



The ALFRED Project

ROMANIA Position Paper

The ALFRED Project is a key milestone for the achievement of the industrial maturity of the Lead Fast Reactor concept. Through ALFRED, Europe will achieve a leading position on the Lead fast reactor technology, thereby addressing the challenges of the European Union energy policy for a sustainable energy scenario. The implementation of ALFRED in Romania will be an opportunity to reinforce the R&D and innovation capacity, and to stimulate the Romanian industry towards a consistent socio-economic development.

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Prepared by RATEN ICN



Lead Fast Reactors in the present European and Romanian context

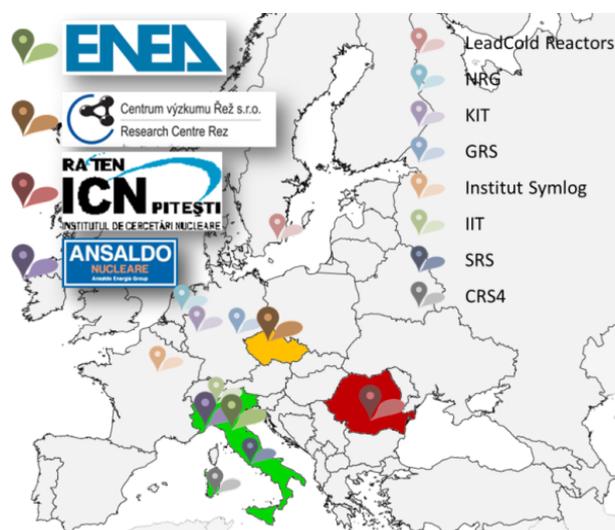
The Union Energy Package adopted by the European Commission in 2015 recognizes the contribution of the nuclear energy in the total electricity production and its consistent role in the energy mix. Nuclear power is able to ensure the fulfilment of the goals of increased safety, higher sustainability and economic competitiveness.

In this framework, sharing the vision of *Generation-IV International Forum (GIF)* regarding the development of the innovative Nuclear Energy Systems (NES) and taking into consideration the priorities expressed in the Strategic Research Agenda of Sustainable Nuclear Energy Technological Platform (SNETP), the European Sustainable Nuclear Industrial Initiative (ESNII) selected three innovative technologies for the future of nuclear power.

Among the systems supported by ESNII, Romania selected the *Lead-cooled Fast Reactor (LFR)* for the same reason gathering worldwide attention: the promise to fulfil all the Generation-IV objectives. The cooling by molten lead ensures top-level safety performances, while allowing for design simplification (thus more reliable, robust and economic solutions). The fast neutron spectrum guarantees the closure of the fuel cycle, maximizing the use of natural resources and drastically reducing the amount of radioactive waste.

RATEN ICN is a member of the European platforms SNETP, IGD-TP, ESNII and EERA. A large interest of the national research was concretized in a deep involvement in the design and development of the LFR concepts since the beginning of the very fruitful European projects ELSY and LEADER. More recently, in 2017, Romania became a full-member of OECD/NEA based on the recognition of the expertise in the safe exploitation of the nuclear facilities, the permanent efforts in supporting the capacity building process, and the consistent contribution to the development of innovative nuclear systems.

Considering that the innovative technologies require robust collaborative strategies and actions gathering all stakeholders, in particular the science, industry, and regulatory communities, each with their specific competencies and responsibilities, Romania (represented by RATEN ICN), along with Ansaldo Nucleare (IT), and ENEA (IT) founded in December 2013 the FALCON (Fostering ALFRED Construction) European Consortium oriented towards a progressive growth of LFR technology to the industrial maturity.



More than 10 well-known European organizations, (research centres, industry, universities, and technical safety organizations) have signed agreements of collaboration with FALCON. Based on the expertise of RATEN ICN as national nuclear research organization and operator of TRIGA Research Reactors, on the advantages of an existing nuclear site, and on the socio-economic impact on local and regional level, Mioveni Nuclear Platform was selected as reference site for ALFRED demonstrator.



ALFRED - a key milestone for Lead Fast Reactor excellence in Europe and Romania

The Advanced LFR European Demonstrator (ALFRED) has been conceived to demonstrate the viability of the LFR concept. In support of its licensing process and in order to provide the needed research, testing and qualification support, new research infrastructures (RIs) are envisaged to be built on RATEN ICN site.

ALFRED and the RIs will be part of a distributed pan-European infrastructure (Mioveni-Ro, Brassimone-It, Rez-Cz) allowing open cooperation and networking, improved knowledge, expertise and competences exchange in addressing the research challenges on Generation IV systems and supporting Europe in reaching a leading position on nuclear technology.

These RIs will act as comprehensive support for LFR technology and ALFRED reactor from the design stage up to its safe operation and will consist of 6 infrastructures, each of them having specific research targets: *HELENA2*: multipurpose (pump, valves, sub/assemblies and erosion/corrosion) investigations in lead; *ATHENA*: full-scale testing of the components; investigation of the steam generator tube rupture and the fluid-structure interaction; assessment of systems behavior in a pool configuration; *Meltin' Pot*: fuel-(clad)-coolant interaction; *Hands-ON*: core simulator for S/As manipulation and handling tests in air; *ChemLab*: coolant and cover gas chemistry; auxiliary systems development; *ELF*: long-running system tests (endurance).

The whole research infrastructure will increase the European experimental potential supporting the synergy of the actions spread across Europe and focused on the development of innovative nuclear systems. Moreover, the best approaches and solutions for LFR open issues could be developed along with a more consistent framework for education and training.

As a demonstration reactor, ALFRED implementation will allow industry, research organizations, safety authorities and universities across Europe with a keen interest in innovative nuclear systems the opportunity to improve their strategies and preparedness on all operational aspects of future LFRs.

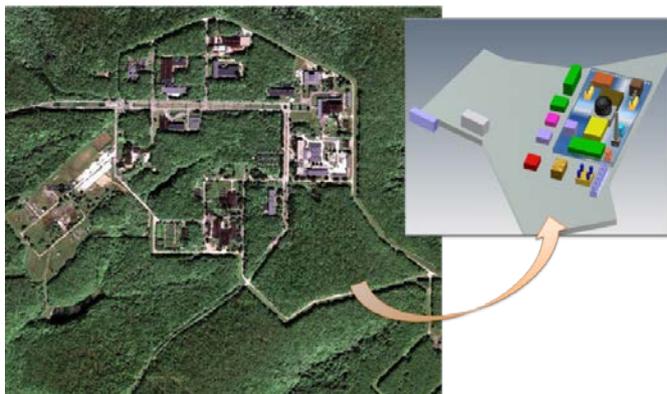
Along with the associated RIs to be implemented, ALFRED will contribute to the integration of materials research at European level strengthening the scientific and technological bases in addressing the issues and challenges of Heavy Liquid Metal (HLM) fast-evolving technologies. Moreover, the outcomes of the research activities performed in the RIs can be fully exploited in other energy-related fields including fusion, solar power, hydrogen production, industrial applications or aerospace applications.

Along with the European key organizations and based on the long-term expertise in the safe operation of its nuclear facilities, Romania will contribute to the common efforts that will bring Europe in the spotlight of the LFR technology, strengthening its international leadership in nuclear power.



Romania: the suitable site for ALFRED

The nuclear sector in Romania has a longstanding tradition, with more than 45 years of experience contributing to a successful nuclear power program, including the operation of two CANDU units providing a share of 18% in the national electricity production. RATEN ICN ensures the scientific and technical support for the nuclear power programme in Romania. The organization has been involved in the design of Lead Cooled Fast Reactors since 2006 (FP6- ELSY Project and FP7 – LEADER Project).



Taking into consideration European R&D progress in LFR and the expertise of the R&D organizations in the field, Romanian Government expressed in February 2011 the availability to host ALFRED demonstrator in Romania.

A step forward has been done in 2015 with the inclusion of the project *"Demo Facility for Lead Cooled Fast Reactor Technology"* in the *Regional Smart Specialization Strategy of South Muntenia Region (Area 6 High-Technology Products)*. ALFRED demonstrator and the associated RIs stimulate the capacity improvement for research, development and innovation, in line with the goals stated in the Regional Development Plan for 2014-2020.

More recently, in February 2017, by Governmental Decision no.81, ALFRED was included in the *"National Strategy for Research and Innovation"* as a major European and international project in Romania: "Romania is the leader of initiatives that capitalize on its scientific performances, its natural facilities or technological capabilities at ELI-NP, DANUBIUS-RI, ALFRED".

In April 2017 *ROMATOM*, a Romanian legal entity of the nuclear industry, issued a position paper, entitled *"Why ALFRED Project in Romania?"*, in support of Project implementation: "In the ALFRED project implementation as a demonstrator, all the Romanian national nuclear industry is expected to be involved. ROMATOM sustains and encourages the development and implementation of this project as a major and priority national project. The national nuclear industry is ready to become an active factor in ALFRED project, by supporting FALCON Consortium".

The national consortium *CESINA*, coordinated by RATEN-ICN, was established in May 2017 in the presence of Romania's Prime Minister. CESINA gathers the main Romanian actors involved in the development of the ALFRED Project for the coordination of supporting activities ranging from education and training of qualified human resources, research and development.

Moreover, *the Romanian Ministry of Energy and the Ministry of Research and Innovation* are supporting the R&D devoted to LFR concept which are developed under the National Programme on "Advanced Nuclear Reactors and Fuel Cycles" coordinated by RATEN ICN. The Programme is focused on studies and developments in the field of HLM technology with a specific focus on its application to lead-cooled innovative nuclear fission systems and on the development of ALFRED Demonstrator and implementation encompassing all the needed disciplines being focused on: Materials and Technologies for Advanced Nuclear Systems; Infrastructure Development for Study, Characterization, Testing and Qualification of Materials and Components for Gen IV Reactors; Nuclear Reactors Physics & Safety Computations for Advanced Reactors; Activities in Support of Advanced Reactors Siting and Licensing; Human Resource Development.



ALFRED: an asset for Romania, South-Muntenia region and Mioveni

The implementation of ALFRED demonstrator in Romania will transform our country in the focal point of the LFR technology development. This high technology will consolidate the position of the nuclear sector and will create the conditions for a greater sustainability of nuclear power (better use of natural resources of uranium, great reduction of the amount and radiotoxicity of radioactive wastes, improved safety, and better economics). The project will be a real generator of innovations, technological development, and intellectual property rights. Romania has a real chance to be a partner in the development of a new technology.

The achievement of RIs will offer a unique set of facilities at international level, addressing technological LFR challenges and building the R&D excellence in the field of HLM.

Their implementation will produce a relevant impact at national level by stimulating the national research through the active involvement of the R&D organizations, industry and universities in national and international programmes addressing the innovative nuclear systems. The new experimental infrastructures, along with the associated methods and tools, will bring the R&D teams to a higher scientific and technological level due to improved competences and new skills development.

The assimilation of HLM high complex technology is a step forward in improving Romania's innovative performance and its composite indicator of Research Excellence among the EU member states; research, development and innovation capacity improvement represent important determinants contributing to drawing Romania's performance map.

Industry involvement from an early stage represents the base for a technology transfer plan. Whether necessary, based on industrial needs and identified gaps, start-up companies could be designed and implemented, boosting the economy at a national and European level. The added values of start-ups, spin-offs, and SMEs (Small and Medium Enterprises) will contribute to the economic growth, creation of new jobs and diversification of services.

On the other hand ALFRED and the new facilities implemented on Mioveni site will stimulate the regional development by strengthening the R&D poles in the region and will reinforce the nuclear field as a smart specialization of the region South-Muntenia of Romania. By tackling the "specialized diversification" concept, as a key component of the smart specialization strategy, links with communities and networks from other sectors with a keen interest in HLM technologies (industry, green energy, fusion, aerospace, etc.) will be created in order to implement and exploit the concept. The multidisciplinary nature of these activities that are based on the existing workforce and expertise will lead to further economic opportunities.

Moreover, the word "innovation" is a magic one for the young scientists and engineers willing to apply their new ideas, so far, contributing to the reduction of loss of highly qualified human resources.

ALFRED also brings benefits to the local community. The increase in the number of jobs will impact on the local taxes and economy by the employee's local expenditure and by stimulating other activities as health services, transport, tourism, recreation, etc). A strong impact is expected in the education and training. Thus, the two Romanian universities (Politechnica University of Bucharest and University of Pitesti) acting as a main pool of young talents following a career in nuclear will increase their number of students and already improved their curricula in order to address the LFR main aspects.



A strong commitment, a leading position

In line with the ALFRED Roadmap, Romania is called to play a significant role in the implementation of a new, high technology and to take advantage of all the related opportunities, so far, consolidating its position in the field of innovative nuclear systems development.

Facing the challenges of complex technologies, Romania needs an accelerated change of the R&D vision and structure that should be innovation oriented and should support the joint research projects between science and industry; all these will impel the development of new products, will help reaching a higher level of technological readiness and will shorten the time needed for results commercialization. Advanced forms of support (including the financial instruments) for technology transfer, innovative entrepreneurship and applied research and development should be conceived and applied.

To accelerate significantly the research and innovative development, it would be necessary for the different participants in the process to achieve a high level of cooperation and compliance at all levels of governance.

All the Romanian actors (Government, safety authority, industry, research organizations and universities) will strengthen and focus their efforts in a comprehensive manner in order to reinforce the national position in the nuclear field and to take advantage of all the derived opportunities leading to socio-economic developments.