THE ALFRED PROJECT

Italy Position Paper

The ALFRED Project is framed as a priority to address the challenges of the European Union energy policy. Italian industries, research centers and academia have invested in developing and promoting the Project. The ALFRED implementation in Romania will represent an opportunity for the Italian system and is worth support towards the decision makers and European level.

Originally prepared by
ENEA and Ansaldo Nucleare S.p.A

July 2017

Lead Fast Reactors to address the challenges of the EU energy vision

The European Union set out challenging goals in its Energy policy for the 2050 horizon. The driving priorities are the sustainability and the security of energy supply, as well as the reduction of green-house gas emitting energy sources. The European Energy policy anticipated the COP21 objectives, confirming Europe as a leader in the global fight to climate change.

The SET-Plan (namely, Strategic Energy Technology Plan) defines a list of actions to accelerate the development and deployment of low-carbon technologies and achieve the goals of the European Energy Policy. In particular, the plan includes the nuclear technology as an important asset of the EU energy system transformation. Nuclear already represents a safe, carbon-free, secure and energy intensive source. However, its further deployment is undermined by public concerns on safety and sustainability aspects.

The next generation – *Generation-IV* – nuclear energy systems are developed to improve the safety and reliability, the sustainability, the economics, the proliferation resistance and physical protection with respect to currently operating reactors (considered of Generation-II) and those presently being built (said of Generation-III or III+). The new paradigm offered by the future nuclear energy systems will possibly address the public concerns, thus representing a desirable component of a balanced energy mix for a safe, sustainable and secure energy scenario.

safety	elimination of the need for off-site emergency actions
sustainability	optimal use of resources and minimization of waste
economics	competitiveness with other energy sources
PR&PP	protection against non-civil use and attack/sabotage

In particular, *Lead-cooled Fast Reactors* (LFRs) represent the optimal Generation IV candidates. The molten lead as a coolant allows for design simplification (thus more reliable, robust and economic solutions), while ensuring top-level safety performances. On the other hand, the fast neutron spectrum guarantees the closure of the fuel cycle[1], thereby maximizing the use of natural resource while minimizing the radioactive waste.

The industrial interest on LFR technology increased worldwide, thanks to the enhanced safety and sustainability performances, the potential for economic

[1] A reactor operates in closed fuel cycle when the spent fuel unloaded from the reactor is reprocessed to fabricate new fuel. Through this indefinite multi-recycling, much less waste is generated, and much less natural resources used. Not all the reactors, however, are able to operate in this way: only reactors with a “fast spectrum” (i.e., using high-energy neutrons) can, differently from those being used today (which use neutrons at lower, “thermal” energies).

competitiveness and the unique flexibility in terms of plant size and potential applications. The technological experience gained in Europe since the late 90s is paralleled only by Russia. Recently, China, USA and other Countries are investing on LFR technology development plans and proposing commercial LFR options.

In the European context, the attractive features of the LFR technology are being considered for the industrial deployment of a lead-cooled Small Modular Reactor[2] (SMR), able to achieve commercial maturity in a short-term. It will offer a more advanced alternative to current generation reactors facing retirement between 2035-2040, while progressively achieving top-scoring performances in economics, safety, sustainability and proliferation resistance in line with the Generation-IV objectives.

ALFRED: the cornerstone for Lead Fast Reactors deployment

An *Advanced LFR European Demonstrator* (ALFRED) has been conceived to serve the industrial deployment of the technology. ALFRED is a research reactor designed with the specific purpose to test and qualify innovative components and procedures to be used in commercial reactors. ALFRED will offer a representative operational environment of interest for research organizations, industry and safety authorities.

Advanced	integrates innovation to bring Europe to leadership.
Lead-cooled	exploits lead properties for superior performances.
Fast	extracts the full energy potential of the fuel.
Reactor	reproduces future plants for testing and support.
European	lives in a pan-European collaborative dimension.
Demonstrator	proves the LFR is a Gen-IV champion.

ALFRED will complement a large set of experimental facilities – either already operating or under preparation – where basic science to applied technology can be developed and tested. The whole research infrastructure will be open to the European communities to boost the generation of excellent knowledge and innovation-intensive products and solutions. This research infrastructure will sustain the future fleet of LFRs throughout their whole life-cycle, from design and construction to their safe and sustainable operation.

The international consortium "Fostering ALFRED Construction", namely FALCON, coordinated the implementation of the European demonstrator at

[2] Small Modular Reactors are novel concepts based on the idea of replacing traditional large-scale power plants with a series of smaller units. Standardized design and factory construction help enhancing the economy of volumes to compensate for the loss of economy of scale, thereby maintaining competitiveness. SMRs can be deployed as they are, for small networks, or in multi-units installations benefitting from modularity for flexibility and reduction of operation costs.

the Mioveni nuclear platform, identified by the Romanian Government as candidate site. The consortium was established in 2013 by the Italian Ansaldo Nucleare and ENEA, along with the Romanian RATEN-ICN. Presently it gathers a broad number of key European organizations from academia, research and industry. The expertise of Italian industry in engineering, procurement and construction management for large nuclear projects on one hand, and the know-how and experimental facilities of ENEA on the other one, are the key assets of FALCON in pursuing all the managerial, research, technical, financial and educational activities needed to prepare the European and Romanian systems for the construction of the demonstrator.

The realization of ALFRED is envisioned by 2029: in this way, the early return of operational experience will be used in the design and licensing of the SMR concept to be deployed at the 2035 horizon. The roadmap to this goal is organized by phases:

- a Viability Phase, having as key milestone the green light for ALFRED construction in Romania by 2019, including political support and pre-licensing by the Romanian safety authority, CNCAN;
- a Preparatory Phase, aimed at the finalization and licensing of the design of the demonstrator by 2023, including siting and site preparation, and qualification of the supply chain.

In line with the strategic specialization of the Sud Muntenia region for social and economic advancement, the use of European infrastructural funds (ESIF) is foreseen for the construction of ALFRED. National contributions and private investments will complement the funding scheme. A short-term concrete perspective for the industrial deployment of a commercial technology is a key factor to consolidate the national political endorsement and attract private investors. The experimental facilities of the research infrastructure will offer the necessary support to the industry: to smooth the initial efforts required to specialize in a new technology, by reducing the initial investment and shortening the time-to-return.

ALFRED as an asset for Italy

The Italian research and industry system has been investing a relevant contribution into the advancement of the LFR technology for the last 20 years. At the same time, ALFRED represents a unique opportunity for the Italian system.

The Italian Ministry of Economic Development acknowledged the importance of the actions being performed, and secured a dedicated line of research

activities on the LFR technology, since 2006. This grant catalyzes around ALFRED the whole Italian system in a synergic development effort: academia, through the Inter-University Consortium for Nuclear Technology Research (CIRTEN); research, with ENEA as leading player; industry, with Ansaldo Nucleare, SRS Srl, CrioTec, Greenpumps, ATB Riva Calzoni and Mangiarotti among the main ones. To date, the invested efforts sum up to about 20 M€.

The winning factors for this program are the complementarities of the involved players, and the strong industrial vocation imprinted since the beginning. In facts, the Italian system still plays a leading role in nuclear research and development, despite the atypical situation of a country not pursuing nuclear technologies for energy production. As a matter of fact, the Italian endeavor in innovation and enhanced safety started earlier than in other European countries, thereby prompting the Italian system to successfully compete in the R&D international arena, as well as in the foreign markets still prone to nuclear energy production. Presently, Italy is acknowledged as a world-class reference in core design, passive safety systems, components prototyping and technological demonstration. Besides the impressive scientific production, the spin-offs of this leadership are manifold: contracts, collaborations and consultancies from all around the World are the most remarkable outreaches, largely paying back the initial investment.

The challenges to make ALFRED real

In the European context, the mandate for implementing the SET Plan is assigned to technology platforms. Concerning nuclear, the Sustainable Nuclear Energy Technology Platform (SNETP) relies on the European Sustainable Nuclear Industrial Initiative (ESNII) for the achievement of the long-term objectives sought for nuclear technologies. To this extent, ESNII endorses and supports demonstration programs for advanced nuclear energy systems, including the ALFRED project for proving the viability of the LFR technology.

The acceleration of the LFR development, through the deployment of a demonstrator in Romania, is a unique opportunity that must be seized. Supporting the ALFRED project will permit industry to start immediately testing and qualifying solutions, preparing for a short-term market perspective offered by the retirement of current reactors, approaching end of life in the 2035-40 time-frame. Strengthening the support on the LFR is also a needed action to contrast the breaking competitors at global level, thus letting the European, and notably Italian, system to maintain a leading position and a competitive advantage in pursuing all the related opportunities.