influence has probably increased the occurrence of compound extreme events since the 1950s, including a global increase in the frequency of concurrent heatwaves and droughts (high confidence).

It has also probably increased wildfires in some regions of all inhabited continents and compound flooding in some regions.

These latter assessments have medium confidence.

The adverse effects of climate change cannot be denied. According to the statements of politi*cal actors (https://jurnalul.ro/stiri/politica/klaus-iohannis-summitul-cop28-schimbari-climat*ice-energie-950080.html) "we must accelerate our actions to mitigate climate change and, in particular, rapidly decarbonise our energy systems". Romania considers nuclear energy to be a stable source of energy, contributing to energy security and decarbonisation, considered essential in decarbonising the energy system and achieving climate neutrality by 2050, as promoted in national and European strategies. Unlike fossil fuel-based energy sources, which generate significant emissions of carbon dioxide and other air pollutants, nuclear energy provides constant, reliable electricity with almost zero greenhouse gas emissions during the operation phase.

According to the Intergovernmental Panel on Climate Change (IPCC), nuclear energy is among the technologies with the lowest life cycle emissions, with an average value of approximately 12 gCO_2-eq/kWh, comparable to wind energy and lower than solar photovoltaics (World Nuclear Association, 2023). In addition, nuclear energy avoids 1.5 gigatonnes of CO_2 globally annually and contributes to a significant reduction in natural gas demand, according to the International Energy Agency (IEA, 2022). In the long term, the International Atomic Energy Agency (IAEA) estimates that nuclear energy has prevented the accumulation of approximately 70 Gt of CO_2 over the past five decades, and currently continues to avoid over 1 Gt of CO_2 annually (IAEA, 2022).

The reduction of greenhouse gas emissions from energy production, given the European Union target of at least a 55% reduction by 2030 compared to 1990 levels, can be supported by implementing the nuclear capacities provided for in the Strategy, alongside other low-emission technologies. At the same time, at regional and national levels, energy security and independence are relevant strategic objectives for the development of the nuclear sector.

Emerging innovations and technologies, such as SMRs, through their high efficiency and operational flexibility, can accelerate decarbonisation also in sectors that are difficult to electrify (green hydrogen, district heating). Increasing investments in SMRs supports climate change adaptation, reducing the environmental impact of large energy infrastructures.

Climate change affects the plans and projects included in the SNDDN on three major dimensions:

(A) physical infrastructure;

(B) production capacity;

(C) nuclear safety and security risks.

A. Nuclear infrastructure

Water resources and cooling

- *Cooling water temperature:*

CANDU reactors in Romania use the Danube as a source of cooling water.

In France, plants such as Golfech and Bugey were forced to reduce power or shut down reactors in the summers of 2003, 2018 and 2022 due to excessive river heating (source: ASN France, 2023 https://www.asn.fr/information/archives-des-actualites/l-asn-tire-le-retour-d-experience-des-decisions-prises-pendant-la-canicule-de-l-ete-2022). Similar situations are possible in Romania.

- *Water availability:*

Reduced Danube flows (during periods of prolonged drought) can reduce the water resource needed for cooling.

According to the International Commission for the Protection of the Danube River (ICPDR, 2022), the Danube flow could decrease by 10–15% by 2050 under the RCP4.5 s*cenario.*
(https://www.icpdr.org/sites/default/files/nodes/documents/danube_climate_adaptation_study_2018.pdf).

- *Floods:*

"Heavy rain plus flash flooding" events can affect water capture and discharge infrastructure.

Under the Environmental Agreement approved by Government Decision No. 737/2013 for the project “Continuation of the Construction and Completion Works for Units 3 and 4 at Cernavodă NPP”, Units 3 and 4 may enter operation after completion of the hydrotechnical works on the Bala branch, which will regulate flows among the Bala, Borcea and Old Danube branches. These works will help maintain the current bathymetry of Reach I of the Danube-Black Sea Canal and ensure adequate long-term cooling-water conditions for the simultaneous operation of four nuclear units at Cernavodă NPP. After completion of the Bala works, future studies will reassess the estimated potential effects of climate change on the hydrological regime of characteristic minimum Danube flows, in order to validate the working assumptions concerning maintenance of the current flow value.

Temperatures and materials

Effects on structures:

Heat waves can affect the performance of materials, especially electrical cables, control equipment and ventilation systems.
Increasing ambient temperature can reduce the lifespan of certain lens components**.**

Seismic and climate resilience:

Romania is exposed to seismic risk (Vrancea area, Shabla area). The interaction between earthquakes and climatic effects (e.g. soil weakened by floods) can increase the vulnerability of infrastructure.

Access and logistics

Extreme weather events (storms, floods, wildfires) can block land access routes or interrupt the supply of essential materials (nuclear fuel, spare parts).

B. Energy production

Power reductions and shutdowns

In cases where the discharged cooling water exceeds legal temperature limits, the reactor must reduce its power or even shut down.

EDF estimates that annual production losses associated with pressure on water resources currently amount to approximately 0.3% of total production and could increase to 1.5% by 2050. During peak periods, less than 5% of European nuclear capacity was unavailable because of heatwave restrictions, with France accounting for most of these cases (Historical Heat Wave Performance Analysis of European Energy Systems (2018-2024)).

The energy mix and the role of nuclear energy

Climate change increases the volatility of renewable energy production: drought affects hydropower plants, lack of wind reduces wind production, and heat waves can limit photovoltaics.

In this context, nuclear energy provides stability and ensures the baseload production necessary to balance the grid.

Lifespan and modernisation

Heat waves and climate stress can accelerate the ageing of equipment.

Future feasibility studies for extending the life of the Cernavodă NPP must also include adaptation analyses to climate scenarios for the post-2030 period.

Nuclear safety and security risks.

Climate change introduces new vulnerabilities for the security of nuclear facilities, which could directly affect the plans and projects included in the national strategy for the development of the nuclear sector. These risks can manifest themselves on several levels:

Operational safety risks

Extreme temperatures and heat waves can affect cooling systems, causing power reductions or unplanned reactor shutdowns. Rising surface water temperatures limit the ability to dissipate heat, affecting both performance and environmental compliance.

Droughts can reduce the availability of water resources for cooling, especially for reactors located on inland rivers. This requires the assessment of long-term hydrological scenarios and the adaptation of cooling infrastructure.

Extreme events (storms, floods) can endanger sites located in low-lying areas, increasing the risk of flooding of critical security and power supply systems.

Nuclear security risks

Disruptions in energy and water supplies can generate unforeseen circumstances in which security systems must operate autonomously for longer periods, increasing pressure on resources and personnel.

Environmental risks and social acceptability

Extreme weather events, which could affect the operation of nuclear power plants, may lead to public perception of increased vulnerability, which may negatively influence decision-making and public acceptance of the nuclear programme in the future.

The need for strategic adaptation

The strategy must integrate climate resilience plans for each site, including upgrading cooling infrastructure, additional flood barriers, and redundant electrical power systems.

It is essential to include emergency scenarios adapted to new climate conditions, with periodic exercises and international cooperation for coordinated response.

Regulatory norms will need to be updated to reflect these new conditions, including stricter seismic, hydrological and meteorological design standards.

IMMUNIZING THE PROPOSED STRATEGY TO CLIMATE CHANGE

- is a process that integrates climate change mitigation and adaptation measures into the development of infrastructure projects included in the strategy *(COMMISSION COMMUNICATION — Technical guidance on climate-proofing infrastructure 2021-2027 (2021/C 373/01)).*
- comprises two pillars:

i) climate neutrality – *climate change mitigation* and

ii) climate change resilience – a*daptation to climate change*.

A. Climate change mitigation:

The assessment looks at the potential impact of plans and projects covered by the strategy on climate change, mainly through the lens of associated greenhouse gas emissions throughout the life cycle.

Compared to the baseline scenario, some projects are expected to generate additional emissions during construction, operation and decommissioning, as well as through indirect effects (e.g. energy consumption and related activities). By integrating energy efficiency measures early, using low-emission technologies, optimising logistics and applying reduction/offset solutions, the impact on the carbon footprint can be limited and the contribution to climate objectives can be improved.

The carbon footprint represents the amount of greenhouse gases (GHG) we produce per year through human and industrial activities, such as: burning fossil fuels to produce heat or electricity, through electricity consumption, fuel consumption for personal transportation, etc.

The greenhouse gases that contribute to the carbon footprint, according to the Kyoto Protocol, are represented by:

- Carbon dioxide (CO2);
- Methane (C_H 4);
- Nitrous oxide (N_2 O);
- Hydrofluorocarbons (HFCs);
- Perfluorocarbons (PFCs);
- Sulphur hexafluoride (SF6);

- Nitrogen trifluoride (NF_3).

The process of quantifying greenhouse gas emissions converts all emissions into tons of carbon dioxide called CO_2 e (equivalent) using the global warming potential (GWP).

The GWP (Global Warming Potential) values over a 100-year horizon, according to the IPCC Fifth Assessment Report (AR5), are found in the following table *(https://ghgprotocol.org/sites/default/files/Global-Warming-Potential*)

TABLE 36- SUMMARY OF GWP-100 VALUES ACCORDING TO AR5

Greenhouse gas	GWP (100 years, AR5)
CO_2	1
CH_4	28
N_2O	265
SF_6	23,500
NF_3	16 100

Regarding the SNDDN objectives analysed, there are no significant direct emissions of CO_2, CH_4 or N_2O during nuclear fission.

No fluorinated gases (HFC, PFC, SF_6, NF_3) are released from the nuclear process itself.

Nuclear reactors are virtually "zero-emissions" in operation.

There are indirect emissions (throughout the entire life cycle):

- CO_2 from uranium mining, transportation and refining.
- CO_2 and N_2O from power plant construction (cement, steel, concrete manufacturing).
- CO_2 from the transportation of nuclear fuel and materials.
- CO_2 and CH_4 from radioactive waste management (infrastructure, geological disposal).
- SF_6 – may occur marginally, used as an insulating gas in high-voltage electrical equipment associated with the plant.

The implementation of the strategy's objectives does not involve land exploitation activities - agriculture that would lead to increased air emissions with an impact on the climate.

The implementation of the strategy's objectives does not require deforestation activities that would lead to increased air emissions with an impact on the climate.

The impact on natural absorbers (soil, forests, oceans) is insignificant, forested areas are not affected; possible limited interactions with surface waters are within acceptable limits.

TABLE 37 - IDENTIFICATION OF THE EFFECTS OF THE STRATEGY ON CLIMATE CHANGE

Project activities	Positive effects	adverse effects
Construction works - assembly, transportation, maintenance		GHG emissions, *insignificant, temporary and local in nature*
Decarbonising the energy mix:	Nuclear energy replaces coal/gas generation and lowers the carbon intensity of the kWh delivered. GHG emissions avoided compared to the reference scenario (t CO_2e/year).	
RES integration	Firm capacity for network stabilisation. Number/duration of unplanned outages in extreme weather events. Reduced territorial footprint: high energy density → lower pressure on land/ecosystems, with indirect positive effects on natural carbon reservoirs. Resistance to weather extremes: climate-resilience design and operation → continuity in heat waves, drought, torrential rains.	
Air quality co-benefits	Reduction of SO_2, NO_x, PM compared to burning fossil fuels (climate-health benefits).	

Effects of the strategy on climate change

Nuclear context: emissions occur predominantly in the construction phase and upstream (fuel chain – extraction, conversion, enrichment, manufacturing, transport). In operation, direct emissions are very low; there is no combustion of fossil fuels in the generation process and GHG emissions are negligible.

TABLE 38 - EFFECTS OF THE STRATEGY ON CLIMATE CHANGE

Criterion	Characterisation
Nature/direction	Predominantly negative (emissions) in construction; negligible in operation; net positive effect by avoiding the use of fossil fuels.
Intensity	Small in construction; very small in operation.
Magnitude	Low compared with the fossil-fuel scenario;
Spatial extent	Local (construction site, logistics corridors)
Duration / temporality	Temporary (construction); long-term operation with negligible direct emissions.
Frequency	Intermittent in construction; low and stable in operation.
Reversibility	Local: effects cease after completion of construction; CO_2 persists in the atmosphere → irreversible on a climate scale.
Cumulativeness	Reduced locally; at the energy system level, the effect is counterbalanced by the avoidance of emissions from the use of fossil resources.

In terms of clima**te neutrality, this** is also known as “net zero emissions”. The term refers to achieving a balance between carbon dioxide emissions and the reduction of carbon

dioxide from the atmosphere through sinks. A CO 2 sink is any system that absorbs more CO 2 than it emits[1]. **The most important sinks are soil, forests and oceans**.

A society becomes climate neutral when the amount of carbon dioxide emitted by human activities is completely absorbed by sink systems. Hence the name "net zero emissions": it does not mean that human activities will no longer emit any CO 2, but only that they will emit enough that the gases can be absorbed and processed by forests, plants, oceans, seas, soil, etc., so that the gases will no longer accumulate in the Earth's atmosphere, creating the greenhouse effect.

The strategy has no impact on forest areas, but it will have an impact on surface waters, which is within permissible limits, **so we cannot speak of a significant impact on emission absorbers.**

Regarding indirect GHG emissions caused by increased energy demand, we mention that the strategy follows the European Union's policy in the field of environmental protection and emission reduction:

- The EU aims to become climate neutral by 2050 at the latest;
- in line with the objectives of the Green Deal, the Commission proposed a target to reduce greenhouse gas (GHG) emissions by at least 55% by 2030, and Parliament called for a GHG emissions reduction target of 60% by 2030 for energy from renewable sources (https*://www.consilium.europa.eu/ro/policies/european-green-deal*);
- Under the Treaties, the EU has the responsibility to guarantee security of supply, and Member States have the responsibility to determine the structure of their energy supply and choose energy sources, while respecting the EU's objectives of achieving climate neutrality by 2050;
- The European Union (EU) has set ambitious goals for the decarbonisation of the economies of its member states, adopting a series of actions, including the continued development of renewable energy sources (RES).

The proposed strategy is part of the economic and environmental policies of the European Union, having as a starting point the national and international Conventions on climate change, based on which Romania has developed the Integrated National Plan for Energy and Climate Change 2020 - 2030.

Climate change is due to the industrialisation of the planet and the massive use of fossil fuels. While natural climate change occurs over very long periods of time, which allows plant and animal species to adapt to new climatic conditions, anthropogenic changes are very rapid and consequently pose an enormous threat to fragile ecosystems.

The proposed projects/plans fall within the general trend of sustainable development, aiming to use equipment that produces as little GHG as possible, using alternatives to fossil fuels (electricity from nuclear sources).

Indirect GHG emissions generated by any activities or direct support infrastructure related to the implementation of the proposed strategy

[1]https://www.europarl.europa.eu/news/ro/headlines/society/20190926STO62270/ce-este-neutralitatea-emisiilior-de-dioxid-de-carbon

During the construction works related to the strategy's objectives, teams of specialised personnel will be mobilised to implement the projects, which may cause a temporary increase in car traffic in the area during the execution period.

Also, during the construction period, equipment and materials, including construction materials necessary for the implementation of the construction works, will need to be brought to the site, which will lead to an increase in freight transport in the area.

The following is a list of indirect GHG emissions (Scope 2 and 3, according to the GHG Protocol) associated with the implementation of the National Strategy for the Development of the Nuclear Sector (SNDDN), i.e. those emissions generated by activities and support infrastructures necessary for the implementation/operation of nuclear projects, but which do not appear as direct emissions at the power plant operator.

1) Nuclear fuel chain, as an example: manufacturing of fuel pellets and bundles (energy, process gases, internal transport), fuel transport, packaging and auxiliary materials (metals, polymers, wood).

2) Goods and construction: production of heavy components, construction materials (cement/concrete, steel-concrete, aggregates, copper/aluminium cables), auxiliary buildings and equipment (pumps, fittings, HVAC, I&C), waste containers/storage facilities (steel, special concrete, cementing).

3) Energy and utilities: electricity and heat supplied to the construction site and support facilities (site organisation and logistics bases).

4) Logistics & transportation: transportation of oversized components, transportation of construction materials, personnel movement, inspection and testing services, network infrastructures and integration.

5) Water and supporting hydrotechnical works.

6) Operation & maintenance.

7) Radioactive waste & spent fuel: transport to intermediate/final repository, specialised containers, cementation/encapsulation, conventional operational waste.

8) Decommissioning: dismantling, decontamination, cutting, waste transport for recycling/disposal.

9) Institutional and digital support: office buildings, training centres, IT & data centres (energy, equipment), professional services (engineering, consulting - travel, equipment).

10. Other direct support activities, as appropriate, associated with implementation.

B. Adaptation to climate change

Climate change adaptation: this takes into account the project's vulnerability to future climate change and its capacity to adapt to the impacts of climate change, which may be uncertain.

Uncertainty refers to the impact of climate change on the project. Although nuclear safety analyses are carried out for nuclear power plants and climate change is taken into account in the design, there can be no certainty regarding the climate models used (they in turn use different emission scenarios) which lead to different projections of temperature, precipitation, water level, intensity of extreme phenomena, etc. A project designed today cannot accurately predict which scenario will materialise at the site in 20–50 years.

The same uncertainty applies to:

- limited spatial and temporal resolution of climate models (for projects with particular importance of local microclimates);
- interactions between climatic and non-climatic factors and the lack of predictability of extreme events, which can be statistically estimated, but not exactly predicted.

Heat waves. Drought.

Heat waves have an impact on agriculture, the economy and biodiversity. [2]But **the biggest impact of heat waves is on health. The elderl**y, very young children and people with certain chronic conditions are particularly affected. The number of deaths is usually used to quantify the impact of heat waves. According to a study published in 2023 in the journal Na[3]ture, 61,672 deaths were recorded in Europe as a result of heat waves from 30 May to 4 September 2022.

During this period, heat waves in Romania led to increased mortality, especially in the south and southeast. The most vulnerable are men aged 65-79.

Heat waves and drought could affect project implementation by:

- the impossibility for the builder's employees to be able to work on the project during the heat wave;
- difficulties in supplying materials (oversized transport may be delayed due to transport restrictions caused by high temperatures);
- extreme temperatures **and** drought can reduce crop yields, thus disrupting food supplies, leading to increased prices => unforeseen costs in project implementation;
- Heat waves cause rapid drying of vegetation and soil, thus increasing the likelihood of wildfires breaking out and spreading.

In addition, heat waves put a huge strain on energy systems. The increased demand for cooling energy during a heat wave can lead to power outages and additional costs. Air conditioners, by generating waste heat, contribute to rising temperatures in urban areas. This increases the urban heat island effect. The ur[4]ban heat island in turn increases the effects of heat waves.

As the climate warms, precipitation patterns change, evaporation increases, glaciers melt, and sea levels rise. All of these factors affect the availability of freshwater.

More frequent a*nd severe droughts, together with rising water temperatures, are expected to reduce both water quality and water avai*lability. Such conditions promote the growth of toxic algae and bacteria and will exacerbate water scarcity, which has already been caused largely by human activity.

The increase in the number of cloudbursts (sudden torrential rains) could also influence the quality and quantity of available freshwater, as stormwater can lead to the ingress of untreated wastewater into surface waters.

Europe's rivers generally originate in mountainous areas, and 40% of Europe's freshwater comes from the Alps. However, changes in snow and glacier dynamics, as well as precipitation patterns, can lead to temporary water shortages across Europe. Changes in river

[2]https://www.infoclima.ro/acasa/cum-ne-pun-in-pericol-sanatatea-valurile-de-caldura
[3]https://www.nature.com/articles/s41591-023-02419-z
[4]https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(21)01209-5/fulltext

flows due to drought can also affect inland waterway transport, which could harm the project's supply.

Some of the objectives proposed by the strategy will use water as a resource during the operation period.

Construction activity may cause a limited increase in water demand.

Climate change is expected to lead to increased precipitation in many areas. Increased precipitation over long periods will mainly result in river flooding and overflows, while cloudbursts can cause flash floods (when extreme precipitation alone causes flooding, without overflows).

Climate change is likely to lead to more flooding across Europe in the coming years. Torrential rains are expected to become more frequent and intense due to higher temperatures, and flash floods will occur more frequently across Europe.

Health burden: The summer of 2022 generated 61,672 heat-related deaths (30 May–4 September) in Europe, out of an estimated total of 62,862 for the entire season; relative mortality was higher in Mediterranean countries. Southern and southeastern regions of Romania appear among the most exposed. (Heat*-related mortality in Europe during the summer of 2022, https://www.nature.com)*

Water supply: in 2022, 40% of the EU territory experienced seasonal water scarcity conditions (WEI+>20%), and Romania experienced water stress especially in spring-summer; the trend intensifies after 2010. (*Water scarcity conditions in Europe, https://www.eea.europa.eu/)*

Impact pathways specific to the nuclear sector

A. Labour - construction site (heat waves):

- medical risk/accidents; decreased productivity; temporary shutdowns; technological degradation, danger of vegetation fires.

B. Cooling - water resource (drought/heat):

- decreasing flows and **increasing inlet water temperatures m**ay result in power reduction or operating limitations; risk of a**lgal blooms at h**igh temperatures; strict thermal discharge a**nd flow requireme**nts **(Unit**ed States Government Accountability Office, Report to Congressional Requesters, NUCLEAR POWER PLANTS NRC Should Take Actions to Fully Consider the Potential Effects of Climate Change, https://www.gao.gov/)

C. Supply chain:

- road restrictions during heatwaves, track expansions, low levels on inland waterways → delays in oversized/material transport.

D. Energy system:

- Cooling dem**and in**creases sharply during heat waves, putting pressure on the grid; nuclear units can stabilise the syste**m, but heat waves c**an, in parallel, limit the production of surface water-cooled thermal power plants:
  a. Measures to adapt projects to current conditions: maintaining the continuity and safety of nuclear operations in extreme heat and drought conditions, in compliance with EU/IAEA requirements.

b. Taking measures to ensure work continuity: developing a heat wave plan - staggered/night schedule, work-rest cycles, hydration, cool shaded areas, automatic stop-work at doorsteps;
c. Low flows/algal alert lead to temporary shutdowns of pumps/equipment, switching to stored water.
d. Continuous monitoring of atmospheric conditions and water parameters used, as well as fires.

E. Extreme low temperatures

- restrictions on construction work;
- restrictions on the operation of nuclear and auxiliary facilities:
  - Cooling: colder water increases thermodynamic efficiency, but there are risks of ice at the inlets, clogging of the grates, vibrations/pump failures.
  - frost on structures/neighbourhood, formation of hoarfrost;
  - affecting automation and control systems;

In addition to heat waves, a current consequence of climate change is cold waves. Even though the global average temperature has increased by about 1.2º C and will continue to increase, there will be short-term variations associated with blizzards or cold waves. And climate change may even lead to an increase in the frequency and intensity of extreme winter events in some regions. We will still have cold waves in the future, but unfortunately we will have to get used to heat waves more and more.

Cold waves can affect the strategy's objectives for short periods both during the construction period due to the impossibility of carrying out the actual construction activity, but also during the exploitation period due to extreme temperatures during the tourist season.

Repeated freeze-thaw on proposed structures, such as concrete, may lead to their degradation, but only approved materials that are not affected by freeze-thaw damage will be used in the project.

Both the impact of a project on climate change (i.e. mitigation aspects) and the impact of climate change on the strategy and its implementation (i.e. adaptation aspects) were taken into account from an early stage in the decision-making process for its development.

Regarding th**e vulnerability of the strategy to climate change,** given the specifics of the plans and projects, their location, anthropogenic and natural risk factors, including climate change (floods, frosts, earthquakes) are external factors that are difficult to control, which derive from the evolution of climate phenomena at global and regional level:

- Increasing average temperatures – may affect the availability of water resources for cooling nuclear power plants.
- The increased frequency of extreme weather events (floods, droughts, violent storms) – can disrupt energy infrastructure, logistics chains and community security.
- Changes in the hydrological regime – reduced river flow during periods of prolonged drought can limit the cooling capacity of power plants.

Sensitivity of the sectors targeted in the strategy:

- Nuclear energy – dependent on the stability of environmental conditions (cooling water, stability of energy transmission networks).
- Critical infrastructure – vulnerable to extreme phenomena (earthquakes, heat

waves, storms), with an impact on safety and maintenance costs.

- Socio-economic environment – populations in the vicinity of nuclear sites may be exposed to additional risks generated by climate change, which may amplify public opposition.

The strategy's ability to adapt to climate change

The nuclear development strategy integrates the principle of climate resilience as a strategic objective, considering the possible difficulties in the process of adapting to the effects of climate change, such as:

- Integrated climate scenarios, reflecting potential developments in temperatures, precipitation patterns, water levels and the frequency of extreme weather events (drought, floods, heat waves, etc.), could have a direct impact on nuclear infrastructure and the availability of water resources for cooling.
- Existing nuclear infrastructure may require investments to be adapted to different climatic conditions than those for which it was originally designed.
- Limited institutional and financial capacity could generate delays in the implementation of adaptation measures, for example for updating site selection criteria or aligning in an integrated manner and within a limited time to achieve international cooperation objectives (for example, aligning with IPCC, EURATOM, IAEA recommendations and guidelines, with updating technical standards, climate risk assessment methodologies and climate change resilience design requirements).
- Collaboration with relevant international organisations (IAEA-International Atomic Energy Agency, EURATOM-European Atomic Energy Community, IPCC-Intergovernmental Panel on Climate Change, European Commission) is essential for the periodic updating of nuclear safety standards and their adaptation to new climate realities. Through the exchange of good practices and access to global expertise, the national institutional capacity for adaptation is strengthened and the implementation of plans and projects provided for in the National Strategy for the Development of the Nuclear Sector (SNDDN) and the National Nuclear Programme (PNN) is supported.

Addressing and monitoring the evolution of the issues presented above ensures that the objectives of the nuclear strategy can be maintained under conditions of increased climate variability, supporting a sustainable, safe and adapted nuclear sector to the future climate context.

To mitigate the impact of climate change on the implementation of the strategy, adaptation and resilience-building measures are recommended, based on international best practices and recent scientific recommendations, such as:

- Integrating climate scenarios into strategic planning;
- Securing water resources and increasing the efficiency of use;
- Strengthening infrastructure against extreme events;
- Establishing a monitoring and early warning system;
- Strengthening international cooperation.

7.10. Radiation sources and radiation protection

The implementation of the National Strategy for the Development of the Nuclear Sector involves the construction, operation and expansion of nuclear and research facilities, as well as the development of radioactive waste management infrastructure. All these activities can generate, directly or indirectly, two main categories of emissions/effluents – radioactive and non-radioactive – each with specific characteristics and regulatory requirements.

a) Radioactive gaseous releases

Cernavodă NPP Platform

The main pollutants found in the exhaust air from the reactor building and the service building are: tritium, solid particles, iodine and noble gases. These are taken up by the plant ventilation systems and are appropriately treated by means of D20 vapour recovery systems and ventilation and air filtration systems. Contaminated or potentially contaminated air is collected by the ventilation systems and is discharged through a common exhaust stack after filtration and monitoring.

TABLE 39 - RELEASE VALUES FOR LIQUID AND GASEOUS RADIOACTIVE EFFLUENTS - CERNAVODĂ NPP

	2023	2024
Emisii radioactive în mediu U1+U2 [µSv]	8,60	9,08
Ținta anuală stabilită de CNE Cernavodă [µSv/an]	<9	<9.25
Constrângerea de doză pentru CNE Cernavodă [µSv/an]	250	250
Limita legală pentru populație [mSv/an]	1	1

The sources of radioactive gaseous effluents are the Reactor Building, the spent fuel storage pools, the decontamination centre and the heavy water facility.

Radioactive gaseous effluents resulting from nuclear power plant operation contain noble gases, particles, iodine, tritium, and C-14.

The radioactive gaseous effluents are collected through the plant's ventilation systems, which also ensure air circulation from areas with low contamination potential to areas with high contamination potential. Subsequently, the filtration process and controlled evacuation take place through a dispersion stack with a height of H = 50.3 m and an internal diameter of d = 2.3 m.

tritium removal facility

Under normal operating conditions, both during operation and during planned facility shutdowns, the project may generate tritium-vapour releases through the CTRF stack (according to the Environmental Impact Assessment Report for the project “Construction of the Cernavodă Tritium Removal Facility”). The resulting tritium releases are expected to have a negligible impact.

The following presents the constructive and functional characteristics of the ventilation stacks of the CTRF facility and of the two CANDU units in operation at the Cernavodă NPP.

TABLE 40 - DESIGN AND OPERATING CHARACTERISTICS OF THE VENTILATION STACKS (ENVIRONMENTAL IMPACT ASSESSMENT REPORT FOR THE CERNAVODĂ TRITIUM REMOVAL FACILITY CONSTRUCTION PROJECT)

Denumire	Consum/ producţie	Timp de lucru anual (ore)	Poluanţi	Înălţime (m)	Diametrul interior la vârf al coşului (m)	Viteza, (m/s)	Temperatura (°C)	Debit volumic/ debit masic (m^3/s)
Coș CTRF	320 t/an apă grea	8000	DTO DT	cca. 50	1,7	cca 12,6	20÷30	28,6
Coşul unităţii U1	706,5 MWe putere instalată	8000	DTO	50,3	2,3	8,9 medie	45	44,12
Coşul unităţii U2	706,5 MWe putere instalată	8000	DTO	50,3	2,3	8,9 medie	45	42,68

The annual effective doses of population exposure, as a result of radioactive effluent discharges into the environment from the Cernavodă NPP, without CTRF, are about 20 times lower than the dose constraints established by CNCAN.

Most of the tritium activity released into the environment by the CTRF, during normal operation, is found in the gaseous effluents. The estimated value of the annual tritium emissions from the CTRF is an order of magnitude lower than the annual emission currently made by the two units of the plant. The monitoring results showed that, with regard to the operation of units 1 and 2, the gaseous tritium emissions have an insignificant impact on the quality of the air environmental component. By applying the detritiation process within the CTRF, a gradual reduction of the gaseous tritium emissions from units 1 and 2 of the Cernavodă NPP is estimated, which will be reflected in the reduction of the levels of tritium contamination of the air in the vicinity of the plant.

The CTRF will be equipped with a ventilation system capable of safely discharging the emissions. Tritium releases in molecular form, DT (HT), are estimated at 17 TBq/year. Tritium releases in oxide form, DTO (HTO), are estimated at 33 TBq/year. Total tritium releases from the CTRF are estimated at 50 TBq/year (Environmental Impact Assessment Report for the project “Construction of the Cernavodă Tritium Removal Facility”).

According to the Environmental Impact Assessment Report for the project “Construction of the Cernavodă Tritium Removal Facility”, the Derived Release Limits for tritium—the radionuclide of interest for the CTRF and the limits applied to the management of effluent releases from each Cernavodă NPP unit—are presented in the following table.

TABLE 41 - ASSESSMENT RESULTS FOR AVERAGE TRITIUM ACTIVITY CONCENTRATIONS IN GASEOUS RADIOACTIVE RELEASES DURING NORMAL OPERATION OF THE CTRF AND CERNAVODĂ UNITS 1 AND 2

Denumirea sursei	Formă poluant	Fracție emisie	Debit de activitate (TBq/h)	Debit gaze evacuate (m^3/h)	Emisie anuală tritiu (TBq)	Contribuție la concentrația de activitate (kBq/m^3)	
Coș CTRF	DT/HT	34%	2.13E-03	55000	17	18.4	LDE neautorizate încă
	DTO	66%	4.13E-03	61000	33	35.6	
Coș U1	DTO	~100%	6.33E-02	158830	506	398.5	3950 TBq/an – LDE pentru HTO corespunzătoare unei constrângeri de doză de 52,5 µSv/an
Coș U2	DTO	~100%	5.76E-02	153630	461	374.9	

Source: Environmental Impact Assessment Report for the project "Construction of the Cernavodă Tritium Removal Facility"

During the construction period of the CTRF, the planned radioactive emissions come from stacks U1 and U2, and are within the limit of 3950 TBq/year/unit - LDE for HTO corresponding to a dose constraint of 52.5 µSv/year /unit. CNCAN has approved a dose constraint of 10µSv/year for the CTRF facility.

Prevention of tritium releases is achieved by implementing and maintaining appropriate barrier systems designed to prevent and control emissions.

Small Modular Reactors-SMR

No significant radiological emissions are expected during normal operation.

SMR reactors are designed as closed systems, with multiple containment barriers (fuel → pressure vessel → containers).

No releases of radionuclides to air or water are anticipated under normal condition*s. (Environmental Impact Statement for an Early Site Permit (ESP) at the Clinch River Nuclear Site, US Nuclear Regulatory Commission Office of New Reactors Washington, DC 20555-0001*).

Available assessments indicate that, in general, the impact on air quality would be minimal if all applicable permits and regulations are complied with. According to *the Final Environmental Impact Statement for an Early Site Permit at the Clinch River Nuclear Site Reader's Guide April* 2019, it was assessed that air emissions of radioactive substances under normal operating conditions would comply with local state and federal (USA) standards. Potential gaseous effluents are noble gases, iodine, tritium (HTO), radioactive particles (Environmental Impact Statement for the Construction Permit for the Kairos Hermes Test Reactor). The estimate based on a capacity factor of 80% is ~1% of the reference emissions (80% considered a limiting assumption).

For sites in Romania, the requirements of the European and national legislative framework in force will be applied, including regulations regarding environmental protection and nuclear safety.

DFDSMA

The module is designed to perform functions of shielding the radiation source, ensuring security during waste transport, mechanical resistance, minimising emissions and confining radionuclides.

Under normal operating/transport conditions, no radionuclide releases to air are expected. The radioactive content is fully contained and the integrity of the seals ensures the absence of emissions. Release scenarios are only considered under postulated accident conditions.

DGA

Most disposal concepts cannot completely isolate the long-lived radionuclides present in the waste. Consequently, in the very long term, the main functions of the geological disposal system are to delay and limit the escape of radionuclides from the progressively degrading engineered barrier system into the geological environment and eventually into the biosphere.

Based on information from the specialised literature (The Safety Case for Deep Geological Disposal of Radioactive Waste: 2013 State of the Art- NEA /RWM/R(2013)9) we can highlight the fact that conditions are ensured for protection against the migration of emissions resulting from the operational phase of a geological repository:

- ensuring physical protections from the project phase - design of installations, containers, canisters, metal over-containers;
- filtering ventilation air to retain radioactive contaminants;
- concrete screens and exposure limitation.

Gaseous emissions consist of:

- Methane releases may occur in sedimentary rocks.
- In normal operation, ventilation systems remove the gas and monitor concentrations.
- if ventilation stops (e.g. loss of power), concentrations increase and an explosion risk may occur.
- emissions resulting from electricity consumption for ventilation, pumping, maintenance, etc.

Because the DGA is not yet built and the exact location is not defined, it cannot be accurately estimated: the type of rock, the depth, the construction method, the barriers used, the geological climate, the hydrogeology – all of these greatly influence potential emissions.

Geological repository designs use radionuclide migration models, but these are based on experimental data that may have margins of error.

Detailed studies are needed regarding the rock formation's ability to retain radionuclides, permeability, water flow, potential weak points, etc.

RESEARCH ACTIVITIES

In the field of research activities, the ALFRED and ELI-NP projects are designed so that, during normal operation, radioactive emissions into the environment are undetectable or negligible. In the case of ALFRED, the neutron and gamma field generated in the reactor activates the fuel, structures and liquid lead, but the risk of release is reduced by a system of multiple barriers (mechanical and inherent to the materials), which retain the radionuclides and limit their dispersion. Liquid lead ensures a natural retention of volatile elements (Po, Hg, Cd,

Te, I, Cs, Kr, Xe), and to prevent pollution, radiological monitoring systems, HEPA filters, radioactive iodine and aerosol retention systems and controlled discharge of rare gases are provided, respecting the authorised limits. In accident scenarios, certain species (Te, I, Cs) can pass into the gaseous phase, which justifies the use of efficient systems for purification of the cover gas and control of the source term.

At ELI-NP, the air laden with short-lived radionuclides resulting from the experimental chambers is passed through successive stages of filtration (activated carbon and HEPA filters) and discharged through the dispersion stack of the former VVR-S reactor. The chambers with potential contamination have their own filters on the vacuum exhaust, so that any activated particles are retained before the air enters the general ventilation system. Most experiments do not generate radioactive aerosols, and local contamination with short-lived radionuclides is captured in the exhaust filters. Monitoring is carried out during the experiments to demonstrate that radiation doses are within approved limits, so that the impact on the environment and the population remains very low.

b) Liquid radioactive effluent releases

According to the 2024 SNN Group Consolidated Sustainability Report, the radiologically relevant liquid effluents and the associated Derived Release Limits approved by CNCAN for the operating nuclear power units at Cernavodă NPP are presented in the following table for each receiving watercourse.

TABLE 42 - DERIVED RELEASE LIMITS APPROVED BY CNCAN FOR EACH NUCLEAR UNIT (U1 AND U2) IN OPERATION AT CERNAVODĂ NPP

LDE for liquid effluent emissions into the Danube-Black Sea Canal		**LDE for liquid effluent emissions into the Danube**	
Radionuclide/ Radionuclides Group	**LDE (GBq/year)**	**Radionuclide/ Radionuclides Group**	**LDE (GBq/year)**
H-3	1.97E+06	H-3	4.92E+07
C-14	8.94E-01	C-14	4.28E+01
beta-gamma		**beta-gamma**	
I-131	9.07E-01	I-131	2.39E+01
I-132	8.53E+01	I-132	1.28E+03
I-133	1.92E+01	I-133	1.17E+02
I-134	2.45E+02	I-134	1.40E+03
I-135	2.58E+01	I-135	4.21E+02
Cr-51	2.87E+02	Cr-51	1.14E+03
Mn-54	2.22E+00	Mn-54	5.11E+01
Fe-59	2.19E+00	Fe-59	4.48E+01
Co-58	3.87E+00	Co-58	2.47E+01
Co-60	1.54E-01	Co-60	4.77E+00
Zn-65	5.33E-01	Zn-65	2.47E+01
Sr-89	3.67E+00	Sr-89	9.81E+01
Sr-90+	9.66E-02	Sr-90+	3.98E+00
Zr-95+	3.95E+00	Zr-95+	2.98E+01
Nb-95	1.41E+01	Nb-95	9.42E+01

Mo-99	4.82E+01	Mo-99	8.84E+02
Ru-103	1.75E+01	Ru-103	3.98E+01
Ru-106+	1.52E+00	Ru-106+	4.21E+01
Ag-110m	9.37E-01	Ag-110m	4.21E+01
Sb-122	1.33E+01	Sb-122	3.11E+02
Sb-124	3.31E+00	Sb-124	1.28E+02
Sb-125	1.49E+00	Sb-125	7.16E+01
Te-132	3.06E+00	Te-132	1.10E+02
Cs-134	4.68E-02	Cs-134	1.99E+00
Cs-137	4.78E-02	Cs-137	2.24E+00
Ba-140	4.64E+00	Ba-140	5.11E+01
Ce-141	1.67E+01	Ce-141	2.65E+02
Ce-144	1.93E+00	Ce-144	5.51E+01
I-152	1.49E-01	I-152	5.51E+00
Gd-153	1.97E+01	Gd-153	1.79E+02
I-154	2.02E-01	I-154	7.16E+00
Hf-181	1.11E+01	Hf-181	3.25E+02

tritium removal facility

Emission sources consist of:

- Potentially contaminated fluids from the CTRF technological area (potentially radioactive liquid waste, including water from the fire extinguishing system and water resulting from equipment decontamination); will be collected by gravity in a sealed tank (with a volume of 6 m³) l^{oc}ated in the basement of the CTRF building, from where they will be transferred by pumping to the Radioactive Liquid Waste Management System at Unit 1. The maximum wastewater flow rate that can be taken over by the active sewage system and collected in the basin is 3.7 l/s.
- Liquid effluent emissions, both under normal operating conditions and accident conditions, are managed within the same effluent management system as that used for CANDU Units 1 and 2.
- The operation of the CTRF facility contributes to the reduction of tritium emissions associated with Units 1 and 2 of the Cernavodă NPP, by extracting the tritium accumulated in the heavy water used as a moderator and coolant in CANDU reactors.
- Consequently, the operation of the CTRF contributes to improving the environmental performance of the nuclear power plant, reducing the radiological impact on the population and the environment in the long term.

Small Modular Reactors-SMR

Planned discharges into the aquatic environment will comply with legal limits**.**

DFDSMA

The module is designed to perform the following functions: shielding the radiation source,

ensuring security during waste transport, mechanical resistance, minimising water infiltration and confining radionuclides.

It is planned to collect suspiciously radioactive water from the storage cells during operation (filling) or after the final closure of the storage cell.

Radioactive waste management activities (DFDSMA and DGA)

Under normal operating conditions, no liquid effluents are generated. However, contamination may occur if groundwater or soil can mobilise and transport radionuclides.

The repositories are designed to perform the following functions: shielding the radiation source, ensuring security during waste transport, mechanical resistance, minimising water infiltration, and confining radionuclides.

Potential emissions can also result from extreme situations, earthquakes, floods, changes in hydrogeology.

It is planned to collect suspiciously radioactive water from the storage cells during operation (filling) or after the final closure of the storage cell.

ELI-NP research infrastructure

Buildings where liquid effluents suspected of being radioactive are produced are equipped with special internal networks for their collection and storage.

Potentially contaminated liquids are treated in the Liquid Treatment Plant within the DMDR IFIN-HH which separates radioactive impurities. The water resulting from the liquid treatment plant is analysed and if it falls within the activity limits imposed by the CNCAN authorisation, it is discharged to the river through the C1 collector channel, otherwise the treatment cycle is repeated. The solid part (sludge) in which the radioactive materials are retained is treated as solid radioactive waste, according to the procedures in force and the limits in the operating authorisation.

Non-radioactive emissions

1. Non-radioactive gaseous emissions

Cernavodă NPP

Non-radioactive gaseous emissions come from:

- starting heating plant;
- Diesel generators
- auxiliary and support activities, transport activities and traffic within the premises – result in emissions of suspended particles.

Independent environmental assessments conducted for the Cernavodă NPP confirm that the impact of non-radioactive emissions is insignificant in the long term.

The technological process of producing electricity does not involve the use of volatile organic substances (VOCs) and does not lead to the formation of emissions of nitrogen oxides (NOx) or sulphur oxides (SOx).

Tritium removal facility

The emissions of the CTRF facility during its operation period consist of:

- gaseous emissions resulting from periodic tests of backup generating sets;

- emissions generated by fuel combustion in transport vehicles and other on-site machinery (e.g. NO_x, SO_2, CO, PM_{10}, $PM_{2.5}$ and VOCs).

The calculation of annual greenhouse-gas emissions yields a maximum value of approximately 395 t CO_2/year, based on the operating hours required for operational testing of the two standby diesel generator sets.

NO_x, NO_2, SO_2, CO, PM_{10} and $PM_{2.5}$ will be present for short periods.

The estimated direct greenhouse-gas emissions generated by the two standby diesel generator sets are a maximum of 395.03 t CO_2/year.

Estimated emissions from fossil fuel combustion from stationary sources standby diesel generator sets (from testing periods - 2 hours/month)

	NO_x kg/h	**SO_2 kg/h**	**CO kg/h**	**PM_{10} kg/h**	**$PM_{2.5}$ kg/h**
Flow	10,260	1,089	1,555	0.466	0.390

Source: Environmental Impact Assessment Report for the project "Construction of the Cernavodă Tritium Removal Facility"

Small Modular Reactors - SMR

Non-radioactive gaseous emissions from auxiliary equipment and support activities:

- Auxiliary equipment, emergency diesel generators, may produce limited air emissions but these are not anticipated to lead to significant impacts on air quality for sensitive receptors.
- Transportation of personnel and materials: Road traffic associated with personnel movement, material delivery, and equipment transportation contributes to minor, diffuse air emissions, similar to those encountered at other industrial sites.
- Nuclear Fuel Cycle Emissions: Non-radioactive emissions generated by the nuclear fuel cycle occur primarily in the upstream and downstream stages of reactor operation – namely in the fuel and waste fabrication, enrichment, transportation, and management processes – and occur predominantly off-site (Final Environ*mental Impact Statement for an Early Site Permit at the Clinch River Nuclear Site Reader's Guide April 2019).*

Radioactive waste management activities (DFDSMA and DGA)

The operation of the DFDSMA and DGA facilities generates emissions into the atmosphere that, under normal operating conditions, are non-radioactive. These emissions come from both the use of transport and machinery, as well as from current operating, maintenance and ventilation activities, being similar in type to those encountered in other underground or surface industrial facilities.

The air pollutants generated include nitrogen oxides, carbon monoxide and dioxide, sulphur oxides, particulate matter, volatile organic compounds and water vapour, as well as small amounts of dust, as a result of road traffic. Natural gas from rock, such as methane or other hydrocarbons, which are not radioactive in nature, may also be released in a controlled manner, but which are managed by ventilation systems to prevent safety risks. Under normal operating conditions, these emissions are limited in intensity, localised and do not lead to exceeding the permissible values of air quality indicators.

The DFDSMA and DGA facilities are designed and operated in such a way as not to allow the release of gaseous radioactive emissions or radioactive aerosols into the atmosphere. The isolation, protection and monitoring systems ensure complete separation between radioactive materials and the external environment, and the technological processes do not involve controlled discharges of radioactive substances into the air. Consequently, under normal operating conditions, no effects on air quality from a radiological point of view are anticipated.

Possible adverse effects on air quality are exclusively associated with exceptional or accidental situations, common to both types of objectives, such as damage to protection systems as a result of extreme natural phenomena, incidents during radioactive waste handling operations or unauthorised actions that may compromise the integrity of the facilities. Although the probability of these events is low, they are taken into account in security scenarios and intervention plans, and prevention and control measures are designed to minimise any possible impact on the environment and protected natural areas.

Therefore, from an air quality perspective, the DFDSMA and DGA objectives generate an emission profile comparable to that of other industrial activities, with no radioactive emissions under normal operating conditions, and potential risks are exclusively related to rare accidental events, managed through strict technical and organisational measures.

Research activities (ALFRED AND ELI-NP)

Non-radioactive emissions associated with research activities within the Alfred Project and the ELI-NP infrastructure are comparable to those generated by elements such as thermal power plants, generator sets or technological equipment. During operation, emissions of flue gases resulting from the combustion of fuels such as gasoline or diesel, as well as dust and fines from secondary technological activities, may occur. In addition, certain auxiliary sources, such as kitchens or other operational spaces, may generate emissions of volatile organic compounds such as acrolein. The impact of these emissions is reduced by applying specific technical measures, including the use of low-NOx burners, periodic equipment maintenance systems and flue gas control technologies, so that the level of emissions is maintained within the usual limits for industrial installations of similar complexity.

2. Non-radioactive liquid effluent emissions

Cernavodă NPP

TABLE 43 - REGULATED NON-RADIOACTIVE LIQUID EFFLUENTS DISCHARGED FROM CERNAVODĂ NPP

Category discharged water	Non-radioactive liquid effluents
Domestic wastewater (not radioactively contaminated)	In accordance with Government Decision No. 188/2002 - NTPA 002/2002, as amended and supplemented by Government Decision No. 352/2005
Technological waters	Temperature, pH Suspended solids, Total ionic iron, Chlorides, Ammonium sulphates, Phosphorus, BOD5, Sodium, Calcium, Magnesium, Petroleum product, Free residual chlorine, Hydrazine, Cyclohexylamine, Lithium hydroxide, Hydrazine + lithium hydroxide mixture Hydrazine + morpholine mixture,

	Hydrazine + morpholine + cyclohexylamine mixture, Rhodamine - with discharge into CDMN - with discharge into the Danube-Fluorescein - with discontinuous discharge, RGCC-100 Biomate 5716, ARQUAD MCB – 50 Biocide, Ethylene glycol, Ultima Gold LLT scintillation fluid, PRAESTOL A3040L
Stormwater, including that from underground drainage and that stored in the external drainage base	In accordance with the reference objectives for surface water quality classification

Tritium removal facility

Potential sources of pollution:

- The wastewater from the CTRF facility will be collected, transported and discharged through a separate system into the existing sewage network on the platform. The wastewater generated by the project reaches a volume of Q us 12 $m_{onths = 1,}$060 m^3 /^{y}ear.
- The rainwater from the CTRF is finally discharged into the Cernavodă NPP distribution basin.
- Cooling waters will not be part of the liquid effluents generated by the project. The continuous operation of the CTRF in a closed circuit will be ensured by refrigeration units.
- Potentially contaminated CTRF process effluents from the technological area, including water from the used fire extinguishing system and water resulting from equipment decontamination, will be collected by gravity in a sealed sump located in the basement of the CTRF building, from where they will be transferred by pumping to the Radioactive Liquid Waste Management System at Unit 1.

The CTRF project will be connected to the domestic and storm sewer systems, respectively to the Radioactive Liquid Waste Management System at U1.

Small Modular Reactors-SMR

Liquid effluent emissions result from the operation of the facility and will be regulated by the following regulatory acts:

- cooling waters (from cooling towers or auxiliary systems) - may contain dissolved salts, suspensions, biocide residues (chlorine, bromine, amine compounds) and anti-corrosive agents;
- domestic sanitary wastewater - treated before discharge;
- rainwater - can carry suspended particles, traces of oils/fuels from industrial areas;
- non-radiological liquid effluents from the operation of auxiliary systems and support facilities, such as HVAC (heating, ventilation and air conditioning) systems, control laboratories and equipment washing and maintenance activities.

DFDSMA

Non-radioactive liquid emissions consist of:

- domestic wastewater resulting from the use of sanitary units and from condensation;

- conventional, clean wastewater, resulting accidentally as a result of breaks/cracks in pipes;
- rainwater.

Radioactive waste management activities (DFDSMA and DGA)

In the operating phase (normal operation) of a deep geological repository when introducing and sealing waste, non-radiological emissions are mainly of a conventional, not nuclear, nature:

- infiltration waters (from rock or aquifer) pumped and drained from galleries that generally contain mineral salts, fine sediments, possibly dissolved construction additives.
- domestic wastewater from personnel activities;
- process water from equipment cooling or surface cleaning.
- minor oil/technical fluid leaks from machinery (prevented by strict procedures and retention basins).

Research infrastructure

The resulting emissions consist of: domestic water, rainwater, wastewater resulting from the company's own car wash platform.

7.11. WASTE GENERATION AND MANAGEMENT

According to the Consolidated Sustainability Report at SNN Group level (2024), the activities specific to the nuclear sector and affiliated entities are carried out in full compliance with the national and European legislative framework on waste management, having as its central objective the prevention of generation, minimisation, recovery and safe disposal of all waste flows, radioactive and non-radioactive.

Within nuclear facilities, all activities involving the generation, handling, treatment, temporary storage or disposal of radioactive waste are carried out based on authorisations issued by the National Commission for the Control of Nuclear Activities (CNCAN), according to national regulations harmonised with the standards of the International Atomic Energy Agency (IAEA).

The management and monitoring of waste resulting from the strategy implementation activity, from technological processes and from other auxiliary activities carried out, will be carried out in accordance with Emergency Ordinance No. 92 of August 19, 2021 on the waste regime, which establishes the necessary measures to protect the environment and the health of the population, by preventing or reducing the adverse effects determined by the generation and management of waste and by reducing the general effects of resource use and increasing the efficiency of their use.

The management of packaging and packaging waste will be carried out in accordance with the provisions of Law 249/2015, with subsequent amendments and supplements.

The transport of hazardous and non-hazardous waste on the territory of Romania will be carried out in accordance with the provisions of Decision No. 1061/2008, with subsequent amendments and supplements.

Waste generated during the implementation and execution of the plan will be classified and reported in accordance with Decision No. 856 of August 16, 2002 on waste management

records and for the approval of the list of waste, including hazardous waste.

The quantities and types of waste generated as a result of the implementation of all plans/projects provided for by the National Strategy will be estimated within each plan/project, usually from the conceptual phase.

The AGENȚIA NUCLEARĂ ȘI PENTRU DEȘEURI RADIOACTIVE is the national authority competent in the field of promotion, development and monitoring of nuclear activities for exclusively peaceful purposes and of the safe management of radioactive waste, including their final disposal. The activities for the safe management of radioactive waste and spent nuclear fuel are carried out on the basis of the National Medium and Long-Term Strategy for the Safe Management of Spent Nuclear Fuel and Radioactive Waste, a document that is developed by ANDR and approved by Government Decision. According to the provisions of Ordinance 11/2003, ANDR periodically develops and revises, taking into account technical and scientific progress, as well as the recommendations and good practices derived from peer reviews, the National Medium and Long-Term Strategy for the Safe Management of Spent Nuclear Fuel and Radioactive Waste.

The medium and long-term National Strategy on the safe management of spent nuclear fuel and radioactive waste, approved by Government Decision 102/2022, is the programmatic document on the basis of which radioactive waste management activities are carried out, including their final disposal and the decommissioning of nuclear and radiological facilities.

The management of radioactive waste and spent nuclear fuel, including their final disposal, is based on the following general principles:

a) the principle of "the radioactive waste generator pays";

b) the principle of responsibility of the radioactive waste generator;

c) the principle of using the best existing techniques and technologies without incurring unjustified costs for future generations and taking into account possible transboundary effects;

d) the principle of keeping the generation of radioactive waste to the minimum reasonably practicable level, in accordance with applicable national and international standards, both in terms of activity and volume, through appropriate design measures and operating and decommissioning practices, including the recycling and reuse of materials;

e) the principle of taking into account, in an appropriate manner, the interdependencies between all stages of the generation and management of radioactive waste and spent nuclear fuel;

f) the principle of a gradual approach to the implementation of measures, i.e. the documentation of the decision-making process must be proportional to the risk levels associated with the management of radioactive waste and spent nuclear fuel;

g) the principle of applying an evidence-based and documented decision-making process regarding all stages of spent nuclear fuel and radioactive waste management;

h) the principle of managing spent nuclear fuel and radioactive waste in safe conditions, including in the long term, with passive safety features, namely safety components that do not require external sources of mechanical, human or electrical energy action

The main types of waste estimated to be generated during the implementation and operation of the National Strategy projects are presented below, for projects/investments

where this information was considered in environmental documentation prepared and published by the date of preparation of this report.

1. Non-radioactive waste

Non-radioactive waste resulting from energy activities

According to the Environmental Impact Assessment Report for the project "Refurbishment of Cernavodă NPP Unit 1 and Expansion of the Interim Spent Fuel Storage Facility with MACSTOR 400 Modules", operation of Unit 1 after refurbishment will generate the same types of non-radioactive waste, in quantities similar to those generated during its first operating cycle. Similar types and quantities of waste are expected from the operation of Units 2, 3 and 4.

The main categories of non-radioactive waste generated at Cernavodă NPP are classified as follows:

- chemical waste resulting from the use of, or withdrawal from use of, various substances and mixtures;
- industrial waste;
- Household waste - waste similar to municipal waste.

The types of non-radioactive waste generated by operation of the nuclear facilities at the Cernavodă NPP site are presented in the following table:

TABLE 44 - TYPES AND ESTIMATED QUANTITIES OF NON-RADIOACTIVE WASTE GENERATED AT THE CERNAVODĂ NPP SITE

No.	Waste type	Waste code under Government Decision No. 856/2002	Annual quantity (tonnes)
1.	Waste oils	13 07 01*/ 13 02 08*	20 - 40
2.	Oils without halogen content	12 01 09*/ 13 05 07*	10 – 76
3.	Waste with organic matter content	16 10 01*/ 19 02 08*/ 16 03 05*	0.5 – 42
4.	Hydraulic turbine fluid (FRF)	13 01 11*	Included under waste oils
5.	Sulphuric acid solution	16 06 06*/ 11 01 06*	–
6.	Absorbents, filter materials and polishing materials	15 02 03	0.5 – 1.5
7.	Spent ion-exchange resins	19 09 05	0.2 – 40
8.	Plastic waste (containers for biological samples)	18 01 03*	0.8 – 1.5
9.	Construction waste (concrete, soil, gravel, etc.)	17 05 04/ 17 01 01/ 17 01 07/ 20 02 02	3000 – 10000
10.	Antifreeze (ethylene glycol)	16 01 14*	6 – 25
11.	Batteries and accumulators	16 06 01*	0 – 13
12.	PCB-free transformer oils	13 03 07*	0 – 76
13.	Laboratory reagents containing hazardous substances/mixtures	16 05 06*	1 – 13

14.	Expired medicines (KI)	18 01 09	0 – 25 (kg)
15.	Wood waste	17 02 01	2 – 12
16.	Iron and copper waste	16 01 17 / 17 04 05 / 17 04 01/ 15 01 04	20 – 630
17.	Paper waste	19 12 01 / 15 01 01 / 20 01 01	15 – 25
18.	Plastic waste	15 01 02 / 16 01 19	0.3 – 1
19.	Absorbents, filter materials and polishing materials contaminated with hazardous chemicals	15 02 02*	5 – 55
20.	Activated alumina (inorganic hazardous waste)	16 03 03*	0 – 3
21.	Polyurethane waterproofing material / glass wool	17 09 04	4 – 30
22.	Waste of aluminium	17 04 11/ 17 04 02	< 1
23.	Household waste	20 02 01/ 20 03 01	19620 m^3
24.	WEEE	16 02 03*/ 16 02 11*/ 16 02 13*/ 20 01 21*	0.5 – 15
25.	Waste electrical and electronic equipment	20 01 36/ 16 02 14	1 – 10
26.	Spent ceramic insulators	16 02 16	< 1
27.	Plastic packaging waste	20 01 39/ 15 01 02	< 1
28.	Plastic or glass packaging contaminated with hazardous substances	17 02 04*	< 1
29.	Used toners	08 03 17*	< 1
30.	Waste of polyurethane foam	17 06 04	< 4
31.	Glass waste	15 01 07 /16 01 20	< 1

Non-radioactive waste resulting from radioactive waste management activities (DFDSMA and DGA)

Conventional waste

- assimilable municipal waste (paper, cardboard, plastic, food waste from administrative and social spaces);
- packaging (bags, boxes, pallets, protective materials for equipment);
- construction and repair waste (in the case of maintenance work: concrete scraps, scrap iron, insulation materials);
- used oils and greases from mechanical equipment maintenance;
- electrical and electronic waste (WEEE) resulting from the periodic replacement of control equipment, computers, electrical systems;
- solvents, paints, adhesives and other chemicals used in maintenance;
- chemically contaminated absorbent materials (not radioactive);

Non-radioactive hazardous waste

- used filters from ventilation and air purification systems;
- residual chemicals from maintenance activities (solvents, paints, adhesives, technical detergents).
- used batteries and accumulators from electrical equipment and underground vehicles;
- chemically contaminated (not radioactive) absorbent materials used in technical interventions.

Cernavodă Tritium Removal Facility (CTRF),

The CTRF activity during its operation results in the following types of non-radioactive waste:

TABLE 45 - ESTIMATED QUANTITIES OF NON-RADIOACTIVE WASTE GENERATED OVER THE ENTIRE OPERATING PERIOD

Types of waste	Description	Waste code	Quantity/volume t
Paper and cardboard	Paper and cardboard waste generated by personnel servicing the facility	20 01 01	5
Glass	Glass waste generated by personnel servicing the facility	20 01 02	1.7
Plastic materials	Plastic waste generated by personnel servicing the facility	20 01 39	13
Metals	Metal items generated by personnel servicing the facility	20 01 40	1
Packaging containing residues or contaminated with hazardous substances	Packaging containing residues or contaminated with hazardous substances	15 01 10*	1.1
Absorbents, filter materials (including oil filters not otherwise specified) and protective clothing contaminated with hazardous substances	Absorbents, filter materials (including oil filters not otherwise specified) and protective clothing contaminated with hazardous substances	15 02 02*	0.3
Wooden packaging	Packaging waste - wood	15 01 03	5.5
Paper and cardboard packaging	Packaging waste - paper and cardboard	15 01 01	0.6
Plastic packaging	Plastic packaging waste	15 01 02	3.6
Composite packaging	Composite packaging materials	15 01 05	0.055
Mixed municipal waste	Household waste generated by personnel servicing the facility	20 03 01	32.5

Nuclear power plant based on SMR modules

According to public impact assessment studies as well as various other specialised studies and reports, some of the non-radioactive waste generated in nuclear facilities (especially

in auxiliary, maintenance or decommissioning operations) is similar to conventional waste produced by other complex industrial facilities.

This is because most of the ancillary activities in a nuclear facility – maintenance, construction, ventilation, laboratories, HVAC systems, mechanical and electrical installations, temporary storage, equipment washing – do not involve direct contact with radioactive materials. Therefore, the waste resulting from these streams does not contain radiological contaminants, but has characteristics similar to conventional industrial waste.

- Hazardous chemical waste: acids, bases, solvents, technical oils, anti-corrosive agents, corrosion inhibitors.
- Metal and plastic waste resulting from maintenance and auxiliary construction activities.
- Municipal/household waste: resulting from staff activities (paper, food scraps, packaging).

Mioveni Platform

The following table provides a general indicative list of waste that may be generated by operation of the ATHENA and ChemLab supporting research infrastructure.

TABLE 46 - TYPES OF WASTE POTENTIALLY GENERATED DURING OPERATION AND THEIR MANAGEMENT

Waste name	Waste code	Waste management
Metal waste	20 01 40	Collected separately and recovered through authorised companies in to the extent practicable
Wood waste	20 01 38	Collected separately and recovered through authorised companies, where recovery is practicable.
Plastic/ PET/ PVC	20 01 39	Collected separately and recovered through authorised companies in to the extent practicable
Cardboard/ Paper	20 01 01	Collected separately and recovered through authorised companies in limit of recovery possibilities
Household and industrial waste	20 03 01	Separate collection, temporary storage and disposal by specialised companies at a non-hazardous waste landfill
Electrical and electronic waste	20 01 35*	Collected separately and recovered through authorised companies within the limits of recovery possibilities.

The Măgurele Platform

The waste resulting from the ELI-NP project activity is: domestic water, waste resulting from research activity, waste from wastewater treatment plants, waste resulting from decommissioning activity, depending on the results of the radioactive concentration analysis.

The types of waste during the decommissioning period will be similar to those during the construction and operation period and the quantities will be established during the decommissioning design phase. It is stipulated by environmental and nuclear regulations that:

- the decommissioning of nuclear facilities will be the subject of a decommissioning plan/project that will be analysed from an environmental point of view;

- for each nuclear facility, CNCAN requires licensees to ensure the development of a preliminary decommissioning plan starting with the authorisation, construction and subsequent periodic updates until final shutdown. At this stage, the final decommissioning plan is developed (see CNCAN specific norm).

- decommissioning projects will be the subject of future updates of the SNDDN and PNN because they go beyond the 2030-2050 horizon, at least for the nuclear installations on the Cernavodă NPP platform.

2. Radioactive waste

The radioactive waste classification system is defined by CNCAN in regulation NDR-03, Norm on the classification of radioactive waste, approved by Order of the President of CNCAN no. 156/2005. In accordance with the provisions of art. 6 of Order 156/2005, the general classification of radioactive waste refers strictly to the requirements regarding the method of ensuring isolation from the biosphere during the final disposal of radioactive waste.

According to the general classification, radioactive waste is divided into:

a) exempt waste;

b) transitional waste;

c) very low-level waste;

d) short-lived low- and intermediate-level waste (LILW-SL);

e) long-lived low- and intermediate-level waste (LILW-LL);

f) high-level waste (HLW).

Cernavodă NPP

The types and quantities of solid radioactive waste forecast to be produced as a result of the Unit 1 reactor refurbishment activities were evaluated based on international experience and taking into account the technical solutions to be adopted in the pre-disposal stage.

This waste is divided into two categories according to the mechanism by which the materials became radioactive in the reactor systems. The first category, activated waste, includes pressure tubes, calandria tubes, spacers and lateral structural components. The second category comprises contaminated waste and includes components and equipment located outside the reactor core, together with equipment, tools and consumable materials radioactively contaminated as a result of refurbishment activities. For the first category, quantities and contamination levels were estimated using activation calculation codes; for the second category, the estimates were obtained by rescaling the quantities of waste generated during the retubing of Wolsong Unit 1 to the specific conditions of Cernavodă NPP Unit 1.

The following table presents the quantity of radioactive waste estimated to result from the Unit 1 refurbishment activities.

TABLE 47 - ESTIMATED INVENTORY OF SOLID RADIOACTIVE WASTE RESULTING FROM RETUBING CERNAVODĂ NPP UNIT 1

Radioactive waste source		Estimated volume after compaction [m³]	Volume reduction factor	Gross volume [m³]
Pressure tubes		8.62	2.8	23.98
Calandria tubes		5.710	5.5	31.48
Calandria-tube inserts		0.72	N/A	0.72
Lateral structural components		54.5	N/A	54.5
Feeder pipes		198.4	N/A	198.4
Other reactor components and low-activity waste (tools)		52.7	N/A	52.7
High-level waste from shielded equipment used for retubing		32.4	N/A	32.4
Low-level waste from shielded equipment used for retubing		62.9	N/A	62.9
Solid radioactive waste	Vinyl	129.4	8.55	1106
	Paper	111.8	9.50	1062
	Metal	90.4	3.22	291
	Textiles	69.6	8.49	591
	Plastic	39.6	11.74	465
	Other	91.7	8.94	820
Spent ion-exchange resins*		21.0	N/A	21
Spent filters		3.6	N/A	3.6
Total		973.05		4816.2

Note: Spent ion-exchange resins will be stored in the Unit 1 spent ion-exchange resin storage tanks.

The table below presents an estimate of the quantities of radioactive liquid waste that will result from the retubing activities of the Unit 1 reactor.

TABLE 48 - ESTIMATED QUANTITIES OF LIQUID RADIOACTIVE WASTE RESULTING FROM RETUBING THE UNIT 1 REACTOR

Liquid radioactive waste	Estimated quantity [L]
Demineralised water from the VRS cooler	200
Demineralised water from the	2000

CTI cooler	
CRC lubricating oil	80
Ethylene glycol	< 400
Hydraulic oil	< 400

Estimated quantities of waste from Units 1 and 2 of Cernavodă NPP - types, composition and quantities (according to the 2019 Environmental Permit)

Radioactive waste - types, composition, quantities

The radioactive waste managed under the radioactive waste management programme comprises solid low- and intermediate-level waste and organic and aqueous liquid waste. Radioactive waste is collected in dedicated containers labelled for each type of waste.

TABLE 49 - RADIOACTIVE WASTE

Waste type	Composition	Quantities 1996-2015 (m^3)	Interim storage method
1. Solid radioactive waste, Type 1* * - contact dose rate at the container surface containers < 2 mSv/h	> non-compactable	368.9	Interim Solid Radioactive Waste Storage Facility - storage hall - Type A packages
	> compactable	333.74	Interim Solid Radioactive Waste Storage Facility - storage hall - Type A packages
	> spent filter cartridges*	5.29	Interim Solid Radioactive Waste Storage Facility - spent filter cartridge repository
2. Solid radioactive waste, Type 2* * - contact dose rate at the container surface the containers 2 ÷ 125 mSv/h	> non-compactable	4	Interim Solid Radioactive Waste Storage Facility
	> spent filter cartridges*	1.24	Interim Solid Radioactive Waste Storage Facility - spent filter cartridge repository
3. Solid radioactive waste, Type 3* * - contact dose rate at the container surface containers > 125 mSv/h	> spent filter cartridges*	0.00	Interim Solid Radioactive Waste Storage Facility - spent filter cartridge repository
	> activated components from nuclear systems and highly contaminated items	0.00	Quadricell
4. Spent radioactive ion-exchange resins	IRN 77, 78, 150, 154; carbon	164.62	In three tanks made of reinforced concrete, lined on the inside with a layer of epoxy paint, capacity of each tank: 200 cubic metres
5. Organic liquid radioactive waste	> Used oil	53.02	Interim Solid Radioactive Waste Storage Facility - storage hall (after solidification in polymer NOCHAR) - industrial packages - Type A packages
	> spent solvent	2.42	Interim Solid Radioactive Waste Storage Facility - storage hall - industrial packages

	> scintillation cocktails	5.50	Interim Solid Radioactive Waste Storage Facility - storage hall - industrial packages
	> sludge	11.22	Services Building, elevation 93 m above Black Sea level, room S-006
6. Flammable solid radioactive waste	> cellulosic and plastic materials soaked in flammable solutions	43.12	Interim Solid Radioactive Waste Storage Facility - storage hall - Type A packages

Note*:

Type 1 waste: low-level, contact dose rate < 2 mSv/h;

Type 2 waste: intermediate-level, with contact dose rates between 2 mSv/h and 125 mSv/h;

Type 3 waste: intermediate-level, with contact dose rates above 125 mSv/h.

Spent nuclear fuel management

The management, handling and control of spent nuclear fuel is carried out according to practices approved by CNCAN and closely supervised by the International Atomic Energy Agency, IAEA, based on international conventions.

Waste resulting from the operation of DFDSMA and DGA

Radioactive waste consisting of very small quantities, generated by the operation of the repositories themselves, such as: personal protective equipment (overalls, gloves, boots, masks) that have come into contact with the controlled areas of the repository; cleaning materials and consumables contaminated with low levels of radioactive contamination; filters used in ventilation systems that can retain traces of radionuclides. Radioactive wastewater (especially from handling areas), which is collected separately, monitored and treated before discharge or reconditioned.

This secondary radioactive waste produced by DFDSMA personnel and equipment is classified as very low/low level waste (VLLW/LLW).

They are collected separately, radiologically monitored, conditioned and reintroduced into the facility's storage flow, so they subsequently become "storage waste", but have a different internal origin from shipments received from outside.

Cernavodă Tritium Removal Facility (CTRF)

TABLE 50- QUANTITIES AND CHARACTERISTICS OF SOLID RADIOACTIVE WASTE AND RADIOACTIVE OILS ESTIMATED TO BE GENERATED BY THE CTRF

BSI	System	Equipment location	Waste type	Quantity(kg)	Frequency
38520	Helium purification	TR03	Oil	15	Once a year
	Helium compressors	TR102	Oil	200	Once a year
	Metal bellows pumps, valves, transducers, tritium monitors	TR03	Solid	300	Once a year
38510	Columns LPCE	TR03	Catalyst/filler (solid)	2700	Every 5 years

	Dryers	TR03	Molecular sieves (solid)	300	Every 5 years
	Gasification column	TR02	Solid filling	40	Unknown
	Water pumps	TR02	Solid	15 kg × 13	One in 10 years
	Water pumps	TR02	Oil	10	8000 hours or every 2 years
	Mechanical filters	TR02	Solid	4	Once a year
38500	Maintenance materials (e.g. cleaning materials)	CTRF Building	Solid	200	Once a year
38590	LCS Valves/material replacement	TR02	Solid	50	Once every 10 years
38530	TGHSS - GBADS dryers	DR300 DR301	Molecular sieves (solid)	21.7 kg × 2 units	Once a year
38540	ADS	TR02	Molecular sieves (solid)	200	Once every 5 years

LCS - Liquid Collection System CTRF, BSI 38590
TGHSS - Tritium Gas Handling and Storage System, BSI 38530
ADS - Atmosphere Detritiation System, BSI 38540
LPCE - Liquid Phase Catalytic Exchange, BSI 38510
CDS - Cryogenic Distillation System, BSI 38520

In addition, the CTRF is estimated to generate a total of 1.4 m^3/year of spent ion-exchange resins associated with the two CANDU units.

SMR

The waste generated by the activity of SMRs is:

Radioactive waste related to reactor operation

- spent nuclear fuel – the most important flow, resulting from the operation of the reactor (the management method depends on the SMR technology);
- low- and intermediate-level waste (LLW/ILW) – results from water filtration processes in the primary circuit (ion exchange resins, sludge, contaminated filters).

Radioactive waste generated by the actual operation of the plant

- personal protective equipment (overalls, gloves, boots, masks) used in controlled areas;
- cleaning materials and easily contaminated consumables (cloths, rags, technical wipes);
- secondary packaging and containers for handling fuel or radioactive waste;
- radioactive wastewater (especially from primary circuit maintenance areas), which is collected, treated and monitored.

To date, there are few studies that have analysed aspects related to the management of radioactive waste generated by small modular reactors (SMRs), and those carried out so far have not yet been validated by detailed theoretical calculations or by an extensive comparative analysis of different design concepts.

Mioveni Platform

Radioactive waste generated during ALFRED operation includes spent nuclear fuel, activated materials (structures, cladding and other irradiated components), liquid and solid operational waste (e.g. filters, electrostatic components and purification components) and waste from decommissioning and dismantling. Quantities will depend on the reactor operating period and fuel-cycle efficiency; over the long term, spent nuclear fuel and activated reactor materials will constitute significant quantities.

Low/intermediate level waste will also result, consisting of inactive or slightly activated components, filters, wear materials, liquids, etc., which are relatively less hazardous, but require treatment and storage.

Măgurele Platform - ELI-NP Research Infrastructure

The radioactive waste results from liquid effluents - radioactive suspect waters and waste specific to the research activity: activated parts, targets. The solid part (sludge) in which the radioactive materials are retained in the Liquid Treatment Station within the DMDR IFIN-HH, which separates the radioactive materials, is treated as solid radioactive waste, according to the procedures in force and the limits in the operating authorisation.

The final disposal of low and medium-level waste resulting from ionising radiation applications in industry, medicine and research is carried out in the National Radioactive Waste Repository, located in Băița Bihor and managed by IFIN-HH.

Waste management plan

According to the Medium and Long-Term National Strategy on the Safe Management of Spent Nuclear Fuel and Radioactive Waste, the final disposal requirements for each category of radioactive waste are as follows:

i. exempted waste can be permanently disposed of without restrictions;
ii. transitional waste is stored on an interim basis until it qualifies as exempt waste, after which it may be disposed of without restriction;
iii. very low-level waste can be permanently disposed of on the surface, requiring less complex arrangements than short-lived low-level waste;
iv. short-lived low- and intermediate-level waste (LILW-SL) may be disposed of in near-surface disposal facilities;
v. long-lived low- and intermediate-level waste (LILW-LL) may be disposed of only in deep geological repositories;
vi. high-level waste may be disposed of only in deep geological repositories.

Short-lived low- and intermediate-level radioactive waste (LILW-SL) generated by the operation, refurbishment and decommissioning of the nuclear units at Cernavodă NPP will be disposed of in the DFDSMA. Until the DFDSMA is commissioned, LILW-SL radioactive waste will be stored on an interim basis in dedicated facilities at the Cernavodă NPP site.

Spent nuclear fuel is currently classified as waste and will be disposed of in a deep geological repository together with long-lived low- and intermediate-level radioactive waste (LILW-LL). Siting and construction activities for the repository will be planned so that the facility becomes operational in 2055. Until the deep geological repository is commissioned,

both spent nuclear fuel and LILW-LL radioactive waste will be stored on an interim basis in dedicated facilities.

LILW-SL radioactive waste generated by operation and decommissioning of nuclear and radiological facilities outside the nuclear fuel cycle, for example research facilities, will be disposed of at the IFIN-HH Băița Bihor National Radioactive Waste Repository (DNDR) until its closure. After closure of the DNDR, institutional LILW-SL meeting the requirements for near-surface disposal will be disposed of at the DFDSMA.

Management of LILW-LL radioactive waste from Cernavodă NPP

During the operation and maintenance of the two existing units at Cernavodă NPP, LILW-LL radioactive waste is generated. This radioactive waste includes spent ion exchange resins from systems not in contact with nuclear fuel (plus some resins in contact with nuclear fuel, depending on the operating time and irradiation history), filters, reactivated control rods and other components.

Additional quantities of LILW-LL radioactive waste are expected to be generated in the future when the nuclear units are refurbished to extend their operating lives. This radioactive waste will consist largely of metallic reactor components, including pressure tubes and calandria tubes.

LILW-LL radioactive waste resulting from operation and refurbishment of the Cernavodă NPP units must be segregated and stored on an interim basis at the site before final disposal in a deep geological repository, once that facility becomes available. According to the estimates in the Medium- and Long-Term National Strategy on the Safe Management of Spent Nuclear Fuel and Radioactive Waste, the total anticipated quantity of LILW-LL radioactive waste generated during operation and refurbishment of all four nuclear units is 852 m^3 (unconditioned waste volume). The DIDSR interim storage facilities for LILW-LL radioactive waste must be expanded to accommodate these quantities until the deep geological repository becomes operational.

International best practice is to process LILW-LL radioactive waste into a stable solid form suitable for final disposal. LILW-LL radioactive waste generated at Cernavodă NPP is stored on an interim basis at the site and will be treated, conditioned and packaged before final disposal in the deep geological repository. Its final disposal will comply with the waste acceptance criteria established for the geological disposal facility. Radioactive waste generated by research reactors is stored on an interim basis in dedicated facilities at the IFIN-HH and RATEN ICN sites.

Additional interim storage capacity is therefore required at the Cernavodă NPP site for the LILW-LL radioactive waste generated by refurbishment. The new interim storage facility must be available when refurbishment of Unit 1 begins. To meet this need, the SNDDN and PNN provide for construction of DIDR-U5 as part of the Units 1 and 2 Refurbishment Project; the facility will provide interim storage for both LILW-SL and LILW-LL waste generated during refurbishment.

Management of LILW-SL radioactive waste from Cernavodă NPP

According to the estimates in the M*edium- and Long-Term National Strategy for the Safe Management of Spent Nuclear Fuel and Radioactive Waste, operation* and maintenance

of Units 1 and 2, which are in commercial operation at Cernavodă NPP, generate approximately 100 m³/year (unconditioned volume) of LILW-SL radioactive waste. This quantity is expected to double when all four reactors are in operation. Larger quantities of LILW-SL radioactive waste will be generated in the future when Units 1 and 2 are refurbished to extend their operating lives.

The refurbishment process of a CANDU unit will result in a volume of approximately 1,200 m³ of LILW-SL radioactive waste.

Activities involving LILW-SL radioactive waste at Cernavodă NPP form part of pre-storage management, which precedes final disposal. Pre-storage management includes processing and interim storage, together with transfer operations undertaken for interim storage. Radioactive-waste processing comprises any operation that changes the characteristics of the waste, including pretreatment and treatment.

The processing takes into account the characteristics of each type of radioactive waste, as well as the requirements imposed by each stage of radioactive waste management. For solid radioactive waste in the LILW-SL category, pre-treatment includes the following activities: collection, sorting, neutralisation and decontamination and may also include an interim storage period. The treatment of solid radioactive waste in the LILW-SL category includes volume reduction by compaction or shredding, separation of incinerable from non-incinerable, after an interim storage period and is carried out by authorised operators.

Radioactive waste that is, or is suspected of being, contaminated with C-14 is not compacted and is packaged separately. Solid LILW-SL is packaged in 220-litre stainless-steel drums and transported for interim storage to the Interim Storage Facility for Solid Radioactive Waste (DIDSR), located within the physical-security perimeter of the Cernavodă NPP site. The facility is designed for interim storage of both LILW-SL and LILW-LL, except spent ion-exchange resins and reactivity-control mechanisms.

The management of spent ion exchange resins is carried out through the Cernavodă NPP radioactive spent resin handling system. The resins in contact with the nuclear fuel and those that do not come into contact with the nuclear fuel are separated and stored on an interim basis in 3 concrete tanks (200 m³ each), located in the basement of the Services Building.

For organic liquid waste and radioactive organic solid-liquid mixtures in the LILW-SL category, pre-treatment includes the following activities: collection, handling, segregation, neutralisation and storage in the basement of the Services Building.

The treatment of organic liquid radioactive waste and radioactive organic solid-liquid mixtures in the LILW-SL category includes changing the composition (solidification) by absorption in the polymer structure, reducing the volume of solidified radioactive waste by incineration, a method applied after a period of interim storage and carried out by authorised operators, removing radioactivity by decontamination methods (in the case of oils). Organic liquid waste and radioactive organic solid-liquid mixtures, classified in the LILW-SL category, after solidification, are subjected to characterisation and are temporarily stored (interim storage) within the DIDSR.

LILW-SL radioactive waste arising from the operation and refurbishment of the nuclear units at Cernavodă NPP is intended for final disposal at the DFDSMA, a repository planned for construction in the Cernavodă NPP exclusion zone. The waste will be disposed of at the

DFDSMA after treatment and conditioning by the licensee, in accordance with the DFDSMA waste-acceptance criteria.

Management of spent nuclear fuel from Cernavodă NPP

The operation of Units 1 and 2 at the Cernavodă NPP generates the majority of the spent nuclear fuel in Romania, at an average rate of approximately 180 tonnes U per year. According to the Energy Strategy, it is expected that another 2 CANDU units will be built at the Cernavodă NPP in the coming period. In this case, the total spent nuclear fuel generation rate will reach approximately 360 tonnes U per year, when the other two units become operational.

The Cernavodă NPP policy for the safe management of CANDU spent nuclear fuel resulting from the operation of Units 1 and 2 at Cernavodă NPP is as follows:

- wet interim storage in the spent fuel pool of each reactor, for a period of at least 6 years;
- dry interim storage in the dry interim storage facility for spent fuel, until final disposal in the deep geological repository.

The small quantities of spent nuclear fuel that were transported from the Cernavodă NPP to RATEN ICN for post-irradiation examination are stored on an interim basis in storage wells located in the hot cells within the Post-Irradiation Examination Laboratory.

The interim storage solution for spent nuclear fuel, chosen in 2000 and implemented at Cernavodă NPP starting with 2003, when the first DICA module was put into operation, is based on the MACSTOR (Modular Air-Cooled Storage) dry storage system developed by AECL, using the MACSTOR 200 module. Currently, a number of 27 MACSTOR 200 modules are authorised on the DICA site, with a capacity of 12,000 bundles/module.

Cernavodă NPP has carried out the necessary studies to switch to the MACSTOR 400 module which, compared to the MACSTOR 200 module, has double the storage capacity (24,000 bundles/module). An increase in the number of planned MACSTOR modules from 27 modules to 37 modules is foreseen as follows: 17 MACSTOR 200 modules and 20 MACSTOR 400 modules. The MACSTOR 400 modules will be built in stages, module by module, in a staggered manner, so as to ensure the necessary interim storage space for the spent fuel from the nuclear power units in operation.

Management of non-radioactive waste from Cernavodă NPP

According to the Environmental Authorisation, Cernavodă NPP does not carry out treatment, recovery, recycling and disposal operations of generated non-radioactive waste. Non-radioactive waste is collected separately at the place of generation and stored in containers identified for the respective type of waste, in specially designed spaces approved by regulatory acts.

Routines and cleaning standards are issued for carrying out waste collection activities from collection areas, arranging the spaces, labeling, recording and transferring them to temporary storage areas. Recoverable waste (ferrous and non-ferrous metals, plastic, PET, paper, batteries and accumulators, etc.) is handed over on a contractual basis to authorised companies according to specific legal requirements.

Hazardous waste is collected separately, correctly labelled and transferred from the place of generation to temporary storage areas (where applicable). Non-radioactive industrial waste is disposed of/recovered in accordance with plant procedures and specific legal regulations in force regarding the recording of quantity, nature, origin and, where applicable, destination, frequency, mode of transport, treatment method and disposal/recovery operations for appropriate reporting to environmental authorities. Municipal and municipal-like waste is collected and transferred on the basis of a service contract to ecological landfills.

Radioactive waste management Măgurele Platform

According to the IFIN-HH activity report, the Măgurele platform houses the Radioactive Waste Treatment Station, built in collaboration with companies from Great Britain and becoming operational in 1975, being specialised and authorised for the collection, treatment and conditioning of radioactive waste outside the scope of the nuclear fuel cycle.

Until the construction and commissioning of the radioactive waste management facility within IFIN-HH, the generated radioactive waste was stored on an interim basis in the Măgurele Fort. During the period 1974 – 1976, the waste stored in the fort was transferred to the STDR interim storage facilities, where it was fully treated and conditioned.

In 1985, following complex geological, hydrogeological, sociological, commercial and seismic studies, a radioactive waste management facility for the final disposal of short-lived low- and intermediate-level radioactive waste was developed and commissioned at Băița, Bihor County, and is also operated and managed by IFIN-HH. This facility is Romania's only final radioactive waste repository and, in accordance with the relevant National Strategy, will remain the only such facility for at least the next ten years; it is a facility of national importance for the safe management of institutional radioactive waste. The repository occupies two abandoned exploration galleries of a former uranium mine forming part of an extensive interconnected network of uranium prospecting and mining galleries. Gallery 50 and several cross-galleries leading to it were widened and modified for waste disposal before the facility became operational in 1985. The repository was designed for approximately 5,000 m³ of conditioned waste (21,000 standard 220-litre containers of low- and intermediate-level radioactive waste) and, after 39 years of operation, is currently 54% full. The original purpose of the two radioactive waste management facilities was to manage waste generated by research and development activities on the Măgurele Platform. Over time, they have developed into an integrated national infrastructure dedicated to the treatment and disposal of radioactive waste outside the nuclear fuel cycle. A team specialising in decommissioning nuclear facilities was also established to provide technical support to institutions seeking to terminate or commence operation of facilities carrying out nuclear activities.

Thus, the collection, transport, treatment and conditioning, interim storage and long-term storage of institutional radioactive waste (excluding waste generated by Cernavodă NPP operation and mining waste) are carried out by IFIN-HH through the Radioactive Waste Treatment Plant at Măgurele. Radioactive waste meeting the Waste Acceptance Criteria (WAC) established by the operating authorisations is treated, conditioned, transported and disposed of at the National Radioactive Waste Repository at Băița, Bihor County. The two facilities for pre-storage and final storage of LILW-SL waste were modernised between 2010 and 2015, resulting

in the implementation of treatment and conditioning technologies compatible with the applicable waste acceptance requirements.

Current activities are designed to ensure implementation of all principles for the optimal and safe management of radioactive waste. Appropriate conditions and facilities are provided for the interim storage of transitional radioactive waste pending radioactive decay; treatment, conditioning and storage technologies are implemented; suitable waste-handling methods are available; and administrative and organisational measures are applied at all stages of management under radiological safety conditions.

After completion of treatment operations intended to reduce volume (radiological characterisation and, where applicable, unrestricted release), including supercompaction and treatment of liquid radioactive effluents, the management process enters the conditioning stage. The purpose of conditioning is to obtain a stable final form suitable for handling, transport, interim storage and/or final storage. Conditioning consists mainly of immobilising the waste matrix and final packaging in an authorised package, resulting in a radioactive waste package that meets the applicable acceptance requirements for interim storage or final storage.

7.12. CUMULATIVE IMPACT OF THE STRATEGY (PROPOSED PLANS AND PROJECTS) WITH OTHER PLANS AND PROJECTS IN THE AREA

In order to identify and assess potential cumulative effects, existing, proposed or approved strategies/plans and projects that have direct links to the nuclear sector were analysed.

The following national strategic documents were taken into account, which may generate a cumulative impact with the SNDDN and which may affect protected natural areas of Community interest:

- Romania's Energy Strategy 2025-2035, with a perspective to 2050;
- Medium and long-term National Strategy on the safe management of spent nuclear fuel and radioactive waste;
- National Strategy for nuclear safety and security;
- RATEN Development Strategy for the period 2015-2025, Revision I, February 2021.

However, it is important to note that most of these documents contain projects already included in the SNDDN. Therefore, no additional cumulative impact is identified beyond that already assessed within the SNDDN. These documents are included in the analysis only to provide a complete strategic context, to ensure coherence and coordination of objectives, and to demonstrate alignment with national policies in the areas of energy, environment, and sustainable development.

The following table presents the main characteristics of these strategies, their general objectives and the link with the SNDDN.

TABLE 51 - MAIN CHARACTERISTICS AND GENERAL OBJECTIVES OF THE STRATEGIES AND THEIR RELATIONSHIP WITH THE SNDDN

Strategy	Main Features/Objectives
Romania's Energy Strategy 2025-2035, with a perspective to 2050	Energy security. Low-carbon energy Energy efficiency.

	Physical access to energy for all consumers and financial affordability and economic competitiveness of energy. Efficient energy markets. Digitalisation, smart grid development and cybersecurity.
National Strategy on the safe management of spent nuclear fuel and radioactive waste	Establishing appropriate national measures for a high level of safety in the management of spent nuclear fuel and radioactive waste, in order to protect workers and the population against the dangers associated with ionising radiation. Improving the information process and ensuring the necessary public participation regarding the management of spent nuclear fuel and radioactive waste, in compliance with the legal regulations in force regarding classified information and the principle of confidentiality.
National Strategy for nuclear safety and security	Nuclear security and nuclear safety share a common objective: protecting individuals, society and the environment against exposure to ionising radiation or radioactive contamination above the limits permitted by the legislation in force. The main objectives of the strategy focus on continuous improvement of nuclear safety, radiological protection, physical protection, control of protection systems, nuclear safety and security, as well as emergency response preparation, cybersecurity in the nuclear sector, improvement of management systems, national security competencies, intensification of international cooperation and provision of necessary resources.
RATEN Development Strategy for the period 2015-2025, Revision I, February 2021	Maintaining and developing the technical-scientific support capacity for the safe operation of the CANDU units of the Cernavodă NPP and extending their life time. Development of research activities for generation IV reactors, especially lead-cooled and modular fast reactors (SMR). Operation and development of nuclear facilities as essential infrastructure for scientific research, technological development and testing of RATEN under nuclear safety conditions. Management of radioactive waste and spent fuel under nuclear safety conditions. Maintaining and developing capabilities in design and technological engineering, operation and maintenance of nuclear facilities and power plants. Increasing the efficiency of environmental protection and improving radiation protection measures. Development and implementation of nuclear technologies for applications in industry, medicine, physical protection. Developing collaboration and cooperation within national and international bodies. Increasing the volume of services and products for internal and external partners. Developing skills and capabilities for implementing new research areas. Training and professional development of specialists in the field of nuclear R&D, knowledge transfer and R&D programme management.

Considering the above, for each major nuclear platform, existing approved projects or those in the process of approval were taken into account, which are interdependent with the objectives proposed by this strategy.

Cernavodă NPP platform – projects/installations other than nuclear power units and CTRF

- Siting, construction and installation of the Interim Radioactive Waste Storage Facility (DIDR-U5) within the former Unit 5 structure, whose intended use was changed from a nuclear power unit to technological spaces supporting the operating Units 1 and 2 and the future Units 3 and 4 throughout their service lives.
- Location, respectively construction and assembly for the expansion of the Intermediate Spent Fuel Storage Facility (ISF) of the Cernavodă NPP with MACSTOR 400 modules - used for dry interim storage of CANDU-6 type spent fuel bundles (Natural Uranium), until transfer to the DGA.
- The Interim Solid Radioactive Waste Storage Facility (***D***IDSR), used for the interim storage of solid radioactive waste generated by operation of the nuclear power units.

Related activities

- Diversification of the sources of supply of raw materials necessary for the production of nuclear fuel and further developments of SNN in relation to the initial part of the nuclear fuel cycle.
- Maintaining production capacities on the national territory of profitable activities in the field of uranium reserves exploitation, nuclear raw material processing and nuclear fuel production.

Mioveni Platform – projects/installations other than the ALFRED demonstrator and supporting experimental installations

- Nuclear fuel plant;
- TRIGA research nuclear reactor with 14MW stationary zone, 20,000MW pulsed zone;
- LEPI Post-Irradiation Examination Laboratory;
- Radioactive Waste Treatment Plant STDR;
- Radioprotection, Environmental Protection and Civil Protection Laboratory;
- Unit C6 – Section III.

Măgurele Platform - projects/installations other than ELI-NP

The National Research and Development Institute for Nuclear Physics and Engineering "Horia Hulubei" (IFIN-HH) owns and operates 6 facilities and objectives of national interest (in accordance with the provisions of Government Decision No. 786/2014, as subsequently amended and supplemented, on the approval of the List of facilities and special objectives of national interest financed from the funds of the Ministry of Research, Innovation and Digitalisation):

- TANDEM accelerator complex;
- CYCLOTRON TR19 accelerator;

- STDR radioactive waste treatment plant;
- IRASM multi-purpose irradiation facility;
- Advanced computing platform for research in physics and related fields – PACFIZ;
- Extreme Light Infrastructure – Nuclear Physics ELI-NP.

Summary of the effects generated by the implementation of the strategy

Most environmental effects generated by implementation of the National Strategy for the Development of the Nuclear Sector occur predominantly during construction of the specific projects. This stage produces the most significant temporary changes in air quality through increased dust concentrations and emissions from construction activities, together with possible accidental pollution of soil or surface water. Construction works may also increase noise and vibration levels and create temporary physical barriers for wildlife, with the potential for accidental mortality of some species, for example in connection with the DFDSMA and DGA.

In contrast**, during the operation** period, the environmental effects are considerably reduced and occur in a controlled and monitored regime, in accordance with strict nuclear safety and environmental protection regulations. Possible influences may refer to changes in water temperature in the thermal exhaust areas (for example in the case of the Cernavodă NPP) or to minimal radioactive emissions, constantly maintained below legal limits. By applying environmental impact prevention and reduction measures and continuous monitoring programmes, the impact during the operation period is negligible or insignificant, compared to that during the construction phase.

The implementation of the National Strategy for the Development of the Nuclear Sector generates significant positive effects on energy security, economic development and the consolidation of national technological capacities during the operation period. Through an integrated approach to the nuclear cycle, the strategy contributes to increasing Romania's energy independence, stimulating investments and the sustainable use of domestic resources, while ensuring compliance with international safety and environmental protection standards.

Maps summarising the objectives proposed by the strategy

FIGURE 66 - LOCATION OF NUCLEAR POWER GENERATION FACILITIES IN RELATION TO NATURA 2000 SITES

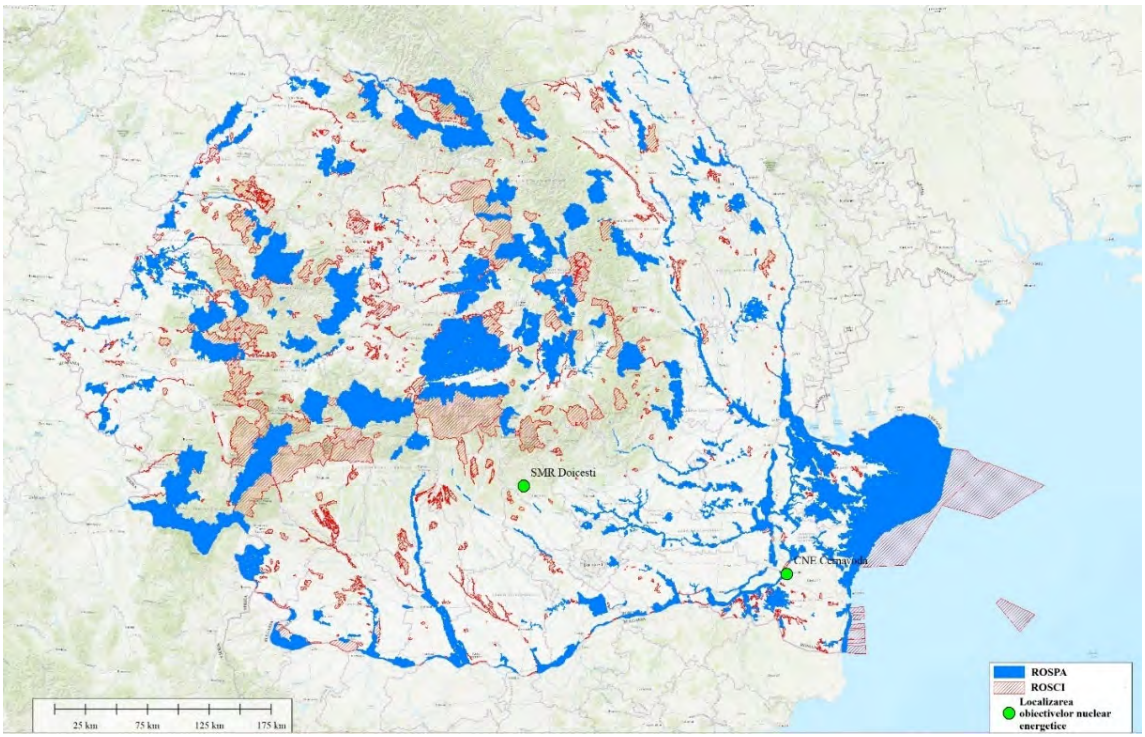


FIGURE 67- LOCATION OF RESEARCH FACILITIES IN RELATION TO NATURA 2000 SITES

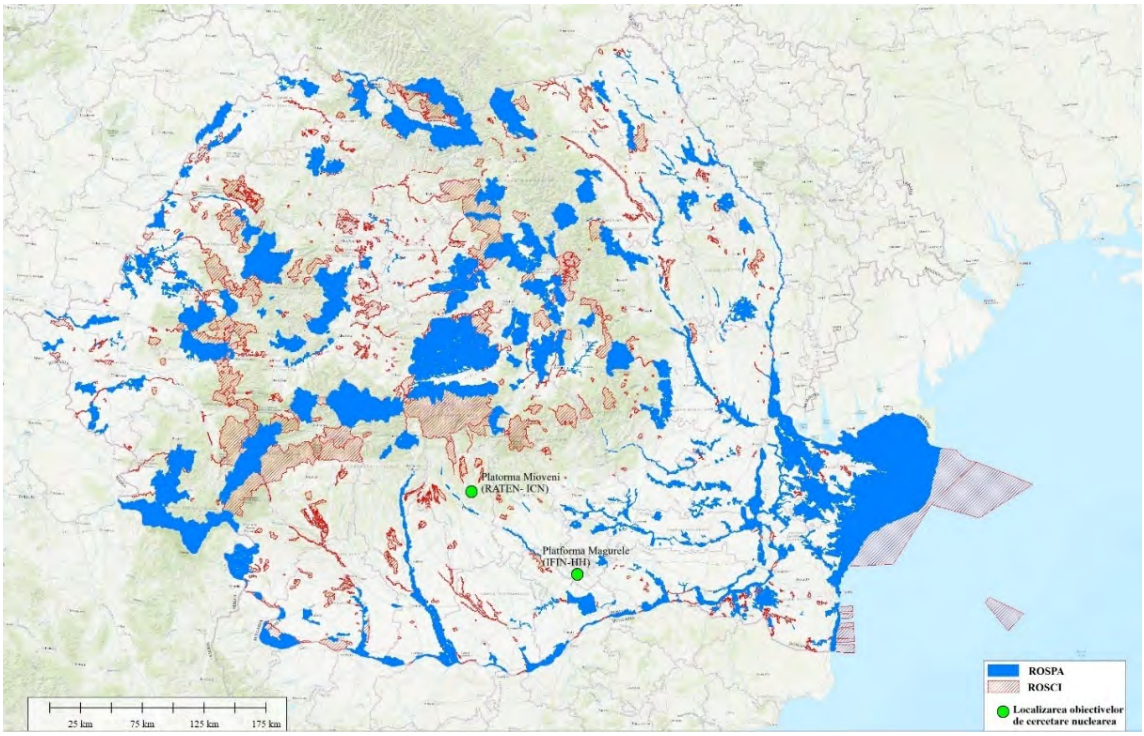
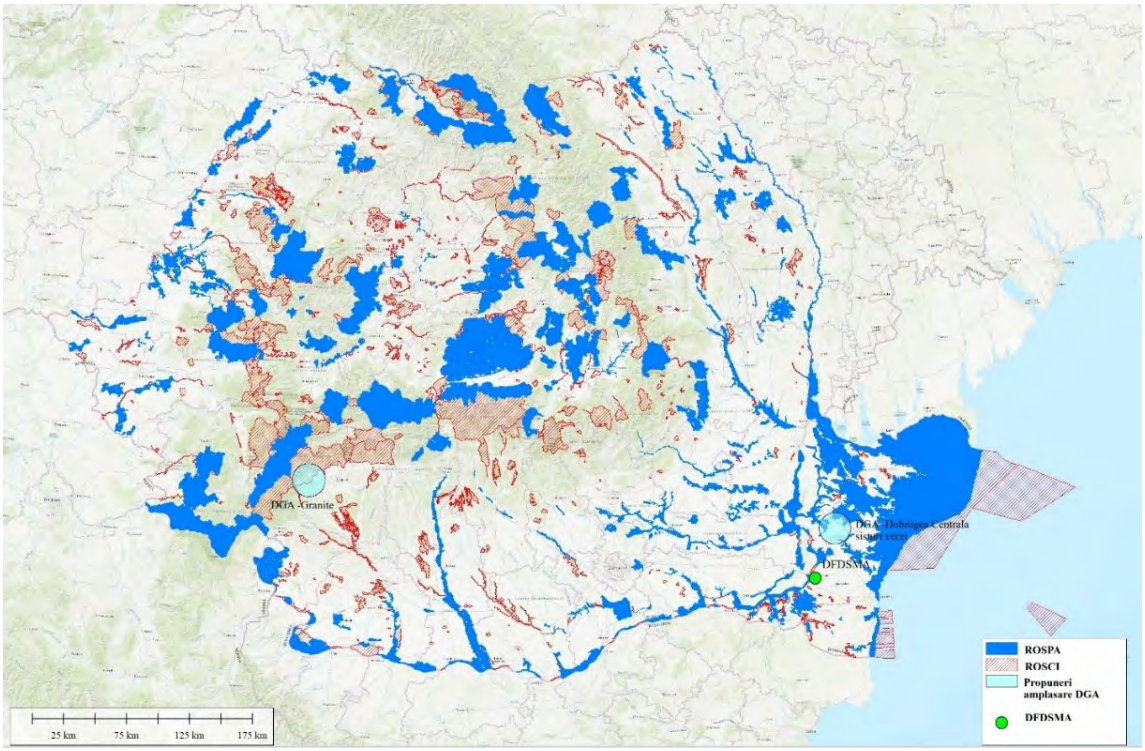


FIGURE 68 - LOCATION OF RADIOACTIVE WASTE DISPOSAL FACILITIES (DFDSMA AND PROPOSED DGA SITING AREAS - CENTRAL DOBROGEA GREEN SCHISTS VS. SOUTHERN CARPATHIAN GRANITES)



a.2) Effects generated by the Strategy projects

The following table presents the relationship between the effects generated during each stage of Strategy implementation:

TABLE 52 CORRELATION OF THE EFFECTS OF IMPLEMENTING THE STRATEGY

Change in air quality	Structural changes to soil	Increase in noise and vibration levels	Generation of radiation	Increase in pollutant concentrations in soil / accidental pollution	Increasing concentrations of pollutants in the aquatic environment	Changes in water-flow velocity/level	Changes in water temperature	Vegetation removal	Creation of physical and behavioural barriers to wildlife	Mortality of individuals	Destruction of nests/shelters	Introduction/spread of invasive species	Effects / Types of activity	Stage
x		x		x					x				Completion of units 3 and 4 at Cernavodă NPP	Construction
x		x		x					x				Re-technological upgrading of units 1 and 2 at Cernavodă NPP	
x		x		x					x				Construction works of the Cernavodă Tritium Removal Facility (CTRF), on the Cernavodă NPP platform	
x	x	x		x				x	x	x	x	x	Building the DFDSMA	
x	x	x		x				x	x	x	x	x	Building the DGA	
x	x	x		x				x					Construction of experimental support facilities for the ALFRED demonstrator	
x	x	x		x				x					Construction of the ALFRED demonstrator, intended to demonstrate the viability of LFR technology	
x	x	x		x					x				Construction of a nuclear power plant based on SMR modules	
													Construction of a research infrastructure for the production of radioactive beams and radioisotopes of medical interest	
													Developing technologies for fundamental and applied nuclear physics research with the high-power laser system at ELI-NP	
			x		x	x	x						conducting activity of output energy (Operation of units 1, 2, 3, 4) - including cooling water capture and technological wastewater discharge	- Operation
			x										conducting activity of output energy (SMR)	
			x										Research activities	
			x							x			Radioactive waste disposal activities	
x													Carrying out activities in administrative spaces, operational buildings and others	
x	x	x		x									Construction-site establishment	D E

x	x	x		x									Decommissioning / demolition works	
x	x	x		x									Land restoration/rehabilitation works at the end of the project life cycle	

Implementation of the objectives set out in the National Strategy for the Development of the Nuclear Sector (SNDDN) generates a range of environmental effects, with different intensities and characteristics depending on the project stage - construction or operation.

Construction period

During the construction phase, environmental effects are predominantly local, temporary and reversible, but may be significant within the intervention areas. Excavation, earthworks, material transport, equipment installation and infrastructure construction cause a range of effects on environmental components.

Changes in air quality may be recorded, caused by increased dust concentrations and emissions from machinery and site traffic. In parallel, excavation and storage activities may lead to structural changes in the soil and, locally, to accidental pollution, caused by leaks of fuels, oils or substances used in the construction process.

The works may generate increased noise and vibration levels, with the potential for discomfort for species on the project site, leading to a disruption of local fauna activity.

Construction site activities may cause the emergence of physical and behavioural barriers for wildlife, which may disrupt the activity of species, by modifying travel routes, feeding or breeding areas and, occasionally, accidental mortality of some individuals, especially in the case of DFDSMA and DGA.

Operating period

During the operation period, the effects on the environment are significantly reduced and occur in a controlled, stable and permanently monitored regime, according to nuclear safety and environmental protection requirements.

For nuclear power plants, operation involves the use and discharge of cooling waters, which can generate local changes in surface water temperature in discharge areas. These thermal variations are carefully monitored and regulated to prevent effects on aquatic ecosystems.

Regarding the research and development infrastructure, the operating effects are minimal, limited to negligible emissions to air, water or soil. These facilities do not involve water cooling systems and do not produce significant influences on the aquatic environment.

For the entire period of operation, the effects on air, soil and noise are maintained at a low level, within the limits allowed by legislation. Possible radioactive emissions are strictly monitored and remain constantly below legal thresholds.

In conclusion, the operating period is characterised by a controlled operating regime and predictable, with reduced environmental impacts, while the construction period remains the stage with the highest potential for generating impacts, due to direct physical works on soil, water, air and biodiversity.

The implementation of the SNDDN and the PNN has a major positive impact by strengthening a coherent framework of public policies for the nuclear sector, which integrates

objectives of nuclear safety, energy, research and development and radioactive waste management.

From a climate and air quality perspective, the most important positive contribution is related to the increase in the share of low-carbon electricity production, with a direct effect on reducing greenhouse gas emissions and supporting decarbonisation targets. Major nuclear capacity development projects (such as Units 3 and 4 of the Cernavodă NPP, respectively SMR projects) are explicitly presented in institutional communications as pillars for energy independence/security and for achieving the assumed decarbonisation objectives. In parallel, the decrease in dependence on fossil sources has collateral benefits on air quality (fewer emissions of NOx, SO_2, dust), with positive effects on public health, especially in areas where fossil energy remains an important source for covering consumption.

With regard to energy security and system stability, implementation of the SNDDN/PNN provides benefits by ensuring highly available baseload generation capacity capable of stabilising the power system as the share of variable renewable sources, such as wind and solar, increases. In this respect, nuclear projects are relevant not only for the quantity of electricity generated, but also for the system services they provide, including predictability, adequacy and reduced volatility. They therefore contribute to energy resilience and reduce the risk of supply shortfalls during periods of high demand or low hydropower availability.

Another important positive impact is the development of national research, development and innovation capacity, including through strategic infrastructures and projects associated with the nuclear sector (research, materials, radiation protection, medical/industrial applications). Through the existence of a strategic framework (SNDDN/PNN) that defines directions and objectives, investments in skills, laboratories, international collaborations and training programmes can be prioritised, which strengthens human capital and reduces dependence on external expertise in critical areas.

At the governance, regulatory and safety level, the implementation of the SNDDN/PNN has a positive effect by standardising requirements and increasing predictability for implementers and authorities: it clarifies institutional roles, integrates nuclear and radiological safety requirements and creates premises for multi-annual planning, including for waste management infrastructures and for long-term responsibilities. This institutional consolidation is also relevant for the environment, as it reduces the risk of fragmented approaches and increases the capacity for control and monitoring.

From an environmental and biodiversity perspective, there are indirect positive benefits, by reducing systemic pressures associated with climate change and air pollution, which are known to affect habitats and species (droughts, thermal extremes, hydrological changes). In other words, at a strategic level, the transition to low-emission sources supports the overall objective of maintaining the functioning of ecosystems in the long term.

In conclusion, the implementation of the SNDDN/PNN can have a positive impact by aligning with international initiatives and partnerships (technological, financial, expertise), which increases access to good practices and modern risk management and environmental performance mechanisms, including in the field of SMR and major investment projects.

INTERACTION BETWEEN ENVIRONMENTAL COMPONENTS

Considering, in the analysis, a main environmental component, the table below was developed, which highlights how the impact on one environmental component can generate effects on the other environmental components. The table indicates exclusively the existence of interactions between environmental components, without quantifying their intensity.

TABLE 53- QUALITATIVE ANALYSIS OF INTERACTIONS BETWEEN ENVIRONMENTAL COMPONENTS

Main environmental component	Interaction with other environmental components	Description of interactions – correlation with nuclear strategic objectives
Air	Population and human health	The activities related to the life cycle of nuclear facilities (design, construction, operation, decommissioning) can generate conventional atmospheric emissions and, under strictly controlled conditions, radioactive emissions within the limits established by CNCAN regulations. Ensuring nuclear safety involves the implementation of air radiological monitoring systems and the application of the ALARA principle, with a direct role in protecting the health of the population.
	biodiversity	Atmospheric emissions can influence terrestrial ecosystems in the vicinity of nuclear sites. By complying with nuclear safety and radiological protection requirements, the aim is to prevent any significant effects on biodiversity.
	Material goods and cultural heritage	Dust deposits associated with construction and decommissioning activities can affect material assets. The application of technical standards and control measures contributes to the security of critical infrastructure and the protection of heritage.
	Soil and subsoil	Atmospheric deposition can generate transfer of pollutants to the soil and subsoil. The nuclear strategy integrates prevention and monitoring measures, consistent with the long-term nuclear safety objective.
Water	Air	The management of technological wastewater from nuclear facilities is carried out in closed and controlled systems, so that the risk of impact on the air is minimal. This approach is an integral part of nuclear safety and environmental protection.
	Soil and subsoil	Any accidental leaks or losses may affect the soil and subsoil. In accordance with CNCAN and ANPM requirements, the strategy provides for redundant containment, monitoring and intervention systems,

Main environmental component	Interaction with other environmental components	Description of interactions – correlation with nuclear strategic objectives
		contributing to nuclear safety and the protection of natural resources.
	Population and human health	Protecting water resources used by the population is a major objective of nuclear safety. The strategy aims to prevent any contamination, including radioactive, that could have effects on human health.
	biodiversity	The use of cooling waters and possible thermal changes can influence aquatic ecosystems. The nuclear strategy integrates measures to prevent thermal impact and maintain the ecological status of waters, in accordance with environmental requirements.
	Material goods and cultural heritage	Water quality influences the sustainability of infrastructure and material assets. Controlled wastewater management contributes to the security of nuclear infrastructure.
Soil and subsoil	biodiversity	The siting of nuclear facilities may involve changes in land use and habitat loss. The strategy promotes efficient land use and site rehabilitation, consistent with nuclear safety and environmental protection objectives.
	Population and human health	Preventing soil contamination is essential for protecting the food chain and public health. This issue is addressed within the framework of nuclear safety and radioactive waste management.
	Material goods and cultural heritage	Soil contamination can affect the stability of buildings. The strategy includes monitoring and remediation measures, especially for historical nuclear sites, in accordance with the requirements of ANPM and CNCAN.
Noise and vibration	biodiversity	Noise and vibration are mainly associated with the construction and decommissioning phases. The impacts are temporary and manageable, being taken into account in the environmental assessments, without affecting the nuclear safety objectives.
	Population and human settlements	The strategy requires compliance with legal noise limits, in order to protect the population and maintain the social acceptability of nuclear projects.
	Material goods and cultural heritage	Vibrations can affect the integrity of buildings. The application of technical standards contributes to the security of nuclear and related infrastructure.
Climate	Air	Nuclear energy contributes significantly to the decarbonisation objective by producing electricity with low

Main environmental component	Interaction with other environmental components	Description of interactions – correlation with nuclear strategic objectives
		greenhouse gas emissions. At the same time, climate change is integrated into the safety analyses of nuclear facilities.
	biodiversity	Adaptation to climate change is essential for maintaining ecosystem balance in areas with nuclear infrastructure.
	Population and human settlements	Extreme weather events can affect the safety of nuclear facilities. The strategy integrates climate risk assessment to ensure nuclear safety and security.
	Material goods and cultural heritage	Climate change can accelerate infrastructure degradation. The strategy provides for measures to adapt and increase the resilience of nuclear facilities and associated infrastructure.

8. POSSIBLE SIGNIFICANT EFFECTS ON THE ENVIRONMENT, INCLUDING HUMAN HEALTH, IN A TRANSBOUNDARY CONTEXT

The activities covered by the NATIONAL STRATEGY FOR THE DEVELOPMENT OF THE NUCLEAR SECTOR IN ROMANIA FOR THE PERIOD 2026-2030, with a perspective to 2050, AND THE NATIONAL NUCLEAR PROGRAMME are subject to Law No. 22/2001, as amended, ratifying the Convention on Environmental Impact Assessment in a Transboundary Context, adopted at Espoo on 25 February 1991, and to Directive 2011/92/EU of the European Parliament and of the Council on the assessment of the effects of certain public and private projects on the environment, as amended by Directive 2014/52/EU (the EIA Directive).

For the purposes of Law No. 22/2001, "transboundary impact" means any impact, not necessarily of a global nature, generated by a proposed activity within the limits of an area under the jurisdiction of a Party, the physical origin of which is located, in whole or in part, in the territory under the jurisdiction of another Party.

The assessment of the likelihood of a transboundary impact must take into account a number of factors, such as: the possibility that the project will generate emissions into the atmosphere that will influence the air quality of other states, discharges into waters that may produce downstream effects on the territory of other states, or interventions on bird migration corridors, with the potential to affect species populations in other countries.

The analysis of the potential transboundary impact is carried out depending on the location of the future objectives of the strategy, the distances from the borders of neighbouring states, as well as how the activities related to these objectives can generate effects beyond borders.

The projects included in the National Strategy for the Development of the Nuclear Sector have different implementation periods, determined by factors such as the technical complexity of each project, completing the study stages and obtaining the necessary approvals in the pre-project phase, as well as ensuring compliance with regulatory and nuclear safety requirements, in the different stages of the authorisation process.

TABLE 54 - SNDDN OBJECTIVES ALSO INCLUDED IN RELEVANT RELATED STRATEGIES

No.	The objective	Relevant strategy
1	Completion of Units 3 and 4 at Cernavodă NPP	Romania's Energy Strategy 2025-2035, with a perspective to 2050 Integrated National Plan for Energy and Climate Change 2021-2030
2	Refurbishment of Unit 1 and Refurbishment of Unit 2 at Cernavodă NPP	Romania's Energy Strategy 2025-2035, with a perspective to 2050 Integrated National Plan for Energy and Climate Change 2021-2030
3	Building the DFDSMA	National medium and long-term strategy on safe fuel management spent nuclear and radioactive waste
4	Building the DGA	National medium and long-term strategy on safe fuel management spent nuclear and radioactive waste

5	Construction works of the Cernavodă Tritium Removal Facility (CTRF), on the Cernavodă NPP platform;	The Cernavodă Tritium Removal Facility (CTRF) is aligned with the objectives of Romania's Energy Strategy and the PNIESC concerning the modernisation and safe operation of existing nuclear capacity and is a supporting infrastructure investment for Cernavodă NPP.
6	Construction of a new nuclear power plant based on SMR modules;	Romania's Energy Strategy 2025-2035, with a perspective to 2050 National Integrated Plan for Energy and Climate Change 2021-2030, Updated
7	Construction of experimental support facilities for the ALFRED demonstrator	PNCDI IV – Programme 5.9 is part of the National Research, Development and Innovation Plan IV (PNCDI IV), which is the strategic framework through which Romania finances research and innovation.
8	Construction of the ALFRED demonstrator, intended to demonstrate the viability of LFR technology;	PNCDI IV – Programme 5.9 is part of the National Research, Development and Innovation Plan IV (PNCDI IV), which is the strategic framework through which Romania finances research and innovation.
9	Construction of a research infrastructure for the production of radioactive beams and radioisotopes of medical interest;	National Strategy for Research, Innovation and Smart Specialisation 2022-2027 - Romania participates in the development and operation of research infrastructures of European interest (ESFRI), including in nuclear physics and the use of high-power lasers.
10	Development of technologies for fundamental and applied nuclear physics research with the high-power laser system at ELI-NP.	

For the Unit 1 Re**furbishment Project, the Env**ironmental Agreement of 14 July 2025 presents the conclusions of the transboundary consultations. In March 2022, pursuant to Article 3 of the Espoo Convention, the Ministry of Environment, Waters and Forests transmitted the notification of the intention to implement the project, accompanied by the project presentation memorandum, to Bulgaria, Ukraine, the Republic of Moldova, Hungary and Serbia.

Following the analysis of the comments and observations received during the transboundary consultations on the environmental impact assessment report prepared for the project, MMAP considered it necessary to supplement it with an Addendum that would include both the analyses of the possible transboundary impact carried out by the expert team and which led to the results presented in the environmental impact assessment report, as well as the clarifications provided during the consultations with the parties potentially affected by the project implementation.

Environmental **Agreement No. 1/30.01.2**023 was issued for the CTRF project, "Construction of the Cernavodă Tritium Removal Facility". The CTRF project falls under Annex 3, point 2, to Law No. 22/2001 ratifying, as amended, the Convention on Environmental Impact Assessment in a Transboundary Context, adopted at Espoo on 25 February 1991. The project serves Cernavodă NPP, an activity listed in Annex 1, point 2(b), to Law No. 22/2001.

Impact on neighbouring countries: Bulgaria, Ukraine and the Republic of Moldova Under normal operating conditions, the radiological impact associated with tritium emissions from the CTRF on the surrounding population was estimated as a maximum annual effective dose of 0.7 microSv/year. This effective dose value is estimated for a person residing at the edge of the exclusion zone.

Under these conditions, it can be stated with certainty that the emissions associated with the normal operation of the CTRF have no significant effect on people in neighbouring countries. Moreover, it has been shown that after the commissioning of the CTRF, even after the first year of operation, a reduction of up to 17% of tritium emissions from unit 1 of the Cernavodă NPP can be achieved, which will mean a proportional reduction in the effective dose to the population.

The non-radioactive impact on environmental components, both direct and cumulative, will be negligible, local, reversible and short-term, taking into account the location of the CTRF within the NPP perimeter, the small size of the tritium removal facility, the connection to NPP utilities and the application of NPP procedures for chemical and waste management.

For com**pletion of Cernavodă NPP Units 3 and 4, an Environm**ental Agreement was issued for the project "Continuation of the Construction and Completion Works for Units 3 and 4 at Cernavodă NPP" and approved by Government Decision No. 737 of 25 September 2013; it includes the results of the transboundary procedure,

SMR

For the SMR project, the preliminary engineering design (FEED) was carried out with continued engineering and design studies.

An SMR project in Romania will require an environmental impact assessment in accordance with the applicable legislation. The Espoo procedure (transboundary notification and consultation) will be initiated if the assessment identifies possible transboundary effects. The project falls under Annex I, item 2(b): nuclear power stations and other nuclear reactors, including the dismantling or decommissioning of such power stations or reactors, except research installations for the production and conversion of fissile and fertile materials whose maximum power does not exceed 1 kW of continuous thermal load.

The SMR project is included in the National Integrated Plan for Energy and Climate Change 2021-2030 for which Environmental Endorsement No. 49/14.10.2025 was obtained.

Final Repository for Short-Lived Low- and Intermediate-Level Radioactive Waste (DFDSMA)

For the DFDSMA investment, an Environmental Endorsement was obtained at the PUZ stage in accordance with environmental legislation. The procedure for obtaining the Environmental Agreement is currently in progress. The project falls under Annex I, item 3, and the Espoo procedure will be initiated if the impact assessment identifies possible transboundary effects.

Deep Geological Repository (DGA)

The Deep Geological Repository (DGA) is at the development stage, which comprises site selection, design and construction, followed by operation and closure. Planning of the geological disposal programme follows a phased approach, including the acquisition of the required regulatory documents. The project falls under Annex I, item 3, and the Espoo procedure will be initiated if the impact assessment identifies possible transboundary effects.

The experimental facilities supporting the research infrastructure for radioactive beams and radioisotopes of medical interest, and the development of high-power laser technologies (ELI-NP), do not normally fall within the scope of the Espoo Convention; therefore, a transboundary procedure is not required.

The failure to implement the National Strategy does not require a transboundary strategic assessment; however, specific projects that will emerge later will trigger, as appropriate, EIA/Espoo procedures at project level.

9. PROPOSED MEASURES TO PREVENT, REDUCE AND COMPENSATE FOR ADVERSE ENVIRONMENTAL EFFECTS

According to the provisions of Government Decision No. 1076/2004 on establishing the procedure for carrying out strategic environmental assessment (SEA), sectoral strategies must integrate adequate measures to prevent, reduce and, where appropriate, compensate for significant environmental effects generated by their implementation.

In this context, the general objective of this chapter of the National Strategy for the Development of the Nuclear Sector is to define a coherent and integrated framework of technical, institutional and socio-economic measures, aimed at ensuring:

- measures to prevent, reduce and compensate for significant environmental effects;
- protection of public health and the environment throughout the life cycle of nuclear facilities and activities, including the design, construction, operation, decommissioning stages, as well as the management of spent nuclear fuel and radioactive waste;
- full compliance with the principles and requirements applicable in the field of nuclear and radiological safety, with the objectives of the circular economy, as well as with the requirements of adaptation and resilience to climate change, in line with national and European commitments;
- Consolidation of the positive effects generated by the implementation of the strategy. The objectives relating to nuclear applications intended for environmental monitoring are predominantly of a research, development and monitoring nature and do not require, at a strategic level, additional impact reduction measures.

The strategic objectives, directions of action and specific activities of this National Strategy for the nuclear sector are recommended to be achieved by permanently reporting to the fundamental principles of environmental and security policy and in compliance with the fundamental principles postulated within the strategy:

- nuclear activities are carried out taking into account sustainable development, without endangering the environment and without compromising the ability of future generations to meet their own needs;
- the use of nuclear energy must provide benefits that outweigh the costs and associated risks;
- nuclear activities are carried out within a coherent, predictable and perfectly aligned legislative and organisational framework with international regulations in the field, ensuring the implementation of a safe and controlled nuclear energy programme;
- carrying out nuclear activities in a predictable climate, based on long-term commitments at the political and institutional level;
- compliance with the "polluter pays" principle in nuclear activities and the assumption of responsibility by everyone in the field, according to the regulations in force;
- carrying out activities for exclusively peaceful purposes, taking into account the risks posed by the proliferation of nuclear weapons;

- nuclear activities must be carried out under conditions of maximum security, so that the population and the environment are protected in accordance with national and international standards and regulations in the field;
- the population and the environment, present and future, must be protected against the risks of radiation and radioactive waste must be managed in a manner that avoids imposing undesirable burdens on future generations;
- the educational system and the continuous development of personnel skills, as well as the support of research-development-innovation activities in the nuclear sector, must be calibrated to meet the needs of the national nuclear programme;
- the principle of precaution and prevention will be applied so that through design the impacts are avoided or minimised at source;
- the selection of technologies, technical solutions and operational practices will be carried out based on environmental performance, resource efficiency and cost-effectiveness, by applying the best available techniques (BAT/BREF), where appropriate, in particular for associated conventional facilities and activities (e.g.: auxiliary facilities, non-radioactive waste treatment facilities, auxiliary energy facilities, industrial wastewater treatment plants). For components specific to the nuclear sector, the selection of technical solutions will be carried out in accordance with the principles of nuclear safety and radiation protection, by applying the relevant international standards and guidelines (IAEA), the EURATOM legislative framework, as well as the applicable national regulations (including CNCAN requirements), taking into account the ALARA principle and the requirements for the safe management of radioactive materials and waste.
- in the case of projects involving new locations, these will be established in such a way as not to affect sanitary protection zones or other areas with a protection regime, in compliance with the regulations of Order 119/2014 for the approval of the hygiene and public health norms regarding the living environment of the population;
- For each proposed plan or project, the legal regulatory procedures from the point of view of environmental protection (strategic environmental assessment - SEA and/or environmental impact assessment - EIA) will be followed, in order to identify and select the optimal implementation options, with minimal impact on environmental components, population health and nuclear safety.
- developing monitoring plans for objectives throughout their duration (design, construction, operation and decommissioning stages);
- alignment with EU sustainability policies in implementing the strategy, to ensure coherence with EU climate, biodiversity, circular economy and social policies.

The National Commission for the Control of Nuclear Activities (CNCAN) is the national authority responsible for the regulation, authorisation and control of nuclear activities in Romania.

Nuclear security and nuclear safety have a common objective, namely the protection of the population, professionally exposed personnel, patients and the environment against exposure to ionising radiation or radioactive contamination above the limits permitted by the legislation in force.

Through the norms it issues based on legal provisions, and through the authorisation and control processes it manages, CNCAN ensures the framework for the safe conduct of nuclear activities for exclusively peaceful purposes.

Taking into account the environmental objectives set out in Chapter 6 and the potential impact on environmental components and human health as a result of the implementation of the actions set out in the National Strategy, the table below describes the measures proposed to prevent and reduce significant adverse effects.

As a general measure to protect biodiversity, the provisions imposed by art. 33 of Government Emergency Ordinance no. 57/2007 on the regime of protected natural areas, the conservation of natural habitats, wild flora and fauna, approved with amendments and completions by Law No. 49/2011, will be respected.

The measures for preventing/reducing potential impacts on the environment and human health are presented below.

TABLE 55 - MEASURES FOR PREVENTING/REDUCING POTENTIAL IMPACTS DURING THE IMPLEMENTATION PERIOD

Measure/Recommendation		
O1	**Air and climate protection**	
M1	Maintaining air quality	Maintaining air quality by complying with the maximum permitted limits for atmospheric emissions, in accordance with the legislation in force and the applicable regulatory requirements, during implementation of the Strategy. During the project implementation stage, emission control measures established through the environmental impact assessment procedure and through regulatory acts issued for the project will be applied, in accordance with the legislation in force. Specific measures will be adopted to reduce dust emissions (wetting, covering materials, traffic and transport control), as well as for appropriate waste management. Where appropriate, monitoring of background radiological parameters will be ensured, in accordance with the requirements of the competent authorities.
M2	Air pollution prevention	Reducing atmospheric emissions through the use of modern, low-pollution equipment and low-sulphur fuels, as well as by promoting hybrid equipment, where feasible. Low-emission materials and processes (e.g. low-VOC products, prefabricated elements) will be used to reduce diffuse emissions and the duration of site activities. Logistics optimisation will include establishing routes

		that avoid populated areas, using rail or sea transport where possible, as well as developing domestic supply infrastructure (e.g. charging stations).
M3	Reducing greenhouse gas emissions.	Reducing GHG emissions by optimising transportation and efficiently locating new landfills in proximity to waste generation sources, to reduce transportation distances. Solutions adapted to climate change will be integrated into the design, as well as the use of modern equipment and vehicles, with low consumption and low emissions, while ensuring their proper maintenance.
M4	Choosing locations outside areas with extreme phenomena	The selection of locations will be carried out by avoiding areas with high hazard associated with hydro-meteorological and geotechnical phenomena, based on hazard maps and specialised studies, in order to reduce the risks generated by floods, erosion, landslides or extreme weather conditions.
M5	Application of the principle of radiation protection	Ensuring radiological protection by integrating safety measures from the design phase (shielding, ventilation and filtration systems, interlocks, isolation systems), as well as by respecting the ALARA principle. Radiological zoning (controlled and supervised areas), access control, appropriate marking and monitoring of personnel exposure will be implemented, in accordance with the requirements of the competent authorities.
O2	**Protection of the water component**	
M6	Compliance with legal limit values for pollutant concentrations in wastewater	Ensuring the protection of surface and groundwater by respecting limit values for pollutants, according to the legislation in force and applicable regulatory acts. Project proponents will implement measures to prevent and reduce effects on water resources, in accordance with the requirements of the opinions and permits issued by the competent authorities and with the environmental objectives established by the Water Framework Directive and River Basin Management Plans.
M7	Protection of groundwater and surface water quality	Preventing contamination of groundwater and surface waters by appropriately choosing locations, depending on hydrogeological conditions, and by implementing technical measures to limit the infiltration of pollutants.

		Protection and confinement systems will be implemented (waterproof platforms, geomembranes, sealed gutters, safe tanks), as well as the separation of clean waters from potentially contaminated ones. Waste management will be carried out in specially designed spaces, and uncontrolled discharges of wastewater will be avoided, including during the construction period. In the case of radioactive materials, adequate containment barriers will be provided.
M8	Protection of drinking water quality	Ensuring the quality of drinking water through periodic monitoring of microbiological and physico-chemical parameters, in accordance with the requirements of the legislation in force.
O3	**Protection of the soil and subsoil component**	
M9	Prevention of soil pollution and soil surface degradation as a result of activities carried out during the project implementation stages	Soil protection by complying with project requirements at all stages of the works (construction, decommissioning, stripping, closure) and by implementing measures to prevent chemical contamination and physical degradation. Measures will be implemented to prevent accidental pollution generated by machinery and transport, ensure adequate waste management, as well as soil monitoring and rapid intervention in the event of contamination.
M10	Ensuring the management of radioactive waste and spent fuel in accordance with the applicable national legislative framework, the regulations and requirements of the competent national authority in the nuclear sector, as well as the international obligations assumed by Romania.	Ensuring the safe management of radioactive waste and spent fuel, in accordance with national legislation, the requirements of the competent authority and the international obligations assumed by Romania. Measures will be implemented for the collection, packaging, transport, storage and controlled disposal of waste, by category, ensuring traceability and optimising transport. The decommissioning of nuclear facilities and the final disposal of waste will be carried out under safe conditions, taking into account environmental, economic and social factors, as well as ensuring radiological monitoring during the operation, closure and post-closure of the repositories.
M11	Restoring soil quality where necessary	Restoring the quality of affected soils by assessing the degree of contamination, eliminating or isolating pollution sources and implementing remediation and ecological restoration measures, in order to bring them

		to a state suitable for the planned use. Verification of compliance with target values and post-remedy monitoring will be ensured.
M12	Management of non-radioactive waste	Ensuring the safe management of non-radioactive waste, through collection, packaging, transport, recovery and controlled disposal, depending on its type. The implementation of a monitoring and reporting system will be ensured, allowing for the traceability of waste throughout the entire management chain, in accordance with legal provisions. Waste resulting from the decommissioning of the facilities will be managed and disposed of safely, taking into account environmental, economic and social factors.
O4	**Biodiversity protection**	
M12	Maintaining the favourable conservation status of habitats and species of wild flora and fauna within protected natural areas of Community interest.	To the extent possible, the placement of the objectives proposed by the National Strategy in protected natural areas should be avoided. Compliance with the provisions of the regulatory acts issued for the relevant Strategy projects, where applicable. Verification of the site and its release (translocation) of any fauna of Community interest with reduced locomotor capacity, to appropriate proximal areas (green spaces), before starting the land preparation works; ecological surveillance of the site will be ensured to ensure the translocation of any fauna species that enter areas with potential technological risk (construction site, work fronts, etc.). Installation of textile mesh (construction site shading net - green) to reduce dust propagation at the construction site boundary. Wetting (sprinkling) of work fronts and unstructured access routes. For the Cernavodă NPP projects (Unit 1 refurbishment), maintaining earthen ramps at 45° inclinations at the level of excavations, trenches and foundation pits, to allow micro/mesofauna species that may accidentally fall into them to climb them. For the Cernavodă NPP projects (Unit 1 refurbishment) the use of light sources devoid of the UV component capable of attracting nocturnal species.

		Driving at low speed on unstructured access roads within the construction site perimeter. Creating a convex profile at the access roads level, to allow rainwater to drain towards their boundary and thus avoid the appearance of puddles. For the Cernavodă NPP projects (Unit 1 refurbishment), the construction of networks of grassed rainwater gutters along the access and perimeter roads, at the boundary of the construction site perimeter, to ensure efficient drainage of rainwater; these will function as aggregation areas for amphibian species, invertebrates, etc., effectively limiting their penetration into areas that may pose technological risk problems; in addition, they will function as mechanical steps to retain dust particles washed from the site. Site traffic and equipment operation will be limited to specified routes and work schedules. Inappropriate storage of waste resulting from the works will be avoided. At the end of the works, the temporarily occupied land areas will be ecologically restored. The land area temporarily occupied during the construction period must be judiciously limited to the strict minimum. The location of the construction site organisation, the route of the access road must not affect additional areas, other than those provided for by the project. Vehicles transporting construction materials and construction site equipment will use only existing operating roads or routes approved by projects. Avoiding the location of the deep geological repository within protected natural areas, if there are other solutions (feasible locations outside them). Adapting repository design solutions to take climate change aspects into account No additional land areas will be affected compared to those provided for in the projects. At the end of the works, the temporarily occupied land areas will be ecologically restored. Use of high-performance, quieter equipment and techniques with the lowest practicable emissions. During the execution of the works, appropriate

		measures will be applied to prevent the accidental introduction of invasive alien species, including through the proper management of excavated material, the inspection and cleaning of machinery and equipment coming from other locations, and the application of good environmental management practices. Mechanical removal (proven to be the most effective method of controlling the expansion of invasive species - cutting, mowing, uprooting) of the above-mentioned plant species will be carried out, if the presence of these species is found in the area of future construction works. To avoid affecting vegetation as a result of dust carried in the air and which will subsequently settle on the aerial vegetative organs of plants, the transport of construction materials will be covered as much as possible, and the roads will be watered periodically during the hot season. Technological processes that produce a lot of dust, such as earth fillings, will be reduced during periods of strong wind or more intensive wetting of surfaces will be carried out. For the DGA project, depending on the nests identified, if they cannot be relocated, a buffer zone will be established, and construction activities will be avoided between March 15 and June 10. Waterlogging and the formation of marshes/wetlands on project sites should not be allowed, as they attract water-loving bird species or aquatic-dependent organisms (e.g. amphibians). Any specimen of species of Community interest that will be observed in the area of the construction site organisation or the area where the actual works are being carried out and that is in danger due to the specific works in the area, needs to be relocated. During the construction period, the huts, containers, tanks, ecological toilets, etc., will be placed away from the ground (on metal beams, wooden cabinets, bricks, etc.), to allow the free movement of reptiles and also to prevent them from seeking refuge in the aforementioned facilities. All the enclosures mentioned in the previous

		paragraph will be closed in the absence of workers and even during working hours, in order to prevent wildlife from seeking refuge inside (especially valid during the spring, summer and autumn seasons). Avoid any leakage of liquid fuels, oils, paints, etc. onto the ground. In the event of accidental pollution, these will be eliminated by applying absorbent materials and removed from the site by contracting companies specialised in managing these types of hazardous waste. Fuels, lubricants, paints and other potentially hazardous substances will be stored only in the quantities necessary to carry out the work, in specially designed spaces, waterproofed and equipped with prevention and intervention measures in case of accidental leaks, in compliance with applicable legislation. Construction equipment will be refueled only in specially designated areas without contaminating the soil with petroleum products. Complete prohibition of burning green or dry vegetation, stubble, pasture, at any time of the year Limiting the speed of vehicles in order to avoid road-kill deaths.
O5	**Population health and human settlements**	
M13	Maintaining and improving the quality of the environment and the health of the population in areas potentially affected by the implementation of the strategy	Ensuring environmental protection and the health of the population in potentially affected areas, by implementing measures to reduce the impact of activities, including reducing dust emissions and noise levels generated by traffic and temporary works. Measures such as optimising transport routes, using noise protection screens and properly organising the work schedule will be applied, in order to reduce the population's exposure to pollution factors.
M14	Ensuring and continuously improving the level of nuclear safety	Maintaining and strengthening nuclear safety through the protection of measurement and control systems, correlated with information and physical security measures, including access management and incident response plans. Continuous monitoring of the operation of nuclear facilities will be ensured, in order to ensure efficient and safe operation.
M15	Ensuring and	Strengthening physical protection by implementing

	continuously improving the physical protection of nuclear materials and nuclear facilities	measures to prevent and counter unauthorised access, theft, sabotage and other intentional actions on nuclear materials, facilities and transports. Adequate security systems will be provided, including physical barriers and specific protection technologies.
O6	**Prevention, reduction and compensation of the effects of noise and vibrations**	
M16	Reducing and compensating for the effects of noise and vibration	Limiting the acoustic and vibration impact on the population and the environment, especially in sensitive areas, by applying prevention measures at source, reduction and, where appropriate, compensation for residual effects. Noise and vibration reduction solutions will be integrated from the design phase, and during the construction phase, adequate operational management will be ensured, through the use of equipment with low noise emissions, the organisation of the work schedule, and traffic optimisation.
O7	**LANDSCAPE Protection**	
M17	Harmonious integration of the proposed plan into the existing landscape	The implementation of the objectives set out in the strategy will be carried out in compliance with the applicable legislative framework in the field of territorial planning, urban planning, environmental protection and landscape protection, so that new developments are compatible with the specifics of the local landscape and the functions of the area. Avoiding the implementation of works proposed in the National Strategy within protected natural areas. For major investments, landscape integration will be analysed at the project level. Design solutions will aim to maintain adequate visual quality and avoid negative impact on the general appearance of the area.
O8	**Raising awareness of environmental issues**	
M18	Public awareness of environmental issues	The strategy promotes public information and involvement regarding the potential effects on the environment, resources and health associated with the objectives derived from it, by using the mechanisms and procedures for public information and consultation provided for by applicable legislation (including within the framework of regulatory and authorisation procedures).
O9	**Conservation and efficient use of resources**	
M19	Conservation and protection of natural	Ensuring the sustainable use of natural resources (water, soil and subsoil, materials, energy, biodiversity

	resources	and ecosystem services) by applying integrated measures throughout the project life cycle. Measures will be implemented to prevent soil and subsoil degradation, maintain ecosystem functions and restore them, including through protection during the construction phase, pollution prevention systems, remediation plans and post-closure monitoring.
O10	**Sustainable waste management**	
M20	Preventing and reducing the impact on the environment and human health generated by waste management	Reducing the impact of waste management by applying selective collection and the principle of prevention at source, by optimising processes and material consumption. The recording and traceability of waste by category will be ensured, as well as the implementation of appropriate procedures for the prevention and management of incidents (leaks, fires), in order to protect the environment and the health of the population.

TABLE 56 - MEASURES FOR PREVENTING/REDUCING POTENTIAL IMPACTS DURING THE OPERATION/EXPLOITATION PERIOD

Measure/Recommendation		
O1	**Air and climate protection**	
M1	Maintaining air quality	Ensuring air quality by respecting permissible limits for atmospheric emissions and implementing measures to control fugitive emissions, dust and internal traffic. Efficient ventilation and filtration systems, continuous monitoring of environmental parameters (including radioactivity), as well as hazardous substances and waste management measures will be applied. Data transparency and monitoring of atmospheric deposition will be ensured, in order to prevent and reduce the impact on the environment and public health.
M2	Air pollution prevention	Reducing emissions at source by applying good engineering practices, including local capture, the use of filtration systems and monitoring of operating parameters, depending on the specifics of the activities. low-emission equipment, less polluting fuels and electrification will be promoted, where possible, as well as the implementation of preventive maintenance programmes to limit diffuse emissions.

		Waste management will be carried out in a way that prevents emissions into the atmosphere, through selective collection, appropriate packaging and the application of conditioning and volume reduction methods, including for radioactive waste. Radiological, physicochemical, mechanical and structural characterisations of managed waste. Air radioactivity monitoring. Monitoring of air radioactivity and analysis of atmospheric deposition will be ensured, in order to prevent exceeding permissible limits.
M3	Reducing greenhouse gas emissions.	Reducing greenhouse gas emissions by monitoring and inventorying them throughout the life cycle, in correlation with decarbonisation objectives and the role of the nuclear sector. Measures will be implemented to optimise transportation, use energy-efficient and low-emission equipment, as well as improve the energy efficiency of systems, including by adapting consumption to operational needs.
O2	**Protection of the water component**	
M4	Compliance with legal limit values for pollutant concentrations in wastewater	Ensuring the management and treatment of wastewater, including radioactive liquid effluents, so that their discharge complies with the limit values established by applicable regulations. Dedicated collection, treatment and control systems will be applied for radioactive liquid effluents, in accordance with nuclear safety and environmental protection requirements. Monitoring of wastewater quality parameters will be carried out at the relevant discharge points and with the frequency established by regulatory acts, supplemented, where justified, by automatic or semi-automatic monitoring systems (with a certain frequency), used as an operational control tool to prevent limit values from being exceeded. The operation of the facilities will be maintained within optimal parameters through appropriate maintenance activities.
M 5	Protection of groundwater and surface water quality	Ensuring the protection of surface and groundwater by preventing the infiltration of pollutants and complying with discharge conditions, in accordance with legal

		requirements and the ALARA principle (As Low As Reasonably Achievable). Preventing the infiltration of pollutants into aquifers and protecting watercourses. Wastewater collection, transport and treatment facilities will be maintained in optimal parameters and continuous monitoring of water quality will be carried out, including in areas with nuclear activities, for the prevention and early identification of contamination. Appropriate technical protection systems (containment barriers, anti-infiltration infrastructures, safe storage systems), as well as waste management measures, will be implemented to protect water resources. The maintenance of the ecological flow downstream of the damming and capture works will be ensured, in accordance with the provisions of Government Decision No. 148/2020.
M6	Protection of drinking water quality	Ensuring monitoring of the quality of drinking water used within nuclear facilities, by determining microbiological, physicochemical and radiological parameters, in accordance with applicable regulations, for the protection of water resources and public health.
M7	Permanent monitoring of the technical condition of the storage facilities (infiltration, waterproofing)	Ensuring the integrity of storage facilities by carrying out periodic technical inspections and systematic checks of elements exposed to infiltration or moisture. Operative intervention measures will be applied to remedy any deficiencies and maintain the functionality of the waterproofing systems.
O3	**Protection of the soil and subsoil component**	
M8	Prevention of soil pollution and soil surface degradation as a result of activities carried out	Soil protection by preventing pollution generated by machinery, transport, wastewater networks and other activities, as well as by maintaining the optimal parameters of associated installations and systems. Continuous monitoring of the technical condition of facilities and storage facilities, the proper functioning of wastewater and waste management systems, as well as rapid intervention in case of accidental pollution will be ensured. In relevant areas, soil and vegetation radioactivity monitoring will be carried out, in order to protect the environment and the health of the population.
M 9	Preventing pollution and	Applying dedicated policies and procedures for the

	soil degradation by maintaining wastewater and waste management facilities and systems in optimal condition, monitoring the technical condition of sites and rapid intervention in case of accidental pollution, including monitoring radioactivity in relevant areas.	management of radioactive waste and spent nuclear fuel, including their classification by types and activity levels and the clear establishment of responsibilities throughout the management flow. Reducing waste quantities at source by optimising activities, decontaminating materials before dismantling and strictly separating clean and contaminated materials. Ensuring the safe management, in the short and long term, of radioactive waste and spent fuel, by applying the best available techniques, with passive safety features and without transferring unjustified costs to future generations, also taking into account possible transboundary effects. Safe management of spent nuclear fuel and radioactive waste, including in the long term, with passive safety features, namely components that do not require external sources of mechanical, human or electrical energy. Collection/packaging/transport/recovery/selective storage by waste type. Optimising the transport of spent nuclear fuel and radioactive waste. A monitoring and reporting system will be ensured in accordance with legal requirements, allowing complete traceability of waste throughout the entire management cycle.
O4	**Biodiversity protection**	
M10	Maintaining the favourable conservation status of habitats and species of wild flora and fauna within protected natural areas of Community interest.	To the extent possible, the placement of the objectives proposed by the National Strategy in protected natural areas should be avoided. Compliance with the provisions of the regulatory acts issued for the relevant Strategy projects, where applicable. Regulated measures that contribute to the conservation of biodiversity, natural habitats, flora and fauna within protected areas of Community interest located in the vicinity of projects and on which a potential impact is identified.
O5	**Population health and human settlements**	
M11	Maintaining and improving the quality of	Protecting the environment and the health of the population in the affected areas by implementing

	the environment and the health of the population in the areas affected by the implementation of the strategy	integrated measures to reduce the impact of activities, including reducing dust and noise emissions, creating green curtains and optimising the organisation of activities. The reduction of population exposure to risk factors, including ionising radiation, will be ensured by complying with radiological protection requirements and the ALARA principle, as well as by implementing an adequate framework for prevention and response in emergency situations. Continuous monitoring of environmental components will be carried out to assess the effectiveness of measures and protect the health of the population.
M12	Ensuring and continuously improving the level of nuclear safety and the safe operation of facilities	Maintaining and strengthening nuclear safety by implementing inspection, maintenance and change control programmes, as well as by ensuring the operation of facilities within safety parameters. Ensuring permanent training regarding the preparation of specialised personnel in the field, including intervention personnel in the event of a nuclear accident and/or radiological emergency; Permanent monitoring of the operation of nuclear facilities will be carried out to guarantee efficient and safe operation.
M14	Ensuring and continuously improving the physical protection of nuclear materials and nuclear facilities	Strengthening physical protection by implementing measures to prevent and counter unauthorised access, theft, sabotage and other intentional actions on nuclear materials, facilities and transports. Integrated physical and cyber security systems will be ensured, including barriers and protective technologies, transport security, and continuous monitoring of the efficiency and modernisation of protection systems.
O6	**Prevention, reduction and compensation of the effects of noise and vibrations**	
M15	Reducing and compensating for the effects of noise and vibration	Ensuring control of the acoustic and vibrational impact of nuclear activities, with priority for sensitive receptors, by applying the hierarchy of measures: prevention at source, reduction and compensation only for justified residual effects.
O7	**LANDSCAPE Protection**	
M16	Harmonious integration of the proposed plan into the existing landscape	Ensuring adequate visual integration of the objectives during operation, by applying operation, maintenance and rehabilitation solutions that comply with

		environmental and land use planning requirements. At the end of the life cycle, the safe reintegration of the sites into the territorial context will be promoted, in correlation with local and regional development policies.
O8	**Raising awareness of environmental issues**	
M17	Public awareness of environmental issues	Ensuring public information and involvement regarding the impact on the environment and health, by applying the transparency and consultation mechanisms provided for by legislation. Access to relevant information, in an accessible form, and dialogue with stakeholders will be facilitated, including through information and awareness campaigns.
O9	**Conservation and efficient use of resources**	
M18	Preservation and protection of natural resources	Ensuring the long-term conservation of natural resources (water, soil and subsoil, materials, energy, biodiversity) by applying integrated measures during operation, in order to use them efficiently and protect their quality. Measures will be implemented for the rational use of water, increasing consumption efficiency, preventing soil degradation and maintaining ecosystem functions, including through protection, remediation and continuous monitoring systems.
O10	**Sustainable waste management**	
M19	Preventing and reducing the impact on the environment and human health generated by waste management	Reducing the impact of waste management through selective collection, applying the principle of prevention at source and optimising technological processes. Waste records and traceability will be ensured, as well as the implementation of appropriate procedures for the prevention and management of incidents, in order to protect the environment and public health.

10. REASONS FOR SELECTING THE PREFERRED ALTERNATIVE AND DESCRIPTION OF THE ASSESSMENT METHOD, INCLUDING ANY DIFFICULTIES ENCOUNTERED IN PROCESSING THE REQUIRED INFORMATION

10.1. ALTERNATIVES TO THE NATIONAL STRATEGY

The National Strategy for the nuclear sector (SNDDN) aims to achieve the proposed objectives under conditions of nuclear safety and environmental protection.

According to the provisions of the legislative framework regarding strategic environmental assessment, several alternative development solutions were analysed, in order to substantiate the choice of the optimal option from the point of view of environmental protection, energy security and conservation objectives.

The criteria structure was calibrated to the specifics of the nuclear sector and covered the following areas:

- impact on environmental components: assessment of the carbon footprint (direct and indirect greenhouse gas emissions), the quality of environmental components (air, water, soil/subsoil), the impacts on biodiversity and ecosystem services, acoustic/vibrational pressures and landscape integration, consumption and conservation of resources, the degree of recycling and recovery of materials;
- security and radiation protection: estimation of doses for the population and personnel (in normal mode and in incident/accident scenarios), security of spent fuel and radioactive waste management concepts throughout the entire life cycle, multi-hazard resilience (including extreme climatic events);
- technical and operational: level of technological maturity, availability and reliability of critical installations, capacity for integration into the energy system (connectivity, system services), operational flexibility, cogeneration;
- socio-economic: economic performance, local effects (employment, added value), degree of social acceptability and risk perception;
- governance: institutional and regulatory capacity, realism of the implementation schedule, risk profile (technical, financial, legal), coherence and compatibility with strategic objectives.

According to the provisions of the legislative framework regarding strategic environmental assessment, several alternative development solutions were analysed to substantiate the choice of the optimal option.

Alternative 0 – Not implementing the strategy

This alternative involves maintaining the current situation, without developing the nuclear sector beyond existing capacities. The consequence would be to limit the contribution of nuclear energy to the national energy mix, which may lead to difficulties in achieving decarbonisation objectives and to a greater dependence on conventional (fossil) or imported sources. From an environmental perspective, this option would mean the absence of new pressures on protected natural areas, but would perpetuate greenhouse gas emissions from other energy sectors.

The operation of Unit U1 only until reaching the economic operational lifetime of 30 years, but limited to 245,000 effective hours of operation at nominal power, requires special steps for the owner of the objective SNN S.A. in terms of preparing a complex process of decommissioning and/or conservation of the U1 nuclear power plant and at the same time considerable efforts consisting in ensuring much larger capital investments in new assets than those necessary to extend the lifetime of Unit U1. At the same time, in the event that the process of refurbishing Unit 1 will not be carried out, the national energy production will be reduced by approx. 10%, corresponding to the amount of energy produced by Unit 1.

Abandonment of "Continuation of construction and completion works of Units 3 and 4 at Cernavodă NPP" It ***w***ou***l***d represent the "abandonment" of the construction works already carried out on site for units U3 and U4, requiring compensation through other low-emission sources (natural gas, renewable sources), which may however introduce risks of intermittency and volatility in the energy system.

Failure to implement the strategy could generate sanctions and infringement from the EU and the IAEA for failure to comply with international standards and agreements on radioactive waste management.

In the short term, direct pressures on the environment may appear to be reduced; in the medium and long term, energy security risks, volatile prices and import dependence would increase, and decarbonisation objectives would be difficult to achieve. Alternative 0 is used as a comparison term, but is not preferable.

Alternative 1 – Partial implementation without Units 3 and 4 of Cernavodă NPP

This alternative involves a gradual and selective development of the nuclear sector, with an emphasis on research and development projects and innovative technologies (SMR, ALFRED, ELI-NP), without continuing the programme to expand nuclear energy production capacities by building Units 3 and 4 at the Cernavodă NPP.

From a strategic and energy point of view, this option would lead to a reduced contribution of nuclear energy in the national energy mix, with effects on the level of energy security, independence from energy imports and Romania's ability to achieve the decarbonisation objectives set at European level. The lack of Units 3 and 4 would imply, as mentioned above, a decrease in the share of low-carbon electricity in national production, requiring compensation through other production capacities and/or imports, depending on availability, including through renewable sources and, to cover the firm power deficit and balance the system, through flexible natural gas capacities; this compensation structure may, however, introduce intermittency risks (in the case of RES), exposure to fuel price volatility and risks regarding the adequacy of peak load capacity, with effects on the stability and operating costs of the energy system.

From an environmental perspective, partial implementation could result in lower pressures in certain phases of construction and operation, as well as lower levels of radioactive waste generation, compared to the full scenario. However, the climate benefits associated with the expansion of nuclear capacity would be diminished and the contribution to greenhouse gas (GHG) emissions reductions would be lower than in the reference scenario, as the shortfall in low-emission generation would have to be compensated by other sources, including flexible

natural gas capacities and/or imports, with potentially higher emissions and volatility at the system level.

According to Romania's Energy Strategy 2025-2035, with a perspective to 2050, approved by Government Decision No. 1491/2024, the refurbishment of existing nuclear units and the construction of new units using CANDU technology are priority programmes for achieving decarbonisation targets, diversifying the energy mix and ensuring national energy security.

Maintaining a balanced energy mix that integrates nuclear energy with renewable sources and flexible natural-gas capacity serving a transitional role is a key element in strengthening energy security, limiting dependence on imports, ensuring the adequacy and stable operation of the National Power System and supporting decarbonisation. If Units 3 and 4 are not developed, the contribution of nuclear energy as a low-carbon baseload source may decline, increasing pressure on other technologies to provide firm generation and potentially affecting achievement of the strategic objectives established by the SNDDN.

Alternative 1 generates limited and temporary environmental benefits, especially by avoiding construction impacts, but in the medium and long term it has significant adverse effects by diminishing the contribution of nuclear energy to decarbonisation, delaying the energy transition and reducing climate resilience, by increasing GHG emissions through substitution with fossil sources, increasing pressures on ecosystems through the use of conventional energy resources and stagnating technological progress in the field of nuclear safety and environmental efficiency.

Therefore, from the perspective of environmental protection and climate objectives, this alternative is less favourable than the reference scenario in the Strategy (Alternative 4), as it does not harness the potential of nuclear energy to provide clean, stable and secure energy in the context of decarbonising the national economy.

Alternative 2 - Partial implementation without updating the National Radioactive Waste Management Programme to address new types of reactors (SMR)

Under Alternative 2, the implementation of the strategy is considered partial by maintaining the National Radioactive Waste Management Programme (PNGDR) in its current form, without updates that integrate the requirements, waste streams and management particularities associated with new types of reactors, including small modular reactors (SMRs).

In this scenario, the main risk is not the “non-implementation of final disposal” as the assumed option, but the emergence of inconsistencies and delays in the planning and implementation of final solutions, as a result of the PNGDR not adequately reflecting the new types of waste and the necessary capacities/requirements for the entire management cycle. Consequently, for waste generated by existing facilities and, in particular, for the potential flows associated with SMR (in case of their implementation), the dependence on long-term interim disposal solutions could increase.

The long-term effects of these delays or inconsistencies in providing a final solution would be significantly negative, as maintaining radioactive waste in interim storage facilities for extended periods could increase pressures on security requirements, monitoring, institutional resources and public acceptability. This situation would generate increased long-

term risks, including in the event of accidents, degradation of storage infrastructure or accidental leaks, with possible consequences for groundwater quality and nearby ecosystems.

Therefore, not permanently disposing of radioactive waste does not eliminate the risks associated with it, but rather postpones and amplifies them in the long term. Such a situation runs counter to the principles of precaution, intergenerational responsibility and sustainable management of radioactive waste, established at international and European level.

Also, failure to implement the strategy could attract infringement procedures from the EU and the IAEA for failure to comply with international standards and agreements on radioactive waste management.

In conclusion, the alternative of partial implementation of the strategy, without achieving the final disposal of all categories of radioactive waste generated in Romania, is not acceptable.

The environmental impact of the implementation of the Reference Scenario is positive. The environmental impact assessment of the projects proposed by the Strategy will be carried out in detail within the environmental procedures related to the development phases.

Alternative 3 - Implementation of the Strategy without developing the nuclear research field – ALFRED and ELI-NP

This alternative involves applying the National Nuclear Strategy exclusively in its energy dimension by refurbishing and expanding existing capacities (Cernavodă U1, U3, U4, SMR Doicești, etc.), without including major fundamental or applied nuclear research objectives (ALFRED – Mioveni, ELI-NP-Măgurele). This alternative would eliminate potential additional pressures on research sites, even if they are located on anthropised platforms.

The implementation of alternative 3 from the point of view of the locations would have a very low direct impact, since both ALFRED (Mioveni) and ELI-NP (Măgurele) are located on highly anthropised platforms, without affecting natural habitats of Community interest, the direct impacts of these projects on the environment were already considered low and manageable through mitigation measures.

However, indirectly, the lack of progress in innovative nuclear technologies (e.g. lead fast reactors or research in the field of high-power lasers) could mean a delay in the development of cleaner and more efficient technologies, with long-term benefits for the environment.

In the long term, there would be a loss of innovation opportunities in the nuclear sector and Romania's positioning in leading European and international projects; limiting the development of human resources and know-how in advanced research, with a negative impact on the long-term sustainability of the nuclear sector.

Investments in research and development of advanced technologies, including nuclear, will place Romania on the global map as a centre of excellence in clean energy production and storage technologies. This will include the development of new types of generation IV nuclear reactors and innovative solutions for nuclear fuel and radioactive waste management.

Alternative 3 could generate minor and temporary positive environmental effects by avoiding construction works on existing industrial sites. However, the overall impact is negative, as the non-implementation of the ALFRED and ELI-NP projects limits progress

towards cleaner, safer and more efficient nuclear technologies that would contribute to reducing emissions, optimising the fuel cycle and strengthening radiation protection.

The lack of these research components undermines the principles of precaution, prevention and technological innovation that underpin a sustainable and responsible nuclear policy.

Therefore, from the perspective of environmental protection and strategic sustainability, this alternative is unfavourable, as it reduces Romania's capacity to develop advanced domestic solutions for nuclear safety, circular economy and decarbonisation.

Alternative 4 – Full implementation of the strategy

This alternative involves developing the nuclear sector by refurbishing and expanding existing capacity, including refurbishment of Cernavodă NPP Unit 1 and completion of Units 3 and 4; developing new projects, including small modular reactors and the ALFRED project at Mioveni; and supporting the associated infrastructure, including final radioactive-waste disposal facilities and research and innovation centres. This option makes a substantial contribution to carbon-emission reduction objectives and to strengthening energy security, but may also create pressures on the environment and protected natural areas, which are assessed and managed through specific measures.

The expansion of the national nuclear sector, with the construction of new large-scale units and small modular reactors (SMRs) by 2035, will significantly contribute to increasing low-carbon electricity production, as well as to providing new energy supply solutions in new industrial applications.

Analyses regarding the need to meet environmental and energy security objectives and targets, security of supply and diversification of sources for a balanced energy mix, which would ensure the transition to an energy sector with low greenhouse gas emissions and an affordable energy price for consumers, reveal that investments in nuclear generation capacities represent one of the optimal solutions for covering the electricity production capacity deficit forecast for 2028-2035 as a result of reaching the operating life limit of several existing capacities based on fossil fuels.

The potentially negative impacts associated with the implementation of the projects in the Strategy (noise, temporary emissions during the execution phase, local changes in habitats) are predominantly localised and limited in time and can be managed effectively by applying the hierarchy of measures (avoidance, reduction, restoration and, where appropriate, compensation). These measures will be integrated into the design and implementation and will be complemented by the requirements and conditions established within the framework of the environmental impact assessment procedures and, where appropriate, appropriate assessment, including for the operation and decommissioning phases.

Consequently, the full implementation of the Strategy represents the preferred strategic option, as it ensures the best compatibility with the objectives of environmental protection, energy security and sustainable development, in accordance with the relevant directions and commitments at national and European level.

Based on the RM analysis, the recommended optimal option is the full implementation of the Strategy, with rigorous application of impact prevention and mitigation measures, especially in relation to protected natural areas of Community interest as will result from the regulatory conditions imposed by the environmental authorities for the projects and activities

in the Strategy. The concrete conditions, including monitoring requirements and specific measures, will be established by the regulatory acts issued by the competent authorities for each project and activity.

10.2. ASSESSMENT OF ENVIRONMENTAL EFFECTS USING THE NEGATIVE IMPACT UNITS METHOD

The environmental impact was quantified by converting the level of impact on each environmental component into negative impact units (N), in accordance with the Negat**ive Impact Units Method, both for the** construction of the National Strategy projects/implementation of the National Strategy and for the operation/activity stage. The result indicates an environment aff**ected within acceptable limits.**

This method of quantifying the environmental impact caused by various strategies / plans / projects is based on the transp**osition of the level of impact on** each environmental component in**to negative impact units (N) both** for the construction of the National Strategy projects / implementation of the National Strategy, and for the period of operation / performance of the activity.

Below we present the "Negative Impact Units" Method.

The number of impact units awarded is proportional to the level of impact directly borne by the environmental component or indirectly through the cumulative action of the impact on other environmental components. If the plan has a clear positive effect on the environmental component, without also having adverse effects, the plan is considered to have a positive effect (P). If the plan does not affect the environmental component in any way, it is considered to be unaffected (0).

TABLE 57 - INTERPRETATION OF EFFECTS/IMPACTS ON ENVIRONMENTAL COMPONENTS

INTERPRETATION OF EFFECTS / IMPACTS ON ENVIRONMENTAL COMPONENTS	
P	Positive effect
0	Unaffected
1N	Slightly affected
2N	Affected within permissible limits
3N	Affected beyond permissible limits
4N	Severely affected

N – negative impact unit

Accordingly, the impact levels, positive effects and absence of effects on environmental components are recorded in a table (see the following table) according to the period in which they occur (before and after implementation of the Strategy).

TABLE 58 - QUANTIFICATION OF IMPACTS ON ENVIRONMENTAL COMPONENTS BY PERIOD OF OCCURRENCE

The table is divided into three categories corresponding to each environmental component.

Environmental component (cm)	**IPC**	**IPF**	**IMC_{cm}**
Water	1N	0	1
Air	1N	1N	1
ground	2N	1N	2
biodiversity	2N	2N	2
Human settlements and public health	2N	1N	2
Landscape	2N	2N	2

where:

IPC – Impact during construction/implementation period

IPF – Impact during the period of operation / activity

IMC_{cm} – Maximum quantified impact on the environmental component

1N – Negative Impact Unit

cm – environmental component/environmental component

The $_{IMC}$ cm represents the first stage of impact quantification, resulting in an index of the impact on each environmental component/factor **(c**m).

The resulting index for each environmental component represents the maximum value of the impact level granted either during the construction or operation period of the objective, not taking into account the positive effects or the non-affecting of the environmental component. *(Example: If during the construction period, the environmental component is unaffected (0) and during the operation period, the impact level will be 3N then the index value will be 3. The same will happen when in one of the periods, the environmental component will have positive effects due to the plan, and in the other period the impact level will be 3N).*

In this way, t**he $_{IM}$Ccm will mainly represent the negative impa**ct caused by the assessed Strategy, this being also felt in the calculation for establishing the total quantified impact **(IT**C), using ma**thematical analysi**s.

Positive effects and lack of effects will play an important role in the **spectral analysis.**

Mathematical Analysis

The mathematical analysis results in findin**g the total quantified impact (ITC) by applying the Average I_{MC}c**m Formula and interpreting the placement of the result obtained in one of the ranges corresponding to the total quantified level of environmental impact using **the ITC Interpretation Table.**

Average IMCcm Form$_{ula}$:

$$ITC = \frac{IMC\ water + IMC\ air + IMC\ soil + IMC\ biodiversity + IMC\ human\ settlements\ and\ health + IMC\ landscape}{number\ of\ environmental\ components}$$

where:

ITC – Total quantified impact

IMC Water - Maximum quantified impact index for water

nr.cm – number of environmental components

For the assessed Strategy:

TABLE 59 - INTERPRETATION OF THE TOTAL QUANTIFIED ENVIRONMENTAL IMPACT

$ITC = \frac{1+1+2+2+2+2}{6} = 1{,}66$	
INTERPRETATION OF THE TOTAL QUANTIFIED IMPACT ON THE ENVIRONMENT	
0	Unaffected environment
(0-1]	Slightly affected environment
(1-2]	Environment affected within permissible limits
(2-3]	Environment affected beyond permissible limits
(3-4]	Severely affected environment

Using the ITC Interpretation Table, we find that the ITC value falls within the range (1-2).

Conclusion of the Mathematical Analysis:

The Total Quantified Impact (ITC=1.66) related to the studied National Strategy corresponds to an environment affected within acceptable limits.

Spectral analysis"

The impact-spectrum analysis provides an overall interpretation of the impacts on environmental components, as well as of the positive effects or absence of effects associated with the assessed Strategy, for the two periods considered.

This analysis creates a complete overview of all the effects caused by the proposed plan, including the positive effects, which many other methods of environmental impact analysis do not sufficiently highlight.

Accordingly, in the Impact Units Table, the column corresponding to IMCcm is removed and the effects/impacts on the environmental components are replaced as follows:

TABLE 60 - CORRESPONDENCE OF EFFECTS/IMPACTS WITHIN THE IMPACT SPECTRUM

Correspondence of effects/impacts in the impact spectrum		
P	Green	
0	White	
1N	Yellow	
2N	Orange	
3N	Red	
4N	Black	

The final result will be the spectral table of environmental impact specific to the analysed plan. This table represents the main object on the basis of which the actual analysis is carried out, as a result of which a series of extremely important aspects can be easily observed, contributing to the most accurate assessment of the impact.

TABLE 61 - IMPACT SPECTRUM TABLE

Environmental component (cm)	IPC		IPF	
Water		Slightly affected environment		Unaffected environment
Air		Slightly affected environment		Slightly affected environment
Soil		Environment affected within permissible limits		Slightly affected environment
biodiversity		Environmentally affected within acceptable limits		Environmentally affected within acceptable limits
Human settlements and public health		Environmentally affected within acceptable limits		Slightly affected environment
Landscape		Environment affected within permissible limits		Environmentally affected within acceptable limits

The actual analysis:

Analysing the Spectral Impact Table, a series of aspects emerge:

- Most adverse effects occur during construction of the National Strategy projects/implementation of the National Strategy; the environmental components most affected are soil, biodiversity, human settlements and public health, and landscape;
- water and air will be slightly affected during construction of the National Strategy projects/implementation of the National Strategy;
- during operation/activity, water will not be affected by implementation of the National Strategy;
- air, soil, human settlements and public health will be slightly affected;
- during operation/activity, biodiversity and landscape will be affected, but within acceptable limits;
- With regard to impact level, the predominance of orange corresponds to an environment affected within acceptable limits;
- No environmental component is subject to a significant impact during either assessment period; the colours red and black do not occur in the table.

Conclusion of the spectral analysis:

All these aspects lead to the strengthening of the statement that the total quantified impact caused by the assessed Strategy cor**responds to an affected environment within acceptable limits.**

Conclusion of the impact unit method:

The analysis of the environmental effects of implementing the National Strategy using the "Negative Impact Units" method yields an ITC value of 1.66, corresponding to an environment affected within acceptable limits.

11. MEASURES ENVISAGED FOR MONITORING THE SIGNIFICANT EFFECTS OF IMPLEMENTING THE STRATEGY

The monitoring activity consists of all systematic observation and information actions aimed at preventing and alerting to activities taking place in the nuclear sector, which are not subject to control activity.

The monitoring of this strategy is carried out annually by ANDR, based on the annual reports prepared by the institutions involved in the implementation of the SNDDN, the results of which will be included in a report that will also include an action plan to support the implementation of the SNDDN, drawn up at the proposal of or in collaboration with the institutions involved in the implementation of the SNDDN. The annual reports prepared are published on the ANDR website.

The monitoring of the environmental effects resulting from the implementation of the National Strategy for the Development of the Nuclear Sector will be pursued, in compliance with the provisions of Law No. 111/1996 on the safe conduct of nuclear activities, Law No. 63 of March 9, 2018 amending and supplementing Law No. 111/1996 on the safe conduct, regulation, authorisation and control of nuclear activities and Law No. 292/2018 on the assessment of the impact of certain public and private projects on the environment.

The Ministry of Environment, Waters and Forests (MMAP) has the role of coordinating and supervising environmental monitoring for nuclear and radiological objectives, in cooperation with the National Commission for the Control of Nuclear Activities (CNCAN) and the Ministry of Health.

Monitoring of measures to avoid and reduce the impact of the SNDDN objectives will be carried out in accordance with the provisions of the regulatory acts issued by the competent authorities.

Environmental monitoring consists of tracking non-radiological components (air, water, soil, noise, biodiversity) as well as radiological ones, implicitly the impact of the strategy's activities on the environment and population health.

The promotion, development and monitoring of nuclear activities for exclusively peaceful purposes constitute national priorities in the context of implementing sustainable development programmes for society.

The central public authority for environmental protection organises, according to the law, the environmental radioactivity surveillance network on the territory of Romania, ensuring the information flow necessary for the integrated system for monitoring environmental parameters, being adjusted according to the nature of the activities carried out and the potential sources of impact, with special reference to:

a) pathways of human exposure to radiation, including food chains;

b) radiological impact on local ecosystems;

c) possible accumulation of radioactive materials in the environment;

d) the possibility of other unauthorised emission pathways of radionuclides into the environment;

e) monitoring of radioactive emissions and monitoring of environmental radioactivity in the vicinity of nuclear and radiological facilities, CNCAN norms provide clear requirements/responsibilities.

Depending on the results of the preliminary assessment of the radiological impact, CNCAN may request, within the authorisation process, to ensure, in addition to monitoring radioactive emissions, monitoring of the radioactivity of the environment in the vicinity of the facility.

Given the level of detail of the Nuclear Strategy, the fact that it includes a series of projects that will be implemented in different fields of activity (nuclear energy production, research activities, radioactive waste management), for which the location of one of them is not yet known at this time (the Deep Geological Repository), a detailed programme for monitoring its effects cannot be proposed, but we present a relevant set of monitoring indicators for projects with potential environmental impact, which will be quantified based on the results of individual monitoring programmes at the level of each project.

Environmental radioactivity monitoring differs between the operating stages of a facility. The licensee is required to adjust the nature and scope of the environmental radioactivity monitoring programme accordingly throughout those stages.

Depending on the complexity of the nuclear or radiological facility, the measures envisaged for environmental monitoring mainly include, where appropriate, the following principles and actions:

- maintaining the generation of radioactive waste at the minimum reasonable level;
- gradual approach to the implementation of measures;
- managing spent nuclear fuel and radioactive waste safely, including in the long term;
- application of monitoring of environmental components established by environmental and operating authorisations issued by CNCAN;
- monitoring of radioactive and non-radioactive emissions and effluents, both at the source and in the receiving environment, in order to assess the impact on environmental components;
- technological monitoring of relevant process parameters for preventing and limiting environmental impact;
- periodic reporting of monitoring results to the competent authorities, in accordance with the requirements set out in regulatory acts;
- carrying out post-closure monitoring, where applicable.

The AGENȚIA NUCLEARĂ ȘI PENTRU DEȘEURI RADIOACTIVE is the competent national authority in the field of promotion, development and monitoring of nuclear activities for exclusively peaceful purposes and the safe management of radioactive waste, including its final disposal.

Principles and objectives of monitoring

The monitoring has as its general objective to ensure a continuous, rigorous and transparent assessment of the environmental effects generated by the implementation of the National Strategy for the Development of the Nuclear Sector. In this regard, the monitoring aims to:

- Early detection of significant effects, to identify possible unforeseen impacts on the environment and public health;
- Traceability and credibility of data, ensuring transparency and accuracy of information regarding the environmental and radiological performance of the activities carried out;
- Decision support and adaptive management, providing relevant information for the periodic review of strategic documents and action plans;
- Applying the principles of precaution, prevention and continuous improvement, in accordance with international environmental protection and nuclear safety standards.

Each relevant environmental component (air, water, soil, subsoil, biodiversity, noise and ionising radiation) will be monitored to ensure a complete and integrated assessment. For the component of nuclear research and applications intended for environmental protection, the monitoring of implementation may follow, as appropriate, the number of projects and participations in international programmes regarding the use of nuclear techniques for monitoring environmental components and emerging pollutants.

Monitoring measures

Environmental monitoring of a nuclear project, respectively of a nuclear or radiological installation, is carried out, as appropriate, through the following associated actions:

- The objectives of the National Strategy will be pursued by all licensees who generate or possess radioactive waste, at all stages of the process of their safe management, including during the decommissioning of nuclear and radiological facilities;
- Monitoring of emissions and effluents, radioactive and non-radioactive, at the source and in the receiving environment;
- Monitoring of technological parameters relevant for the assessment of environmental impact and radiological protection;
- Monitoring the quality of environmental components: air, water, soil and subsoil, biodiversity, noise, ionising radiation;
- Controlled releases of radioactive effluents into the environment (authorised discharges from permit holders) fall under CNCAN regulations and control;
- Monitoring by waste types, composition and quantities, method of collection, storage, recovery/disposal, transport;
- Monitoring packaging management: non-radioactive and radioactive industrial packaging will be managed by type;
- Monitoring the management of hazardous substances and mixtures (records of toxic and hazardous products and substances in accordance with the legislation in force).
- Long-term monitoring, including post-closure, to verify environmental stability and the effectiveness of containment barriers;
- Self-monitoring carried out by business owners, according to the regulatory documents issued;

- Periodic reporting of results to the competent authorities according to regulatory acts;
- Integrating monitoring results into the decision-making process for early identification of adverse effects and substantiation of corrective measures**.**

A distinct component is the monitorin**g of radioactivity of environmental components at the national level.**

According to art. 47, para. 2 of Emergency Ordinance no. 195/2005 on environmental protection, with subsequent amendments and supplements, the monitoring of environmental radioactivity throughout the country is organised by the Ministry of Environment, Waters and Forests.

In application of these provisions, the Order of the Ministry of Environment and Natural Resources no. 1978/2010 on the approval of the Regulation on the organisation and functioning of the National Network for the Surveillance of Environmental Radioactivity (RNSRM), establishes the framework through which this monitoring is carried out. The network is coordinated from a scientific, technical and methodological point of view by the National Reference Laboratory for Radioactivity (LNRR), subordinated to the National Agency for the Environment and Protected Areas (ANMAP).

In 2024, RNSRM operated with:

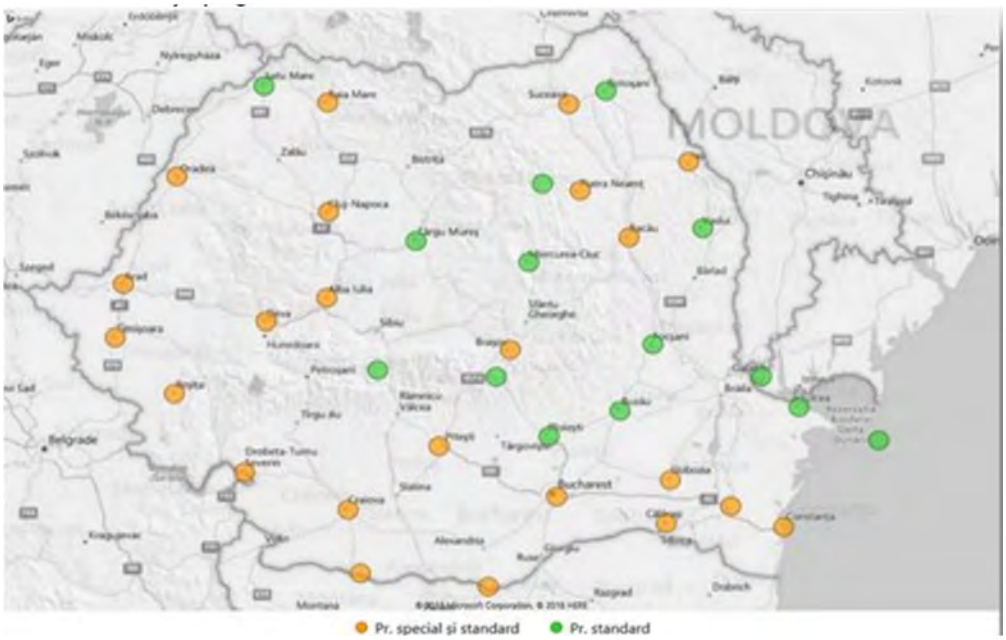
- 37 Environmental Radioactivity Monitoring Stations (ESMS), laboratories located within the County Environmental Directorates (CEDs), part of ANMAP;
- 86 Automatic stations for monitoring the equivalent gamma dose rate absorbed in air.

Their distribution on the territory of Romania covers all landforms.

Of the 37 SSRMs, 9 had a 24-hour/day working schedule (SSRM Cernavodă, SSRM Constanţa, SSRM Bechet, SSRM Craiova, SSRM Piteşti, SSRM Babele, SSRM Cluj, SSRM Toaca and SSRM Iaşi) and 28 had an 11-hour/day working schedule.

For the monitored environmental components (air – through atmospheric aerosols and wet and dry atmospheric deposition; water – surface and groundwater; uncultivated soil; spontaneous vegetation), global beta, beta spectrometric, gamma spectrometric analyses were performed, as well as the determination of the equivalent of the gamma dose rate absorbed in the air.

FIGURE 69- DISTRIBUTION OF MONITORING PROGRAMMES IMPLEMENTED BY THE RNSRM IN 2024



Source: RSM 2024

Under the coordination of LNRR - ANMAP, RNSRM carried out, in 2024, two types of environmental radioactivity monitoring programmes:

- The national standard programme for monitoring radioactivity of environmental components is carried out in a unified manner by all Environmental Radioactivity Monitoring Stations (ERMS) within the RNSRM. This programme is carried out permanently and tracks the evolution over time of radioactivity in the main monitored environmental components;
- The monitoring programme for areas with anthropogenically modified natural background, specific to each area, was carried out in parallel with the standard National Programme for monitoring the radioactivity of environmental components.
- In 2024, this programme was carried out by 23 SSRMs. The programmes with the largest spread were those dedicated to monitoring the radioactivity of environmental components in the areas of influence of nuclear power plants, namely Cernavodă NPP (encompassing Constanța, Călărași and Ialomița counties) and Kozloduy NPP (on Romanian territory, comprising Dolj, Teleorman and Mehedinți counties). The presence of artificial gamma-emitting radionuclides originating from Cernavodă NPP or Kozloduy NPP was not detected in the analysed samples. Other programmes included, among others, uranium mining exploration and exploitation areas, nuclear units (IFIN-HH Bucharest and SCN-FCN Pitești), etc.

Environmental radioactivity is monitored by measuring radioactivity in environmental components and the activity concentrations of radionuclide-containing substances that cause external and internal exposure: soil, air, water and numerous biosphere components, including flora and fauna. Knowledge of the baseline values of these activity concentrations is required in order to track changes over time in substances of radiological-protection interest and to identify significant increases.

The main objectives pursued by monitoring environmental radioactivity are:

- rapid detection of any radiologically significant increases in environmental radioactivity levels in the monitored territory;
- - prompt notification of decision-makers in the event of a radiological emergency and provision of field data to support real-time decisions on the implementation of protective measures;
- control of the operation of radioactive pollution sources with environmental impact in accordance with legal requirements and authorised limits at national level;
- continuous monitoring of natural radioactivity levels, important in assessing the consequences of a radiological emergency;
- providing information to the public.
- Environmental monitoring during the operational period (mainly measuring radionuclide concentrations in environmental components) according to the Environmental Radioactivity Monitoring Programme for each facility (the programme is developed and applied in order to obtain accurate and reliable data on the radiological impact on public health and the environment, due to effluent discharges on an annual basis, under normal operating conditions), assessment of the increase in the level of radioactivity in the food chains specific to the area and assessment of the dose for a member of the critical group and the collective dose for the population resulting from the operation of the facilities;

At project/objective level, monitoring of environmental components through effluent-monitoring programmes and monitoring of receiving-environment quality will be carried out in accordance with the obligations established by regulatory acts (Environmental Permits and Water Management Authorisations) and by CNCAN operating authorisations, including verification that the investigated indicators remain within regulated, standardised and approved limits.

The monitoring activity will be carried out both through the objectives' own laboratories and through third-party specialised laboratories, accredited/certified, according to legal requirements. The results of the investigations will be reported periodically to the competent environmental authorities, as well as to the nuclear regulatory and control authority.

REPORTING

In accordance with the provisions of Directive 2001/42/EC of the European Parliament and of the Council of 27 June 2001 on the assessment of the effects of certain plans and programmes on the environment, transposed into national legislation by GD no. 1076/2004, the implementation of the National Strategy in the nuclear sector will be accompanied by a process of monitoring and reporting the significant effects of the application of plans and programmes on the environment, among other things, in order to identify unforeseen adverse effects, at an early stage, and to be able to take the remedial measures they consider necessary.

Under the Strategic Environmental Assessment procedure established by Government Decision No. 1076/2004, ANDR, as the SNDDN proponent, must submit the results of the environmental monitoring programme annually to the authority that issued the Environmental

Endorsement, by the end of the first quarter of the year following the monitoring period, in accordance with Article 27(3) of Government Decision No. 1076/2004.

Monitoring programme

The scope, objectives, timing and monitoring programme depend on the type and complexity of the project, as well as the characteristics of the Natura 2000 site(s) affected by the project implementation.

For most projects in the SNDDN and associated PNN, monitoring programmes have been established at the planning and environmental impact assessment stages.

For some projects (e.g. SMR and DGA) locations need to be confirmed and it is premature to establish a monitoring programme at the current project planning stage.

The purpose, objectives, calendar and monitoring programme can be reassessed based on field results and regulatory provisions.

In view of the above and the differences in the level of detail of the projects included in the SNDDN and the associated PNN, a relevant set of SNDDN monitoring indicators is proposed below. These indicators will be quantified using the results of the individual monitoring programmes for each project and/or nuclear platform.

TABLE 62 - ENVIRONMENTAL MONITORING PLAN

Environmental aspects	Relevant environmental objectives for the National Strategy for the Development of the Nuclear Sector	Monitoring indicators	Frequency	Description	Responsible entity/entities
Air	Air and climate protection by minimising pollutants released into the air	Emissions of pollutants into the atmosphere (COx, NOx, SO2, suspended particles, heavy metals, VOCs, PAHs) resulting from the construction and operation period. Emissions of radioactive gaseous effluents into the air	It is established by regulations and/or within the regulatory acts of the nuclear or radiological project/installation	By implementing projects, during the construction phase, it is possible that pollutant emissions will have increased values regarding the quality of the surrounding air, but during the operation phase they will have a significant decrease compared to the current situation, through the implementation of non-polluting technologies.	Plan/project owner

Water	Water quality protection.	-Physico-chemical indicators bacteriological and biological characteristics of drinking water. -Physico-chemical indicators of non-radioactive liquid influent and effluent, including monitoring of temperature values. -Indicators for approved chemicals at discharge. - Quality indicators of domestic water and discharged wastewater -Indicators regarding groundwater quality - Emissions of radioactive liquid effluents.	According to the Water Management Approval or Authorisation, regulations and regulatory acts issued by the environmental authority, CNCAN and MS for the nuclear or radiological project/installation	Monitoring must demonstrate compliance with the maximum permitted limits issued by CNCAN and MS environmental regulations or authorisations for the project. Monitoring of water radioactivity (surface and underground) in the vicinity of the facilities must highlight compliance with the permitted limit values, according to CNCAN regulations and/or authorisations applicable to the nuclear/radiological project or facility.	Plan/project owner Plan/project owner

Soil - subsoil	Soil and subsoil protection: Improving soil quality by tracking potential effects on soil and subsoil (including chemical and radiological contamination), through pre- and post-implementation monitoring, where risks exist.	The type and quantity of pollutants introduced into the soil during the construction and operation stages of projects developed within the National Strategy for the Development of the Nuclear Sector. Number of accidental pollution events associated with SNDDN activities and the land area affected by them. Remedial measures used in accidental pollution in nuclear activities.	Notification of environmental events is made according to the regulations and, where applicable, the regulatory acts issued for the nuclear or radiological project/installation. According to the monitoring programme approved by CNCAN.	Monitoring the impact on soil within the SNDDN will be carried out by tracking the type and quantity of pollutants involved, the frequency of accidental pollution, the affected areas, as well as by evaluating the remedial measures applied.	Plan/project owner
biodiversity	Biodiversity conservation: Conservation of habitats and species of flora and fauna of community importance.	Number of protected areas intersected by the DGA project Surface area (ha) of protected natural areas affected by the implementation of the DGA project	In the execution phase and in the operation phase through monitoring programmes, which target different stages of the biological cycle, depending on each class of organism.	The location of projects (those for which the site has not yet been established) will avoid crossing protected natural areas as much as possible or where this is not possible, the occupancy percentage must be minimal and not affect habitats.	Plan/project owner
Human settlements and public health	Protecting citizens from risks that threaten their health and well-being by developing the capacity to respond to these risks.	Compliance with the limits of monitored parameters for environmental components. Data on risk factors for health and well-being (e.g. pollution,	It will be established within the framework of regulatory acts	Monitoring to protect citizens consists of supervising risk factors for health and well-being, assessing the level of exposure of the population, tracking the	Plan/project owner

	Monitoring risk factors. Ensuring and continuously increasing the level of nuclear security.	noise, technological incidents, accidental exposures, etc.).	at the request of environmental authorities. According to monitoring programme approved by CNCAN	response capacity of authorities and operators, as well as reporting and informing the public, in order to prevent and effectively manage situations with potential negative impact.	
Noise and vibrations	Noise and vibration prevention.	-Noise level The following provisions will be respected: -Law 121/2019; -SR 10009/2017/C91:2020	It will be established within the framework of regulatory acts. At the request of environmental authorities	Noise monitoring aims to: -detection of accidental or cumulative exceedances of sound levels; -identification of dominant noise sources; -preventing the occurrence of discomfort or effects on the health of the population.	Plan/project owner

12. NON-TECHNICAL SUMMARY

OVERVIEW OF THE CONTENT AND MAIN OBJECTIVES OF THE SNDDN AND ITS RELATIONSHIP WITH OTHER RELEVANT PLANS AND PROGRAMMES

This environmental report was prepared at the Strategy level, with the environmental procedures related to each plan/project being carried out or in progress through the National Strategy for the Development of the Nuclear Sector in Romania (SNDDN) and the National Nuclear Programme (PNN).

The National Strategy for the Development of the Nuclear Sector, hereinafter referred to as the SNDDN, is the principal policy document underpinning the sustainable development of the nuclear sector in Romania.

Preparation of the SNDDN was carried out in accordance with Article 8 of Government Ordinance No 7/2003 on the promotion, development and monitoring of nuclear activities, republished, as subsequently amended and supplemented, in conjunction with Article 3(1)(a) and Article 4(2)(a) of Annex 1 to Government Decision No 1437/2009 approving the Regulation on the organisation and operation and the organisational structure of the AGENȚIA NUCLEARĂ ȘI PENTRU DEȘEURI RADIOACTIVE, as subsequently amended and supplemented. The principal institutional stakeholders in the sector - ministries, public-administration institutions and authorities, relevant organisations, economic operators and professional associations - were consulted, taking into account the projects/plans proposed in the two strategic documents, particularly information on environmental procedures completed or under way and aspects concerning the environmental impacts of the proposed projects/plans.

Scope

This Strategy applies to the planning, implementation, monitoring and continuous improvement of nuclear power and non-power activities carried out exclusively for the peaceful and sustainable development of society and within the time horizon covered by the Strategy, including:

- Activities regarding the development of nuclear energy projects (such as nuclear research reactors, SMRs, Gen IV reactors);
- Activities relating to the refurbishment and/or construction of new nuclear reactors using CANDU technology;
- Research-development-innovation activities in the nuclear sector;
- Activities relating to the safe management of radioactive waste generated by the operation, refurbishment and decommissioning of nuclear power facilities, research reactors and radiological facilities, as well as the management of spent nuclear fuel;
- Nuclear facility closure and decommissioning activities;
- Activities regarding the conservation of the quality and quantity of heavy water, in the medium and long term, for CANDU nuclear reactors;
- Activities relating to the management of radioactive waste generated by industries other

than the nuclear industry;

- Activities supporting strategic objectives in other national policy areas that interface with the nuclear sector, including mining and energy mineral resources (radioactive ores, consisting of accumulations of uranium and thorium in the form of naturally occurring chemical compounds), and hydrogen production, etc.;
- Activities in industrial, medical and research applications that use radioactive sources.

With regard to the extraction and processing of nuclear raw materials, the National Strategy for the Development of the Nuclear Sector is aligned with the applicable sectoral strategic documents, including the National Strategy for Non-Energy Mineral Resources 2025-2035, approved by Government Decision No. 1464/2024, and Romania's Energy Strategy 2025-2035, with a perspective to 2050, approved by Government Decision No. 1491/2024. These activities are governed by the applicable specific legislative and procedural framework, and the Strategy addresses them at the level of policy coordination insofar as they are relevant to securing the nuclear fuel cycle and security of supply.

Strategy Objectives

Strategic objectives regarding the development of nuclear energy and non-power activities in Romania in the medium and long term:

- SO 1 - Maintaining a high level of performance and increasing the number of nuclear units using CANDU technology;
- SO 2 - Construction of new types of nuclear power plants through a phased approach over time and by reactor technology (small modular reactors - SMRs and innovative Generation IV reactors);
- SO 3 - Development of an integrated fuel cycle to ensure the sustainability and efficiency of nuclear energy;
- SO 4 - Safe management of spent nuclear fuel and radioactive waste, including the closure and institutional control of final radioactive waste disposal facilities;
- SO 5 - Strengthening technical and scientific support capacity and increasing the role of research and innovation in the nuclear sector;
- SO 6 - Ensuring the highly qualified human resources required to achieve the proposed objectives successfully;
- SO 7 - Harnessing the benefits of non-power applications in medicine, industry, agriculture, space applications, hydrogen production, etc.

The development of the nuclear sector, as defined by the strategic objectives of the SNDDN, is carried out in accordance with the National Strategy for Sustainable Development of Romania 2030 and contributes to the achievement of relevant Sustainable Development Goals.

In accordance with the vision and strategic objectives of the SNDDN, the development of the nuclear sector is ensured by carrying out strategic projects of national interest, which are identified within the PNN - an integral part of the SNDDN, namely:

1. Completion of Units 3 and 4 at Cernavodă NPP;
2. Refurbishment of Unit 1 and Refurbishment of Unit 2 at Cernavodă NPP;
3. Building the DFDSMA;

4. Building the DGA;
5. Construction works of the Cernavodă Tritium Removal Facility (CTRF), on the Cernavodă NPP platform;
6. Construction of a new nuclear power plant based on SMR modules;
7. Construction of experimental support facilities for the ALFRED demonstrator;
8. Construction of the ALFRED demonstrator, intended to demonstrate the viability of LFR technology;
9. Construction of a research infrastructure for the production of radioactive beams and radioisotopes of medical interest;
10. Development of technologies for fundamental and applied nuclear physics research with the high-power laser system at ELI-NP.

Directions of action to achieve strategic objectives

In order to implement the strategic objectives defined above, the main directions of action for the field of nuclear energy and non-power activities in Romania have been identified:

SO 1: Maintaining a high level of performance, extending the operating life of existing units and increasing the number of nuclear units using CANDU technology;

SO 2: Construction of new types of nuclear power plants through a phased approach over time and by reactor technology (small modular reactors - SMRs and innovative Generation IV reactors);

SO 3: Development of an integrated fuel cycle to ensure the sustainability and efficiency of nuclear energy;

SO 4: Safe management of spent nuclear fuel and radioactive waste commensurate with the development of nuclear energy, including the closure and institutional control of final radioactive waste disposal facilities;

SO 5 - Strengthening technical and scientific support capacity and increasing the role of research and innovation in the nuclear sector;

SO 6: Ensuring the highly qualified human resources required to achieve the proposed objectives successfully;

SO 7: Harnessing the benefits of non-power applications in medicine, industry, agriculture, research and hydrogen production.

To achieve the strategic objectives and expected results, the action directions will be supported by measures to leverage international cooperation in promoting nuclear projects and to inform the public with a view to increasing public acceptance.

- Leveraging development potential through international cooperation projects;
- Promoting nuclear projects and informing the public in order to increase public acceptance.

Relationship with other relevant plans/programmes/strategies

The SNDDN is developed in correlation with the main programmatic documents in the nuclear sector, taking over and integrating the objectives and directions of action established by them, namely:

- National Nuclear Safety and Security Strategy of 23 July 2014;

- National Strategy on the Safe Management of Nuclear Fuel and radioactive waste approved by Decision No. 102 of January 19, 2022;
- Romania's Energy Strategy 2025-2035, with a perspective to 2050, approved by Government Decision No. 1491 of 21 November 2024.

The SNDDN also took into account the relevant strategic documents, programmes and plans in force or under update, at various stages of adoption at national and sectoral level, which define the current sustainable development, energy, climate, economic, research, security and regulatory framework, as well as the specific documents developed by the organisations involved in the implementation of the national nuclear programme.

These documents include:

- The Integrated National Plan for Energy and Climate Change 2021-2030, approved by Government Decision No. 1076/2021;
- National Integrated Energy and Climate Change Plan (PNIESC), updated October 2024;
- National Investment and Economic Recovery Plan 2021-2027;
- National Roadmap of Research Infrastructures in Romania 2017 approved by the EC;
- National Strategy for Research, Innovation and Smart Specialisation 2022 – 2027, approved by Government Decision 933 of July 20, 2022;
- Romania's long-term strategy for reducing greenhouse gas emissions - Romania Neutral in 2050, approved by Government Decision No. 1215 of November 29, 2023;
- National Strategy on Adaptation to Climate Change for the period 2024-2030, with a perspective to 2050, approved by no. 1,010 of August 14, 2024; National Strategy for Non-Energy Mineral Resources 2025-2035 approved by Government Decision No. 1464 of November 21, 2024;
- National Strategy for Non-Energy Mineral Resources 2025-2035 approved by Government Decision No. 1464 of November 21, 2024; National Strategy for Sustainable Development of Romania 2030, adopted by Government Decision No. 877/November 9, 2018, published in the Official Gazette no. 985/November 21, 2018;
- National Strategy on Critical Infrastructures, Government Decision No. 718 of July 13, 2011;
- Strategy for the Refurbishment Project of Unit 1 of Cernavodă NPP, AGM Decision of 28.09.2017;
- Investment strategy of the National Company Nuclearelectrica S.A. for the period July 1, 2020 - July 1, 2025, approved by the Decision of the Ordinary General Meeting of Shareholders of 12.06.2020;
- Continuation Strategy of the Cernavodă NPP Units 3 and 4 Project, approved by the AGM Decision of 05.04.2021;
- The strategy for diversifying the sources of supply of raw materials necessary for the production of nuclear fuel, approved by the AGM Decision of 25.04.2018;

- SNN Memorandum of Understanding with NuScale Power to exchange technical and economic information regarding innovative nuclear technology developed by NuScale, signed on March 19, 2019;
- Agreement between the Government of Romania and the Government of the United States of America on cooperation in relation to the nuclear energy projects at Cernavodă and in the civil nuclear energy sector in Romania signed on September 21, 2020 and ratified by Law No. 200/16.07.2021;
- Agreement signed at COP26 between SNN and NuScale Power to advance the implementation of NuScale's small modular reactor technology in Romania, signed on November 4, 2021;
- RATEN Development Strategy for the period 2015-2025, Revision I, February 2021;
- Memorandum on the construction of the lead-cooled demonstration reactor, ALFRED, in Romania, approved in the Government meetings of February 9, 2011 and January 7, 2014, respectively;
- Memorandum of Cooperation between ANSALDO Nucleare and ENEA from Italy and the Pitești Nuclear Research Institute, RATEN ICN, for the implementation of the construction of the ALFRED project, from 2013, renewed in 2021;
- National Nuclear or Radiological Emergency Response Plan, CNCAN, 2022.

The SNDDN will be reviewed and updated periodically, depending on the evolution of nuclear strategies, namely:

- ✓ National Nuclear Safety and Security Strategy;
- ✓ National Strategy on the Safe Management of Nuclear Fuel and Radioactive Waste;
- ✓ National Strategy on Critical Infrastructures;
- ✓ The National Radon Action Plan and, last but not least, the provisions of Romania's Energy Strategy 2025-2035, with a perspective to 2050.

The action directions and supporting actions established in the SNDDN are implemented through the major projects, investments, measures and actions of the National Nuclear Programme, which forms an integral part of the SNDDN and is planned and implemented through:

- national and sectoral programmes/plans (e.g. programmes/plans endorsed and/or approved by the Government of Romania, the Ministry of Energy, the Ministry of Research, Innovation and Digitalisation of Education and Research, the Ministry of Economy, Digitalisation, Entrepreneurship and Tourism, CNCAN, ANDR, etc.);
- national and sectoral research-development-innovation programmes/plans (own research-innovation/development/investment/social and environmental/corporate strategies/programmes/plans, etc.) of organisations that have direct responsibility for projects and activities in the nuclear sector provided for in the SNDDN and PNN.

Within the Action Plan for achieving the medium and long-term strategic objectives, it is necessary to monitor the objectives assumed through appropriate performance indicators. The use of these indicators allows for the periodic assessment of the progress made, as well as the relevance and significance of the results for each of the stakeholders involved.

Geographic and administrative location, map presentation and GIS coordinates, including the coordinate reference system used

Cernavodă NPP Platform - The Cernavodă NPP site is located in Constanța County, approx. 2 km SE from the city of Cernavodă and approx. 1.5 km NE from the first lock of the Danube-Black Sea navigable canal (CDMN), being bordered to the northeast by the Cișmelei Valley, and to the southwest by DJ 223 and the secondary railway line, providing access to the industrial and port area of the city of Cernavodă.

DFDSMA location

The DFDSMA site is located outside the built-up area of Saligny commune, Constanța county and is included in the exclusion zone of the Cernavodă NPP (which has a radius of 1 km from Reactor 1, Cernavodă NPP slope – DN22 C – Valea Cișmelei), at approx. 350 m from the boundary of the NPP premises and, respectively, at approx. 750 m from the Bucharest - Constanța railway loop.

Mioveni Platform

The Mioveni platform is located in the Subcarpathian area in Argeș County, about 32 km northeast of the city of Pitești and 1.7 km from the city of Mioveni. The site borders the DACIA-RENAULT Car Plant to the west – 2.5 km, on a wooded plateau that continues towards the neighbouring communes. The general elevation of the plateau is 420÷450 m above the Black Sea level and about 150 m above the Doamnei River bed.

The Măgurele Platform

The Măgurele Platform is located within the built-up area of the city of Măgurele, Ilfov County, southwest of Bucharest (3.5 km from its border and 10 km from the centre) and 1.3 km from the Ciorogârla River. A ring forest with a radius of approximately 800 m constitutes the sanitary protection zone for the nuclear activities carried out on the site, based on the authorisations issued by the regulatory authority - the National Commission for the Control of Nuclear Activities.

Doicești Platform

The Doicești platform, which is located on the site of the former Doicești power plant, located in Dâmbovița County, on the administrative territory of Doicești commune, in the central-southern area of Romania, is a candidate site under evaluation. There are also concerns related to the evaluation of other sites for the implementation of other SMR technologies in the long term.

Location of the Deep Geological Repository

In order to implement the final waste disposal objective, Romania is analysing the possibility of creating a deep geological repository. At the time of the study, the exact location of the deep geological site has not been established, the project being in the early stages of site selection.

Activities generated as a result of strategy implementation

The nuclear development strategy aims to consolidate and expand nuclear uses in Romania, both in the energy sector (energy security, NES stability, decarbonisation) and in the non-energy sector (research, health, industry, agriculture and environment), while respecting the requirements of nuclear safety and environmental protection, the activities of safe management of radioactive waste and spent nuclear fuel originating from the operation of

nuclear facilities (for energy production or/and research reactors), their refurbishment and decommissioning.

Description of the technological processes carried out through the implementation of the strategy

The National Nuclear Strategy aims to produce electricity with low-carbon emissions by using existing nuclear technologies and developing advanced technologies.

In the CANDU type power plants at Cernavodă, the main technological processes used are: transformation of fission energy into thermal energy in the nuclear reactor, transformation of thermal energy into mechanical energy in the turbine, transformation of mechanical energy into electrical energy in the electric generator. They use natural uranium as fuel for generating thermal energy through the nuclear fission process of the natural isotope U-235. The fission process takes place inside the fuel bundles. In the operation of the CANDU 600 nuclear reactor, thermal energy is generated by the fission of nuclear fuel in the core. This energy must be extracted, transferred and utilised in the thermal energy cycle to produce electricity.

The strategy also includes the development of small modular reactors (SMRs), small-sized nuclear units with integrated systems and a high level of safety, which operate on the same principle of steam production for electricity generation, but with greater flexibility in location and operation. In this context, the opportunity of introducing SMR reactors into the national decarbonised energy production is highlighted, followed by the introduction of generation IV reactors, starting with the end of this decade.

The Strategy also provides for construction of a tritium removal facility to reduce the tritium content of the heavy water used at Cernavodă, thereby improving environmental protection and operating conditions.

In the field of research, the strategy supports the development of the ALFRED (liquid lead-cooled) demonstration reactor, which aims to validate a new generation nuclear technology, more efficient in fuel use and with the potential to minimise the quantities of radioactive waste produced, use uranium resources more efficiently, achieve increased economic efficiency, and increase operational safety.

Through these directions, the National Nuclear Strategy contributes to energy security, the reduction of greenhouse gas emissions and long-term technological development.

Justification of the need to implement the strategy

Nuclear energy production is one of the priority directions for Romania's energy security and for reducing greenhouse gas (GHG) emissions in the energy production sector.

To ensure the country's energy security, Romania must urgently expand the exploitation of nuclear energy resources and analyse the possibility of creating a legislative framework that would regulate the concept of reserve capacity from the perspective of costs for producers who will ensure this capacity, in accordance with European legislative provisions.

The expansion of the national nuclear sector, with the construction of new large-scale units and small modular reactors (SMRs), will significantly contribute to increasing low-

carbon electricity production, as well as to ensuring new energy supply solutions in new industrial applications.

One of the fundamental objectives of the National Strategy for the Development of the Nuclear Sector is the safe, sustainable and responsible management of radioactive waste generated by the use of nuclear energy and associated technological applications. The Strategy recognises that a sustainable development of the nuclear sector cannot exist without a solid policy on the treatment, storage and final disposal of this waste.

Description of the implementation stages of the National Strategy for the Development of the Nuclear Sector

The SNDDN and PNN update is for the period 2026-2030, with a perspective to 2050. The life cycle of nuclear facilities is long. Practically, for all existing and planned nuclear facilities in the SNDDN and PNN, the life cycle is beyond 2050, for example the life cycle of nuclear power units U3 and U4 ends after 2100.

The objectives included in the National Strategy for the Development of the Nuclear Sector have different implementation periods, determined by a series of aspects including: the technical complexity of each, the completion of the necessary studies and approvals, the method of ensuring compliance with regulatory and nuclear safety requirements in the different stages of nuclear authorisation.

The natural resources necessary for the implementation of the strategy (water abstraction, renewable resources, non-renewable resources, others) highlighting those that will be exploited within the protected natural area(s) of Community interest

For the operation of units 1, 2, 3 and 4 of the Cernavodă NPP, the main natural resource used will be natural, unenriched uranium, and the new small modular reactors (SMRs), planned for implementation, will use weakly enriched uranium.

Another important resource necessary for the implementation of the Strategy is water. Water, a fundamental natural resource, plays a critical role in the operation of nuclear power plants, being used as a coolant to evacuate the residual heat generated in the reactor.

Other natural resources used in the execution stage of the strategy's objectives are: soil (resulting from excavations and reused for fillings), stone, ballast, natural aggregates for concrete preparation (sand, gravel, etc.).

The core objectives set out in the development strategy will be achieved on land with an anthropogenic character, mainly in the yard-construction land use category, but also agricultural land.

RELEVANT ASPECTS OF THE CURRENT STATE OF THE ENVIRONMENT AND ITS LIKELY EVOLUTION IF THE PROPOSED STRATEGY IS NOT IMPLEMENTED

The characterisation of the current state of the environment was carried out based on the data and information available at the time of the Environmental Report, relating to the national territory. These were validated and made public through the Report on the State of the Environment in Romania – 2024, prepared by the National Agency for the Environment and Protected Areas, as well as through other relevant documents and documentation. The analysis of the current state of the environment was carried out for each environmental component considered relevant.

The environmental aspects analysed include: air quality, water, soil and subsoil geology, climate change, biodiversity, landscape, human settlements, population and human health, cultural heritage, material assets, as well as discomfort factors generated by noise, vibrations, heat, light and radiation.

Seismological activity

The recorded data highlights the fact that some of the seismic sources can generate earthquakes with moment magnitudes Mw>6.5, which can cause deaths and significant economic losses.

The average number of earthquakes of magnitude greater than or equal to the minimum magnitude in 25 years is between 1 and 30, with a maximum expected magnitude between 5.7 and 8.1.

N**ature conservation and biodiversity**

Following the positioning of the project sites in relation to protected natural areas, none of the projects envisaged within the SNDDN, whose location is known, is located within protected natural areas of Community interest. The only protected natural areas likely to be affected by the implementation of the strategy are located in the area of influence of the Cernavodă NPP and, respectively, of the DFDSMA repository. In the area of influence of the Mioveni platform, only the Lacul lui Barca Natural Reserve is found.

Regarding the Deep Geological Repository project, since its exact location has not yet been established, it is not possible to identify the protected natural areas likely to be affected.

The areas of influence of the SNDDN objectives are as follows:

- The Cernavodă NPP platform (which includes the projects Refurbishment of Units 1 and 2, Completion of Units 3 and 4, Heavy water detritiation works) – the Cernavodă NPP influence area was divided into 3 distinct manifestation areas, respectively 10, 20, 30 km (the Cernavodă NPP influence area in accordance with CNCAN requirements and international practice, taking into account radiological risk analyses).
- Mioveni Research Platform (ALFRED) and Măgurele Platform (ELI-NP) – 5 km influence areas, given the research nature and the small size of the possible radiological and technological effects.
- Doicești Platform (Small Modular Reactors- SMR) – 10 km area of influence, corresponding to possible interactions with the environment. The area of influence for

an SMR is estimated at approximately 10 km, compared to 30 km for large reactors, such as those at Cernavodă NPP, because SMRs have a much lower installed capacity, a reduced radiological inventory and use passive safety systems, which significantly limit the potential for the release of radioactive substances. Thus, in hypothetical accident scenarios, emissions would be much lower and radiological effects would manifest themselves in a much smaller area.

- DFDSMA site - a 3 km area of influence was considered for the DFDSMA, justified by the type of waste to be disposed of (short-lived low- and intermediate-level radioactive waste), the multi-barrier protection system and the local nature of potential hydrogeological effects.

DGA location - is currently unknown, the project being only in the host rock selection phase. In this context, several location areas have been proposed, without the final location being established. Therefore, the assessment of the effects on protected natural areas is carried out exclusively at a strategic level, given the preliminary nature of the project and the lack of a concrete location.

Results of field activities carried out

In addition to this monitoring, the consultant carried out its own field surveys to supplement and update the information on environmental conditions in the areas concerned by implementation of the other projects proposed under the Strategy. Field surveys were undertaken in the areas of the Mioveni, Măgurele and Doicești platforms and at the DFDSMA site, for which preparation of separate Appropriate Assessment studies was not required.

Field activities consisted of direct observations of environmental conditions, identification of existing habitats, assessment of the degree of anthropisation, as well as documentation of current land use and possible anthropogenic pressures on the environment. The data obtained allowed a characterisation of the proposed sites and a more rigorous substantiation of the analysis regarding the possible interactions between the strategy objectives and the environment.

The field surveys undertaken by the consultant as part of the assessment of the National Strategy for the Development of the Nuclear Sector showed that the other areas proposed for implementation of the Strategy are also highly anthropised, consisting mainly of industrial land or, in the case of the DFDSMA, agricultural land under continuous anthropogenic pressure. No natural habitats of Community interest or flora or fauna species of high conservation value were identified. Therefore, the local environmental conditions are compatible with the implementation of the objectives provided for in the Strategy.

Climate change

By modifying climatic parameters (amount of precipitation, temperature - amplitude of heat waves and harshness of winter, duration of cold and heat waves, wind speed, global solar radiation, sea surface temperature, etc.) various types of impact of climate risk phenomena on key sectors in Romania have been manifested.

GHG emissions will continue to increase if the implementation and at least maintenance of current policies is not done in the coming period, leading to an average global warming of

3.2°C compared to pre-industrial levels, by 2100. (National Strategy on Adaptation to Climate Change for the period 2024-2030, with a perspective to 2050).

Landscape

Existing nuclear-sector sites and facilities - such as Cernavodă Nuclear Power Plant, the Măgurele nuclear-physics institutes and radioactive-waste repositories - are located in predominantly anthropised landscapes characterised by industrial infrastructure, power-transmission lines and technical structures. Landscape changes in these areas are already stabilised and visual effects are localised.

Human settlements and public health

In areas where nuclear infrastructure exists (Cernavodă, Măgurele, Pitești, Băița, Doicești), the health status of the population is comparable to or superior to the regional average.

According to data from the National Institute of Public Health (INSP) and the Public Health Directorates (DSP), there were no exceedances of biological, radiological or epidemiological indicators that could be associated with nuclear activities.

Cultural heritage

The cultural heritage strategy aims to identify, protect and integrate into development plans the archaeological, built, mobile, intangible and digital heritage, through measures to preserve, adapt and reduce the impact of human activities on them.

Waste generation and management

Short-lived low- and intermediate-level radioactive waste (LILW-SL) generated by the operation, refurbishment and decommissioning of the nuclear units at Cernavodă NPP will be disposed of in the DFDSMA.

Spent nuclear fuel is currently classified as waste and will be disposed of in a deep geological repository together with long-lived low- and intermediate-level radioactive waste (LILW-LL).

LILW-SL radioactive waste generated by the operation and decommissioning of nuclear and radiological facilities outside the nuclear fuel cycle (research, medicine, industry, agriculture and other fields of socio-economic interest) will be disposed of at the IFIN-HH National Radioactive Waste Repository at Băița, Bihor County, until its closure. After closure, institutional LILW-SL radioactive waste meeting the acceptance requirements for near-surface disposal will be disposed of at the DFDSMA;

LILW-LL radioactive waste and problematic radioactive waste generated by the operation and decommissioning of research reactors, as well as disused sealed sources containing long-lived radionuclides from activities outside the nuclear fuel cycle, will be disposed of in the deep geological repository. Until that repository becomes operational, this waste will be stored on an interim basis at the IFIN-HH and RATEN ICN sites;

Spent nuclear fuel generated by the TRIGA reactor will be returned to its country of origin or disposed of in the deep geological repository. Until that repository becomes operational, the fuel will be stored on an interim basis at the RATEN ICN site.

Likely evolution of the environment without implementation of the National Strategy

In the scenario of non-implementation of the National Strategy for the Development of the Nuclear Sector, the current situation is maintained, without significant progress towards decarbonisation, energy security and sustainable management of spent nuclear fuel.

Failure to implement the Strategy would represent a loss of strategic opportunity for Romania, limiting the country's capacity to ensure a sustainable energy transition and to maintain a high level of nuclear safety and environmental protection. In addition, it would lead to failure to meet the energy and environmental development objectives assumed by Romania through the European Green Deal, the Paris Agreement and the National Integrated Energy-Climate Change Plan (PNIESC) and would mean failure to comply with the provisions of art. 14 of Ordinance no. 11/2003 on the safe management of radioactive waste and spent nuclear fuel, which provides for the periodic review of the national strategy in the medium and long term, taking into account technical and scientific progress.

ENVIRONMENTAL CHARACTERISTICS OF AREAS LIKELY TO BE SIGNIFICANTLY AFFECTED

The areas that may be significantly influenced by the implementation of the National Strategy for the Development of the Nuclear Sector (SNDDN) are mainly associated with the following categories of locations:

- existing and future sites for nuclear energy production (nuclear power plants and possible new units or technologies);
- nuclear fuel cycle facilities;
- sites for nuclear research, development and application facilities (including scientific platforms, pilot facilities);
- existing and potential sites for the storage and management of radioactive waste (surface repositories, geological repositories, interim storage facilities).

  Land use in these areas is mixed:
  - industrial and energy lands (industrial platforms, technological areas);
  - agricultural land with a significant share in low-lying areas;
  - forested lands and natural habitats, especially in hilly and mountainous areas;
  - built-up areas – urban and rural localities, residential neighbourhoods, service areas.

Following the analysis, none of the projects provided for within the SNDDN, whose location is known, is located within protected natural areas of Community interest. The locations of the analysed objectives are NOT located inside protected natural areas and most of the objectives have regulatory acts, and the environmental studies and periodic reports carried out did not highlight the existence of adverse effects on biodiversity elements.

EXISTING ENVIRONMENTAL ISSUES RELEVANT TO THE NATIONAL STRATEGY

Based on the analysis of the available information, the environmental assessment indicates that there are no environmental issues associated with the National Strategy for the Development of the Nuclear Sector (SNDDN).

Summary of the main environmental aspects relevant to the National Strategy, for each environmental component analysed, considering potential interactions with environmental components and applicable compliance requirements:

*Soil–subso*il: Monitoring by the authorities has highlighted the presence of radiological contamination at certain points, and the potential risk of soil and subsoil contamination remains a problem in areas such as temporary radioactive waste repositories, spent fuel handling/storage, and in construction/decommissioning phases. In 2023, natural radionuclides (including K-40) and Cs-137, whose presence in the soil is due to the Chernobyl accident, were identified.

*Wat*er: Nuclear energy is highly dependent on water resources; at Cernavodă NPP there is interdependence with the Danube regime. Risks: thermal effect, risk of accidental radioactive contamination (low probability), chemicals from technological processes and reduced flows in drought/heat waves. In 2023, surface water radioactivity remained at low levels without exceedances, and Cs-137 appeared sporadically, in very low concentrations, without indicating "current sources" of contamination.

Climate and air quality: From a climatic point of view, Romania is facing a gradual increase in temperatures and extreme weather events, with implications for cooling and safety. The main risks associated with this factor include: dust/pollutants on construction sites, possible accidental release of radioactive substances (low probability) and vulnerability to heat waves/floods/storms. In 2023, the gamma dose rate was within the natural background limit.

Biodiversity: Nuclear sites and their adjacent areas may exert influences on natural ecosystems, especially in situations where they are located in proximity to Natura 2000 sites, functional ecological corridors or wetlands of Community interest.

Directly, pressures on biodiversity can manifest themselves through: land occupation and habitat conversion, disturbance of fauna and modification of hydrological conditions.

The results obtained in 2023 indicate that the radioactivity of spontaneous vegetation is dominated by natural radionuclides, and the measured levels are comparable to those in previous years and to background values, with no significant radiological impacts on the terrestrial environment being highlighted.

Landscape: Nuclear installations have a relatively concentrated visual impact, with local contrasts (e.g. Cernavodă). New locations are in predominantly industrial areas, with low local aesthetic value; temporary changes may occur during construction/expansion, without affecting landscapes with high aesthetic value or areas protected from a landscape point of view.

*Human settlements and h*ealth: Benefits for energy security and peaceful health uses, but there are persistent concerns about perceived radiological risk and social acceptability. The main environmental and health risks identified include: high risk perception, psychological stress, incidents (low probability), geopolitical context (armed conflict on the

Romanian border, hybrid threats), plus noise/vibration/traffic at construction sites. Monitoring indicates levels within permissible limits; no exceedances were recorded in 2023 of warning/caution limits for environmental components monitored by RNSRM.

Radioactive waste and spent nuclear fuel: This is one of the most important and sensitive issues, with potential risks to soil and groundwater in the event of improper management or loss of barrier integrity; the National Repository at Saligny is planned for the medium term.

*Potential risks: Th*e development of the nuclear sector in Romania, within the framework of the National Strategy for the period 2026–2030, with a perspective to 2050, as well as the implementation of the National Nuclear Programme, involves a complex set of strategic, operational and systemic risks. These risks are generated by the specific nature of nuclear activities, the long implementation horizon, the high safety and security requirements, as well as the constantly evolving geopolitical, economic and technological context.

ENVIRONMENTAL PROTECTION OBJECTIVES ESTABLISHED AT NATIONAL, EU OR INTERNATIONAL LEVEL THAT ARE RELEVANT TO THE STRATEGY, AND HOW THESE OBJECTIVES AND OTHER ENVIRONMENTAL CONSIDERATIONS WERE TAKEN INTO ACCOUNT DURING PREPARATION OF THE STRATEGY

The fundamental objective is to increase the share of nuclear electricity in Romania's total electricity production.

It will be carried out in compliance with the principles of sustainable development of society, under competitive cost conditions and ensuring nuclear security at the level of international standards.

TABLE 63 - ENVIRONMENTAL OBJECTIVES RELEVANT TO THE NATIONAL STRATEGY

Environmental objective	Related measures	Indicators / Targets
O1 Air and climate protection	M1 Maintaining air quality M2 Preventing air pollution M3 Reducing GHG emissions M4 Selecting sites outside areas affected by extreme events M5 Application of the principle of radiation protection	Reducing GHG emissions by 55% by 2030 ("2030 climate targets" – European Commission); maintaining limit values for pollutants
O2 Water protection	M6 Compliance with pollutant limit values M7 Protection of groundwater and surface water M8 Protection of drinking water	Zero significant pollution incidents; compliance with national legislation
O3 Soil and subsoil protection	M9 Soil pollution prevention M10 Carrying out the management of radioactive waste and spent fuel in accordance with national requirements and in accordance with the recommendations of the standards M11 Restoring soil quality where necessary	Reduction of affected areas; restoration of degraded areas; Environmental restoration following the cessation of activities of nuclear power plants or facilities

O4 Biodiversity conservation	M12 Maintaining the favourable status of habitats and species	Favourable conservation status
O5 Population health and human settlements	M13 Monitoring exposure to risk factors and health status.	Reducing the level of population exposure to noise pollution and ionising radiation Ensuring monitoring of radiological exposure and health status in the nuclear sector, as well as for the public Ensuring proper nuclear accident management.
O6 Noise and vibration prevention	M16 Reduction and compensation of noise and vibration effects	Noise levels ≤ regulated limits in all inhabited areas. Compliance with the following provisions: - Law 121/2019 – assessment and management of environmental noise - STAS 10009 – limits for urban areas -Ministry of Health Order 119/2014 – public health norms - Law No. 292/2018 - environmental impact assessment
O7 Landscape protection	M17 Integrating the plan into the existing landscape	Carrying out approved visual assessments in major projects
O8 Public awareness	M18 Information campaigns on environmental issues M19 Appropriate public awareness and information for understanding the nuclear sector	Ensuring a minimum number of major public campaigns / year
O9 Resource conservation	M20 Protection and efficient use of natural resources	Increasing resource efficiency by a sustainable percentage

POTENTIAL SIGNIFICANT ENVIRONMENTAL EFFECTS

The environmental report identifies, describes and assesses the possible significant effects on the environment, the mitigation measures and the conditions for their application, their rational alternatives, taking into account the fact that some elements (for example, future locations for certain objectives) will be defined in the later stages of design and authorisation.

Environmental assessment carried out at a strategic level:

- treats impacts in an integrated manner on environmental components (air, water, soil/subsoil, biodiversity, landscape, noise/vibrations) and on the human health component;
- uses the information available at the strategy level and, where technical detail is not yet available, applies a precautionary approach, based on the experience of similar projects and standard nuclear safety and environmental protection requirements;
- establishes framework measures and requirements for subsequent stages (EIA/Espoo, Natura 2000 Appropriate Assessment, CNCAN and environmental authorisations), so that risks and impacts are kept within acceptable limits, and the principles of ALARA, prevention and precaution are consistently applied.

The execution of works related to the proposed objectives represents the main category of activities with direct impact on environmental components.

Impact on soil and subsoil

During the implementation of the National Strategy, the impact on the soil-subsoil environmental component is related to the activities for the effective achievement of the objectives proposed by the strategy.

- In general, the effects on soil and subsoil are temporary, limited to the construction period and can be remedied by land reclamation. An exception is the areas permanently occupied by the achieved objectives (construction and infrastructure footprint), where the change in land use becomes permanent.
- The impact is mainly local, in terms of surface and volume, but may be longer lasting in areas with excavations, fillings, earthworks and compactions, by modifying the local geological stratification and structure.
- During activities proposed under the National Strategy for the Development of the Nuclear Sector in Romania and the National Nuclear Programme, pollution of the soil and subsoil is not anticipated under normal operating conditions. In abnormal or accident conditions, however, adverse effects may arise, for example from non-compliance with requirements for storing, handling or disposing of waste, including radioactive waste; failures of wastewater transport and treatment systems resulting in uncontrolled discharges; incidents during transfer of liquid radioactive waste, including loading, unloading, coupling and handling; accidental chemical spills; loss of barrier integrity due to extreme external hazards such as earthquakes, floods or severe weather, or deliberate acts; damage to liquid-waste transfer lines; and malfunctioning drainage systems, including clogging, insufficient capacity or inadequate maintenance, which may promote ponding and infiltration.
- The strategy can also contribute to reducing the risk of pollution by improving waste management: optimising transport, using modern technologies for treatment, and making

better use of existing and future storage facilities, which can reduce the quantities of non-compliant waste and situations with potential contamination.

- Under normal operating conditions of the facilities covered by the SNDDN, impacts on soil and subsoil are considered insignificant because of the containment systems and other protection measures provided, together with programmes for monitoring, preventing and controlling emissions.

Impact on water

During implementation of the Strategy, impacts on water are considered manageable at strategic level, provided that appropriate technical prevention, mitigation and monitoring measures are detailed and applied during the design and authorisation stages. These measures must keep the risk of surface-water and groundwater pollution very low and prevent significant effects on Natura 2000 sites within the areas of influence.

During the operation of the facilities, under normal operating conditions, there is no pollution of surface and groundwater.

No significant adverse effects on the environment are predicted, except for small increases in the concentration of discharged substances.

The only area where increased attention is required from the perspective of the potential for amplifying existing pressures is the aquatic environment, where any additional contribution must be prevented through avoidance and control measures from the planning phase, respectively through design and monitoring conditions, so as to maintain the integrity of aquatic ecosystems and water-dependent habitats.

Impact on air

During the construction phase, the impact on air is mainly associated with site activities: excavation, transport and handling of materials, site organisation and operation of machinery. The effects are local and limited to the period of the works.

Radioactive emissions are not normally associated with construction works. They may only occur in specific situations, such as works within existing nuclear facilities or during testing/commissioning phases, where emissions are controlled, filtered and monitored according to legal requirements. The impact is temporary and depends on the site organisation and the protective measures applied.

The predicted impact is low and localised under normal conditions, as emissions (tritium, noble gases, iodine, particles) are discharged in a controlled manner, with monitoring and compliance with authorised limits. In abnormal/accidental situations, the impact may temporarily increase, but is managed through barriers and control procedures, with impact limitable through detection and intervention systems. The effects are temporary and dependent on the magnitude of the accident.

Impact on biodiversity

The SNDDN is compatible with the objectives of environmental protection and with maintaining the integrity of protected natural areas, provided that the regulatory procedural stages and prevention and control measures, an integral part of the strategy's activities, are respected. The locations associated with nuclear activities and projects in the SNDDN and PNN

are predominantly located in areas with a high degree of anthropisation, which limits direct pressures on habitats and species of Community interest and allows for predictable risk management.

For energy objectives, especially the Cernavodă NPP and the SMR project, the most sensitive environmental vector is water. In normal operating conditions, cooling waters constitute a distinct flow from technological wastewater, the former having as its main effect the local thermal increase of the receiver, and the latter being treated and monitored before discharge. The potential impact on aquatic ecosystems is manifested by the warm waters discharged, possible local changes in turbidity and microclimate (short episodes of evaporation fog in specific meteorological conditions). These effects are, however, controllable by limiting the temperature at discharge, designing and operating the discharge points, continuous monitoring of water quality and respecting the conditions imposed by permits. Under these conditions, the influences remain local, do not affect the integrity of Natura 2000 sites and do not lead to structural changes in aquatic habitats.

The conclusions of the study "Appropriate Assessment of the Environmental Impact of Units 3 and 4 of Cernavodă NPP" state that the impact of the Units 3 and 4 project is insignificant and that the simultaneous operation of four nuclear units at the Cernavodă NPP site does not affect the favourable conservation status of habitats and species, including those of Community interest. It was also estimated that the operation of Units 3 and 4 does not have a significant impact on natural habitats or flora and fauna species within the project's area of influence, either directly or indirectly, in the short or long term, during the construction, operation or decommissioning phases, or cumulatively with the potential impact of other activities carried out at Cernavodă NPP. In the context of medium- and long-term climate change projections for Romania, specifically the Dobrogea region, considered together with the generally insignificant environmental impact assessed during the operation of Units 3 and 4, it is estimated that the discharge of heated effluent into the Danube from Cernavodă NPP operating with four nuclear units does not generate adverse effects on species and habitats of conservation interest, and the impact is assessed as insignificant.

Final radioactive waste repositories, namely the final repository for low- and intermediate-level waste and the deep geological repository, are essential components of a responsible nuclear policy. Their need is twofold: to reduce the cumulative risks associated with long-term temporary storage and activities associated with the final part of the nuclear fuel cycle. For the deep geological repository, the impact cannot be quantified before the site is established; however, the selection and exclusion criteria, together with the multi-barrier system (engineered barriers and geological barrier), are designed precisely to prevent the migration of radionuclides to aquifers at relevant concentrations and to avoid crossing sensitive habitats or ecological corridors. Similarly, for the DFDSMA, the heat-free inventory and engineered containment solutions ensure a low, local and manageable risk.

The strategic level analysis indicates that radiological risks in normal operation are low, and credible accident scenarios are of low probability and are covered by prevention, monitoring and response measures. At the project level, the assessments will detail the actual perimeters of influence based on specific modelling (air and hydrogeology), calibrate water resources protection measures and ensure compliance with the Conservation Requirements of Protected Natural Areas.

From the perspective of energy security and climate objectives, implementation of the Strategy is timely and recommended. Nuclear energy provides firm, low-carbon capacity, stabilises the energy system and reduces exposure to volatility in fossil-fuel markets. The strategic benefits outweigh the environmental risks, which under the proposed framework are clearly identifiable, localised and manageable through compliant design, operation and monitoring. Overall, the Strategy can be implemented without significant effects on protected natural areas where project locations are known, with priority given to sound water management at Cernavodă NPP and the SMR project and to responsible development of final radioactive-waste disposal infrastructure.

All the objectives set out in the National Strategy for the Development of the Nuclear Sector (with the exception of the deep geological repository – whose location is unknown) are located outside protected natural areas, in accordance with the provisions of national and European legislation on the conservation of biodiversity and the maintenance of the integrity of the natural heritage. This compliance is the result of the strategic planning process, which integrated criteria for environmental protection and sustainable use of resources, in correlation with energy security objectives. Thus, no areas of habitats of Community interest or of feeding/resting or breeding habitats for bird species for which sites of Community interest have been designated will be lost.

The research activities proposed on the Mioveni and Măgurele platforms are not intended for the production of electricity and do not involve technological flows with the potential for significant environmental impact. Their location on already anthropised platforms, the functional separation of the facilities, the reduced volumes of materials and the strict operating regime mean that any effects will be local, punctual and short-term, and insignificant. In conclusion, the research activities do not generate significant environmental impact and do not affect conservation objectives.

The radioactive waste management component is essential for the long-term credibility and security of the nuclear programme. The DFDSMA and, in the future, the deep geological repository close the management cycle, reduce the cumulative risks of temporary storage and ensure the protection of water resources and biodiversity through the multi-barrier system and strict site selection/exclusion criteria.

At the current stage, the impact of the DGA cannot be quantified before the location is established, but the selection methodology is designed precisely to avoid significant interactions with habitats and species of Community interest. The selection of the future location will be based on complex geological, technical and environmental studies, in accordance with the standards of the International Atomic Energy Agency (IAEA), applicable national legislation and European Union directives. The process will also include environmental impact assessment stages, to ensure compliance with the principles of environmental protection.

Impact on landscape

Impact nature: small-medium magnitude, depending on architectural integration and natural distances/masking, long duration (throughout the life of the objectives), at local-area level (in the potential visibility area), partially reversible (reduced to decommissioning and

through restoration measures) and reduced in industrial areas, medium in sensitive contexts or with open lines of sight to the objective.

Impact on human settlements, the population (social and economic environment) and human health

Provided that the projects and recommendations in the regulatory acts are complied with, the specialised opinions/studies and activities that will be carried out within the framework of the nuclear strategy objectives will not adversely affect the health of the population in the area, by applying the measures provided.

According to national monitoring, no risks or causes for concern have been identified for the social environment or public health, and operation of the facilities has not been associated with adverse health effects. Nature of impact: low to negligible for public health; positive socio-economic effects through employment, local income and services.

Noise and vibration impacts

During activities carried out under the National Strategy, given the industrial location and the control systems at the source/path/receptor, the impact on receptors outside the premises is low–negligible and specific occupational requirements apply to personnel on the premises.

Impact on historical and cultural heritage

Based on the current location of known objectives, the implementation of the Strategy does not generate interactions with historical or cultural heritage assets in the targeted areas. For future investments, the existence of potential impacts will be clarified by completing legal steps, including checks in official heritage lists and registers and, where appropriate, preventive archaeology.

Climate change

Climate change affects the plans and projects included in the SNDDN on three major dimensions: physical infrastructure, production capacity, and nuclear safety and security risks.

Climate change immunisation of the proposed strategy is a process that integrates climate change mitigation measures and climate change adaptation measures into the development of infrastructure projects included in the strategy. It comprises two pillars: climate neutrality – climate change mitigation and climate resilience – climate change adaptation.

The effects of the strategy on climate change in the nuclear context: emissions occur predominantly in the construction phase and upstream (fuel chain – extraction, conversion, enrichment, manufacturing, transport). In operation, direct emissions are very low; there is no combustion of fossil fuels in the generation process, and GHG emissions are negligible.

The objectives of the nuclear strategy can be maintained under conditions of increased climate variability, supporting a sustainable, safe and future climate-adapted nuclear sector.

Radiation sources and radiation protection

The implementation of the National Strategy for the Development of the Nuclear Sector involves the construction, operation and expansion of nuclear and research facilities, as well as the development of radioactive waste management infrastructure. All these activities can

generate, directly or indirectly, two main categories of emissions/effluents – radioactive and non-radioactive – each with specific characteristics and regulatory requirements.

Waste generation and management

According to the Consolidated Sustainability Report at SNN Group level (2024), the activities specific to the nuclear sector and affiliated entities are carried out in full compliance with the national and European legislative framework on waste management, having as its central objective the prevention of generation, minimisation, recovery and safe disposal of all waste flows, radioactive and non-radioactive.

The AGENȚIA NUCLEARĂ ȘI PENTRU DEȘEURI RADIOACTIVE is the national authority competent in the field of promotion, development and monitoring of nuclear activities for exclusively peaceful purposes and of the safe management of radioactive waste, including their final disposal. The activities for the safe management of radioactive waste and spent nuclear fuel are carried out on the basis of the National Medium and Long-Term Strategy for the Safe Management of Spent Nuclear Fuel and Radioactive Waste, a document that is developed by ANDR and approved by Government Decision. According to the provisions of Ordinance 11/2003, ANDR periodically develops and revises, taking into account technical and scientific progress, as well as the recommendations and good practices derived from peer reviews, the National Medium and Long-Term Strategy for the Safe Management of Spent Nuclear Fuel and Radioactive Waste.

The Waste Management Plan is complied with. The final disposal requirements for each category of radioactive waste are as follows:

- exempted waste may be disposed of without restriction;
- transitional waste is stored on an interim basis until it qualifies as exempted waste, after which it may be disposed of without restriction;
- very-low-level waste may be disposed of in a near-surface facility requiring less complex engineered features than those used for short-lived low-level waste;
- short-lived low- and intermediate-level waste (LILW-SL) may be disposed of in near-surface disposal facilities;
- long-lived low- and intermediate-level waste (LILW-LL) may be disposed of only in deep geological repositories;
- high-level waste may be disposed of only in deep geological repositories.

Cumulative impact of the Strategy (proposed plans and projects) with other plans and projects in the area

During the construction phase, environmental effects are predominantly local, temporary and reversible, but may be significant within the intervention areas. Excavation, earthworks, material transport, equipment installation and infrastructure construction cause a range of effects on environmental components.

During the operation period, the environmental effects are significantly reduced and manifest themselves in a controlled, stable and permanently monitored regime, according to nuclear safety and environmental protection requirements, with reduced environmental effects, while the construction period remains the stage with the highest potential for generating effects, due to direct physical works on soil, water, air and biodiversity.

The implementation of the SNDDN and the PNN has a major positive impact by strengthening a coherent framework of public policies for the nuclear sector, which integrates objectives of nuclear safety, energy, research and development and radioactive waste management.

POSSIBLE SIGNIFICANT EFFECTS ON THE ENVIRONMENT, INCLUDING HUMAN HEALTH, IN A TRANSBOUNDARY CONTEXT

The activities covered by this National Strategy are subject to the provisions of Law No. 22/2001 (as amended), on the ratification of the Convention on Environmental Impact Assessment in a Transboundary Context, adopted in Espoo on 25 February 1991, as well as the provisions of Directive 2011/92/EU of the European Parliament and of the Council on the assessment of the effects of certain public and private projects on the environment, as amended by Directive 2014/52/EU (EIA Directive).

The projects included in the National Strategy for the Development of the Nuclear Sector have different implementation periods, determined by factors such as the technical complexity of each project, completing the study stages and obtaining the necessary approvals in the pre-project phase, as well as ensuring compliance with regulatory and nuclear safety requirements, in the different stages of the authorisation process.

TABLE 64 - THE OBJECTIVES CONTAINED IN THE SNDDN ALSO FOUND IN THE RELATED RELEVANT STRATEGIES

No.	The objective	Relevant strategy
1	Completion of Units 3 and 4 at Cernavodă NPP;	Romania's Energy Strategy 2025-2035, with a perspective to 2050
2	Refurbishment of Unit 1 and Refurbishment of Unit 2 at Cernavodă NPP;	Romania's Energy Strategy 2025-2035, with a perspective to 2050
3	Building the DFDSMA	National medium and long-term strategy on safe fuel management spent nuclear and radioactive waste
4	Building the DGA	National medium and long-term strategy on safe fuel management spent nuclear and radioactive waste
5	Construction works of the Cernavodă Tritium Removal Facility (CTRF), on the Cernavodă NPP platform;	The Cernavodă Tritium Removal Facility (CTRF) is aligned with the objectives of Romania's Energy Strategy and the PNIESC concerning the modernisation and safe operation of existing nuclear capacity and is a supporting infrastructure investment for Cernavodă NPP.
6	Construction of a new nuclear power plant based on SMR modules;	Romania's Energy Strategy 2025-2035, with a perspective to 2050
7	Construction of experimental support facilities for the ALFRED demonstrator	PNCDI IV – Programme 5.9 is part of the National Research, Development and Innovation Plan IV (PNCDI IV), which is the strategic framework through which Romania finances research and innovation.
8	Construction of the ALFRED demonstrator, intended to demonstrate the viability of LFR technology;	PNCDI IV – Programme 5.9 is part of the National Research, Development and Innovation Plan IV (PNCDI IV), which is the strategic framework through which Romania finances research and innovation.
9	Construction of a research	National Strategy for Research, Innovation and Smart

	infrastructure for the production of radioactive beams and radioisotopes of medical interest;	Specialisation 2022-2027 - Romania participates in the development and operation of research infrastructures of European interest (ESFRI), including in nuclear physics and the use of high-power lasers.
10	Development of technologies for fundamental and applied nuclear physics research with the high-power laser system at ELI-NP.	

PROPOSED MEASURES TO PREVENT, REDUCE AND COMPENSATE FOR ADVERSE ENVIRONMENTAL EFFECTS

The general objective of the measures proposed to prevent, reduce and compensate for adverse environmental effects in the National Strategy for the Development of the Nuclear Sector is to define a coherent and integrated framework of technical, institutional and socio-economic measures, aimed at ensuring:

- protection of public health and the environment throughout the life cycle of nuclear facilities and activities, including the design, construction, operation, decommissioning stages, as well as the management of spent nuclear fuel and radioactive waste;
- full compliance with the principles and requirements applicable in the field of nuclear and radiological safety, with the objectives of the circular economy, as well as with the requirements of adaptation and resilience to climate change, in line with national and European commitments;
- Consolidation of the positive effects generated by the implementation of the strategy. The objectives relating to nuclear applications intended for environmental monitoring are predominantly of a research, development and monitoring nature and do not require, at a strategic level, additional impact reduction measures.

TABLE 65 - MEASURES FOR PREVENTING/REDUCING POTENTIAL IMPACTS DURING THE IMPLEMENTATION PERIOD

O1 Air and climate protection	
M1	Maintaining air quality
M2	Air pollution prevention
M3	Reducing greenhouse gas emissions (GHG)
M4	Choosing locations outside areas with extreme phenomena
M5	Application of the principle of radiation protection
O2 Water protection	
M6	Compliance with legal limit values for pollutant concentrations in wastewater
M7	Protection of groundwater and surface water quality
M8	Protection of drinking water quality
O3 Soil and subsoil protection	
M9	Prevention of soil pollution and soil surface degradation as a result of activities carried out during the project implementation stages
M10	Management of radioactive waste and spent nuclear fuel in accordance with the applicable national legal framework, the regulations and requirements of the competent national nuclear authority, and Romania's international obligations.
M11	Restoring soil quality where necessary
M12	Management of non-radioactive waste

O4 Biodiversity protection	
M13	Maintaining the favourable conservation status of habitats and species of wild flora and fauna within protected natural areas of Community interest.
O5 Population health and human settlements	
M13	Maintaining and improving environmental quality and public health in areas potentially affected by implementation of the Strategy
M15	Ensuring and continuously improving the level of nuclear safety
M16	Ensuring and continuously improving the physical protection of nuclear materials and nuclear facilities
O6 Prevention, reduction and compensation of the effects of noise and vibrations	
M17	Reducing and compensating for the effects of noise and vibration
O7 Landscape protection	
M18	Harmonious integration of the proposed plan into the existing landscape
O8 Increasing awareness of environmental issues	
M19	Public awareness of environmental issues
O9 Conservation and efficient use of resources	
M20	Conservation and protection of natural resources
O10 Sustainable waste management	
M21	Preventing and reducing the impact on the environment and human health generated by waste management

TABLE 66 - MEASURES FOR PREVENTING/REDUCING POTENTIAL IMPACTS DURING THE OPERATION/EXPLOITATION PERIOD

O1 Air and climate protection	
M1	Maintaining air quality
M2	Air pollution prevention
M3	Reducing greenhouse gas emissions.
O2 Water protection	
M4	Compliance with legal limit values for pollutant concentrations in wastewater
M5	Protection of groundwater and surface water quality
M6	Protection of drinking water quality
M7	Permanent monitoring of the technical condition of the storage facilities (infiltration, waterproofing)
O3 Soil and subsoil protection	
M8	Prevention of soil pollution and soil surface degradation as a result of activities carried out during the project implementation stages
M9	Management of radioactive waste and spent nuclear fuel in accordance with the applicable national legal framework, the regulations and requirements of the competent national nuclear authority, and Romania's international obligations.
M10	Restoring soil quality where necessary
O4 Biodiversity protection	
M11	Maintaining the favourable conservation status of habitats and species of wild flora and fauna within protected natural areas of Community interest.
O5 Population health and human settlements	
M12	Maintaining and improving environmental quality and public health in areas affected by implementation of the Strategy
M13	Ensuring and continuously improving the level of nuclear safety and the safe operation of facilities
M14	Ensuring and continuously improving the physical protection of nuclear materials and nuclear facilities
O6 Prevention, reduction and compensation of the effects of noise and vibrations	

M15	Reducing and compensating for the effects of noise and vibration
O7 Landscape protection	**Landscape protection**
M16	Harmonious integration of the proposed plan into the existing landscape
O8	**Raising awareness of environmental issues**
M17	Public awareness of environmental issues
O9 Conservation and efficient use of resources	
M18	Conservation and protection of natural resources
O10 Sustainable waste management	
M19	Preventing and reducing the impact on the environment and human health generated by waste management

REASONS FOR SELECTING THE PREFERRED ALTERNATIVE AND DESCRIPTION OF THE ASSESSMENT METHOD, INCLUDING ANY DIFFICULTIES ENCOUNTERED IN PROCESSING THE REQUIRED INFORMATION

Alternatives to the National Strategy

According to the provisions of the legislative framework regarding strategic environmental assessment, several alternative development solutions were analysed, in order to substantiate the choice of the optimal option from the point of view of environmental protection, energy security and conservation objectives.

Alternative 0 **Non-implementation of the strategy**

Alternative 1 **Partial implementation without Units 3 and 4 of Cernavodă NPP**

Alternative 2 **Partial implementation without updating the National Radioactive Waste Management Programme, to address new types of reactors (SMR)**

Alternative 3 **Implementation of the Strategy without developing the nuclear research field – ALFRED and ELI-NP**

Alternative 4 **Full implementation of the strategy**

Failure to implement the strategy could attract infringement procedures from the EU and the IAEA for failure to comply with international standards and agreements on radioactive waste management.

The alternative of partial implementation of the strategy, without achieving the final disposal of all categories of radioactive waste generated in Romania, is not acceptable.

The environmental impact of the implementation of the Reference Scenario is positive. The environmental impact assessment of the projects proposed by the Strategy will be carried out in detail within the environmental procedures related to the development phases.

The full implementation of the Strategy is the preferred strategic option, as it ensures the best compatibility with the objectives of environmental protection, energy security and sustainable development, in accordance with relevant directions and commitments at national and European level.

Based on the RM analysis, the recommended optimal option is the full implementation of the Strategy, with rigorous application of impact prevention and mitigation measures, especially in relation to protected natural areas of Community interest as will result from the regulatory conditions imposed by the environmental authorities for the projects and activities in the Strategy. The concrete conditions, including monitoring requirements and specific measures, will be established by the regulatory acts issued by the competent authorities for each project and activity.

Assessment of environmental effects using the Negative Impact Units Method

The environmental impact was quantified by converting the level of impact on each environmental component into negative impact units (N), in accordance with the Negat**ive Impact Units Method, both for the** construction of the National Strategy projects/implementation of the National Strategy and for the operation/activity stage. The result indicates an environment aff**ected within acceptable limits.**

Conclusion of the Mathematical Analysis:

The Total Quantified Impact (ITC=1.66) related to the studied National Strategy corresponds to an environment affected within acceptable limits.

Spectral analysis"

many other methods of environmental impact analysis do not highlight them sufficiently.

The total quantified impact caused by the assessed Strategy corres**ponds to an affected environment within acceptable limits.**

Conclusion of the impact unit method:

The analysis of the environmental effects of implementing the National Strategy using the "Negative Impact Units" method yields an ITC value of 1.66, corresponding to an environment affected within acceptable limits.

MEASURES ENVISAGED FOR MONITORING THE SIGNIFICANT EFFECTS OF IMPLEMENTING THE STRATEGY

The monitoring activity consists of all systematic observation and information actions aimed at preventing and alerting to activities taking place in the nuclear sector, which are not subject to control activity.

The monitoring of this strategy is carried out annually by ANDR, based on the annual reports prepared by the institutions involved in the implementation of the SNDDN, the results of which will be included in a report that will also include an action plan to support the implementation of the SNDDN, drawn up at the proposal of or in collaboration with the institutions involved in the implementation of the SNDDN. The annual reports prepared are published on the ANDR website.

Monitoring of measures to avoid and reduce the impact of the SNDDN objectives will be carried out in accordance with the provisions of the regulatory acts issued by the competent authorities.

Environmental monitoring consists of tracking non-radiological components (air, water, soil, noise, biodiversity) as well as radiological ones, implicitly the impact of the strategy's activities on the environment and population health.

Activities in the nuclear sector subject to the provisions of Ordinance No. 7 of January 30, 2003 (republished, updated) on the promotion, development and monitoring of activities provides regarding monitoring:

- monitoring activities related to the design, location, construction, assembly, commissioning, operation, modification, import, export, conservation and decommissioning of nuclear and radiological facilities;
- monitoring activities related to prospecting, exploration, exploitation and preparation of uranium and thorium ores, as well as the conservation and closure of uranium mines, the decommissioning of tailings dumps and deposits with low uranium content;
- monitoring activities related to the production, supply, treatment, processing, use, storage, transport, transit, import and export of nuclear and radioactive materials, including spent fuel and/or radioactive waste;
- monitoring activities related to the inventory of materials of nuclear interest, including spent fuel and/or radioactive waste, and nuclear and radiological installations, the physical protection of nuclear and radiological installations and the nuclear security of nuclear and radiological installations located on the territory of Romania;
- monitoring activities related to the quality assurance management of nuclear activities;
- protection of professionally exposed personnel, the population, the environment and property against ionising radiation;
- monitoring activities related to the management of nuclear accidents and/or radiological emergencies inside and/or outside a nuclear or radiological installation, including the permanent training and specialisation of the personnel involved;
- initiating normative acts regarding the monitoring of nuclear activities.

Monitoring measures

The monitoring programme is carried out through the following complementary actions:

- The objectives of the National Strategy will be pursued by all licensees who generate or possess radioactive waste, at all stages of the process of their safe management, including during the decommissioning of nuclear and radiological facilities;
- Monitoring of emissions and effluents, radioactive and non-radioactive, at the source and in the receiving environment;
- Monitoring of technological parameters relevant for the assessment of environmental impact and radiological protection;
- Monitoring the quality of environmental components: air, water, soil and subsoil, biodiversity, noise, ionising radiation;

- Controlled releases of radioactive effluents into the environment (authorised discharges from permit holders) fall under CNCAN regulations and control;
- Monitoring by waste types, composition and quantities, method of collection, storage, recovery/disposal, transport;
- Monitoring packaging management: non-radioactive and radioactive industrial packaging will be managed by type;
- Monitoring the management of hazardous substances and mixtures (records of toxic and hazardous products and substances in accordance with the legislation in force).
- Long-term monitoring, including post-closure, to verify environmental stability and the effectiveness of containment barriers;
- Self-monitoring carried out by business owners, according to the regulatory documents issued;
- Periodic reporting of results to the competent authorities according to regulatory acts;
- Integrating monitoring results into the decision-making process for early identification of adverse effects and substantiation of corrective measures**.**

The scope, objectives, timing and monitoring programme depend on the type and complexity of the project, as well as the characteristics of the Natura 2000 site(s) affected by the project implementation.

For most projects in the SNDDN and associated PNN, monitoring programmes have been established during the planning and environmental impact assessment stages.

For some projects (e.g. SMR and DGA) locations need to be confirmed and it is premature to establish a monitoring programme at the current project planning stage.

The purpose, objectives, calendar and monitoring programme can be reassessed based on field results and regulatory provisions.

Considering the above and the differences between the level of detail of the projects in the SNDDN and the associated PNN, a relevant set of SNDDN monitoring indicators is proposed below, which will be quantified based on the results of individual monitoring programmes at the level of each individual project and/or nuclear platform.

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13. ANNEXES

1. **NATIONAL STRATEGY FOR THE DEVELOPMENT OF THE NUCLEAR SECTOR IN ROMANIA for the period 2026-2030, with a perspective to 2050;**

2. **NATIONAL NUCLEAR PROGRAMME;**

3. **ACTION PLAN TO ACHIEVE MEDIUM- AND LONG-TERM STRATEGIC OBJECTIVES**;

4. **APPROPRIATE ASSESSMENT STUDY for the NATIONAL STRATEGY FOR THE DEVELOPMENT OF THE NUCLEAR SECTOR IN ROMANIA FOR THE PERIOD 2026-2030, WITH A PERSPECTIVE TO 2050, AND THE NATIONAL NUCLEAR PROGRAMME.**

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The undersigned SAVU MARIUS FLORIN, sworn translator with authorization no. 15407/2006, issued by the Ministry of Justice of Romania, Ministry of Justice Order no. 496/02.02.2006, certify the accuracy of the translation from ROMANIAN into ENGLISH from the (photocopy) text presented to me.

TRANSLATOR,