



Italian National Agency for New Technologies,
Energy and Sustainable Economic Development

Introduction of HLM cooled reactors

Mariano Tarantino

Bucharest, 16th February 2026

Nuclear Department – Nuclear Energy Systems Division

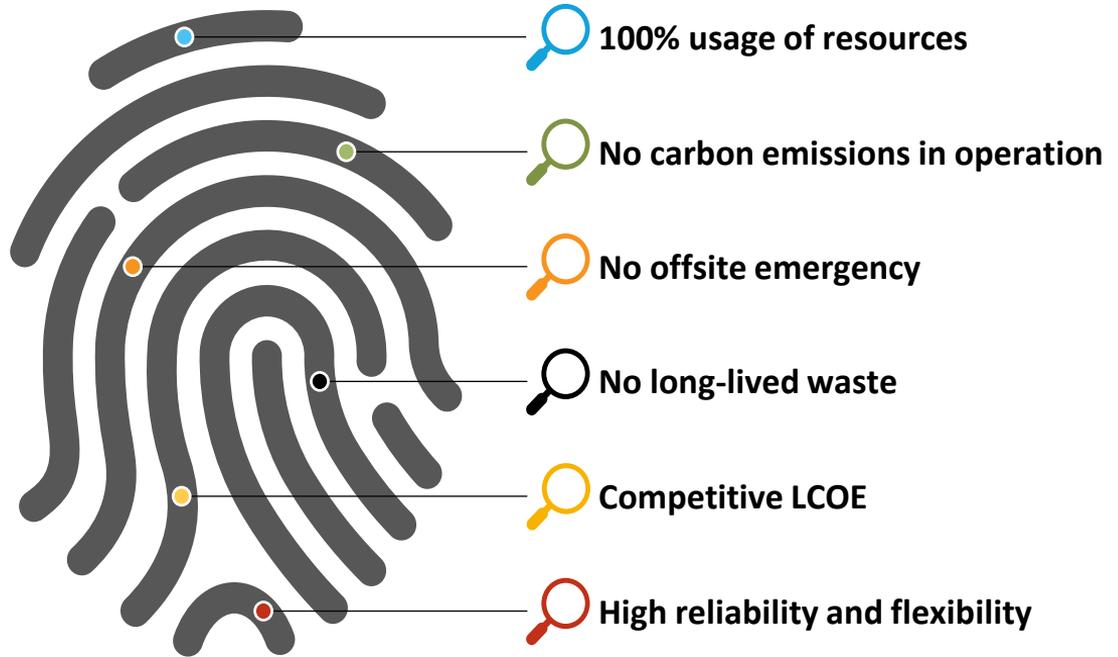


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1111 1010 0000



The «ideal» Nuclear Power Plant

Fission Nuclear Power Plants of a new type are being developed for a short-term deployment (beyond 2030) to replace the current fleet and better integrate future hybrid energy systems: smaller, more flexible, economically competitive, able to produce more than purely electricity.

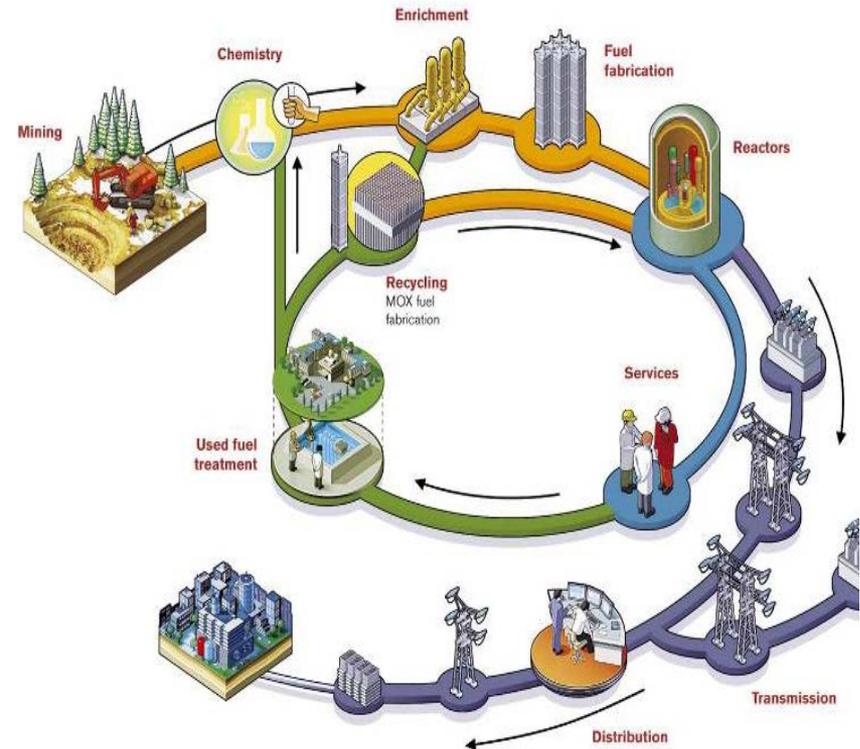


Closure of the fuel cycle

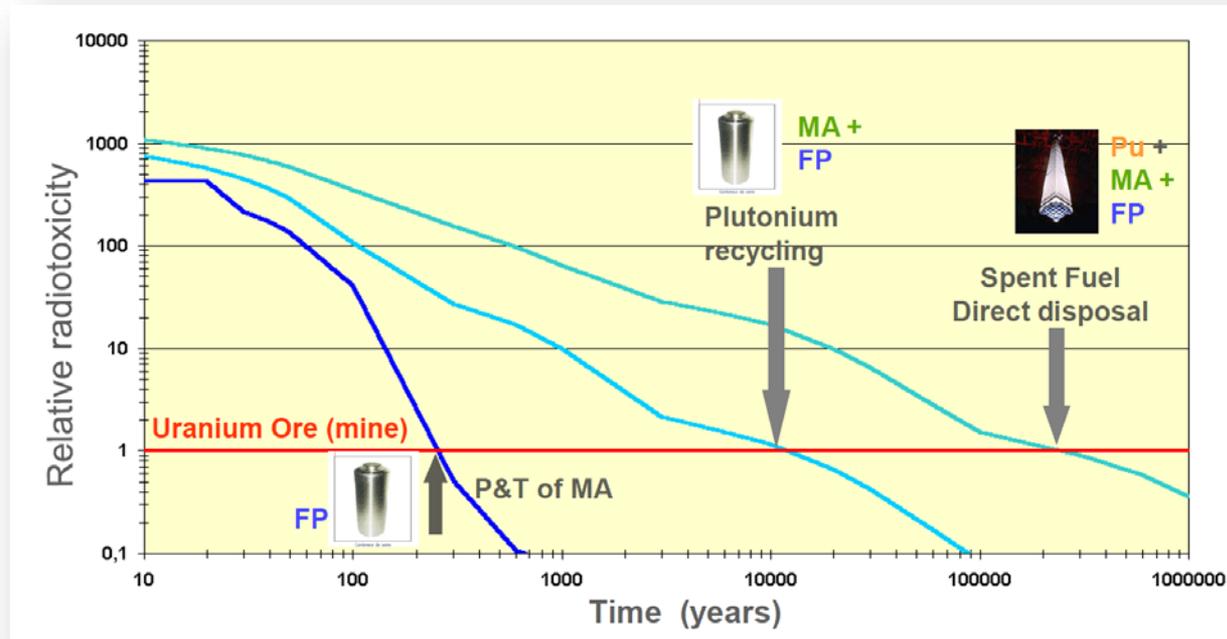
Waste Minimization & Economy

The fission process used in nuclear reactors produces a number of isotopes that can be toxic to human lives and the environment.

Since the start of the large scale deployment of nuclear energy, disposal of the long lived isotopes has been an issue that has had a priority in most nuclear countries.



Waste Minimization & Economy



Recycle of all actinides in spent LWR fuel in fast reactors provides a significant **reduction in the time required for radiotoxicity to decrease to that of the original natural uranium ore used for the LWR fuel** (i.e., man-made impact is eliminated). From **250,000 years down to about 400 years** with 0.1% actinide loss to wastes

Generation IV

GIF-002-00

A Technology Roadmap for Generation IV Nuclear Energy Systems

December 2002

Ten Nations Preparing Today for Tomorrow's Energy Needs



Issued by the
U.S. DOE Nuclear Energy Research Advisory Committee
and the Generation IV International Forum

02-CA0004

The path from current nuclear systems to Generation IV systems is described in a 2002 Roadmap Report entitled “**A technology Roadmap for Generation IV Nuclear Energy Systems**” which:

defines challenging technology goals for Generation IV nuclear energy systems in four areas:

- ✓ **sustainability,**
- ✓ **economics,**
- ✓ **safety and reliability, and**
- ✓ **proliferation resistance and physical protection.**

identifies six systems known as Generation IV to enhance the future role of nuclear energy;

defines and plans the necessary R&D

Generation IV

| <i>Generation IV Systems</i> | <i>Acronym</i> |
|---|----------------|
| Gas-Cooled F ast R eactor | GFR |
| Lead-Cooled F ast R eactor | LFR |
| Molten S alt R eactor | MSR |
| Sodium-Cooled F ast R eactor | SFR |
| Super c ritical W ater-Cooled R eactor | SCWR |
| Very- H igh- T emperature R eactor | VHTR |

Because the capability of fast reactors **to meet the sustainability goal and hence to re-position nuclear energy from the present transition-energy role into an inexhaustible source of clean energy**

- ❖ three out of the six systems selected by GIF (GFR, LFR and SFR) are fast reactors and
- ❖ for two systems (MSR and SCWR) studies have been carried out recently to explore the possibility of them to become fast reactors.

Lead-cooled Fast Reactors

Main advantages and main drawbacks of Lead

| <i>Atomic mass</i> | <i>Absorption cross-section</i> | <i>Boiling Point (°C)</i> | <i>Chemical Reactivity (w/Air and Water)</i> | <i>Risk of Hydrogen formation</i> | <i>Heat transfer properties</i> | <i>Retention of fission products</i> | <i>Density (Kg/m³) @400°C</i> | <i>Melting Point (°C)</i> | <i>Opacity</i> | <i>Compatibility with structural materials</i> |
|--------------------|---------------------------------|---------------------------|--|-----------------------------------|---------------------------------|--------------------------------------|--|---------------------------|----------------|--|
| 207 | Low | 1737 | Inert | No | Good | High | 10580 10580 | 327 | Yes | Corrosive |

- For heavy liquid metal coolants (lead-bismuth alloy, lead) the stored thermal potential energy cannot be converted into kinetic energy.
- There is no significant release of energy and hydrogen in an event of coolant contacting with air, water, structural materials.
- There is no loss of core cooling in an event of tightness failure in the gas system of the primary circuit

Lead cooled Fast Reactor

A comprehensive R&D program is necessary because of:

- The use of a **new coolant and associated technology**, properties, neutronic characteristics, and compatibility with structural materials of the primary system and of the core.
- Innovations which require validation programs of **new components and systems** (the SG and its integration inside the reactor vessel, the extended stem fuel element, the dip coolers of the safety-related DHR system, pump, OCS, ...)
- The use of advanced fuels (*at least in a further stage*).

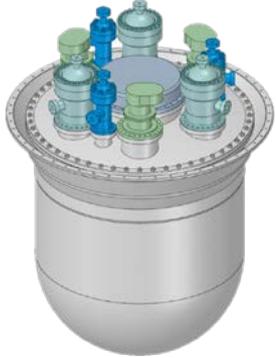


LFRsupported by Europe (and ENEA)

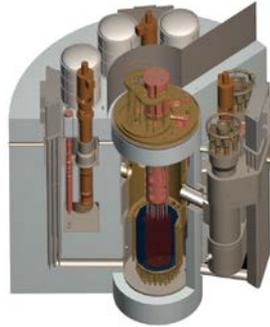
| Ref. | Acronym | Coordinator | Total Budget | EC Contribution |
|------|-----------|-------------|------------------------|------------------------|
| 1 | TECLA | ENEA | 6.061.890,0 € | 2.499.906,0 € |
| 2 | EUROTRANS | KIT | 42.926.414,0 € | 23.000.000,0 € |
| 3 | VELLA | ENEA | 2.147.000,0 € | 2.000.000,0 € |
| 4 | ELSY | ANSALDO | 6.884.590,0 € | 2.949.645,0 € |
| 5 | SEARCH | SCK-CEN | 5.719.903,3 € | 2.977.524,0 € |
| 6 | MATTER | ENEA | 12.180.253,2 € | 5.993.919,0 € |
| 7 | HELMNET | CNR | 718.348,0 € | 499.984,0 € |
| 8 | GETMAT | KIT | 13.959.123,0 € | 7.500.000,0 € |
| 9 | ADRIANA | UJV | 1.429.911,2 € | 992.650,0 € |
| 10 | ARCADIA | RATEN | 3.543.864,0 € | 3.543.864,0 € |
| 11 | CHANDA | CIEMAT | 9.237.814,6 € | 5.400.000,0 € |
| 12 | ESNII + | CEA | 10.362.135,4 € | 6.455.000,0 € |
| 13 | MAXSIMA | SCK-CEN | 10.087.542,0 € | 5.500.000,0 € |
| 14 | SILER | ENEA | 4.450.851,9 € | 2.926.133,4 € |
| 15 | SARGEN-IV | IRSN | 1.293.111,8 € | 999.128,0 € |
| 16 | FREYA | SCK-CEN | 5.060.978,8 € | 2.799.992,0 € |
| 17 | THINS | KIT | 10.592.854,8 € | 5.941.810,8 € |
| 18 | LEADER | ANSALDO | 5.699.396,4 € | 2.994.088,0 € |
| 19 | CDT | SCK-CEN | 4.029.789,0 € | 2.000.000,0 € |
| 20 | GEMMA | ENEA | 6.625.379,4 € | 3.999.182,0 € |
| 21 | INSPYRE | CEA | 9.368.684,1 € | 3.998.478,8 € |
| 22 | SESAME | ENEA | 6.643.280,0 € | 5.200.000,0 € |
| 23 | MYRTE | SCK-CEN | 11.994.610,0 € | 8.995.962,0 € |
| 24 | PATRICIA | SCK-CEN | 8.415.315,6 € | 6.499.979,5 € |
| 25 | PASCAL | ENEA | 4.610.189,1 € | 3.799.238,0 € |
| 26 | HARMONISE | LEI | 2.843.500,0 € | 2.499.999,8 € |
| 26 | LESTO | ENEA | 4.734.755,5 € | 3.998.638,3 € |
| | | | 211.621.485,1 € | 125.965.122,5 € |

| | TRL | TRL Function | Generic Definition | Phase |
|---------------------|-----|--|--|-------------------|
| achieved | 1 | Technology Down-Selection | •Basic principles definition | Screening |
| | 2 | | •Technology concepts and applications definition | |
| Ongoing | 3 | Final Process Selections & integration | •Demonstration of critical function •Proof of concept | Pre-qualification |
| | 4 | | •Lab-scale component validation | |
| | 5 | | •Component validation in a relevant environment | Qualification |
| Further Development | 6 | Full-scale integrated testing | •System/subsystem model or prototype demonstration in relevant environment | Demo |
| | 7 | | •System prototype demonstration in prototypic environment | |
| | 8 | Full-scale demo | •Actual system completed and qualified through test and demonstration | |
| | 9 | | •Actual system proven through successful operations | |

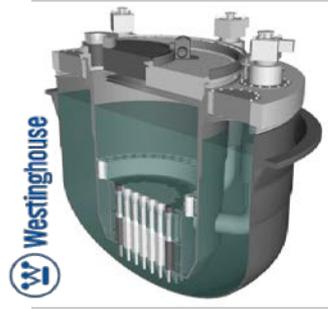
Lead-cooled Fast Reactors



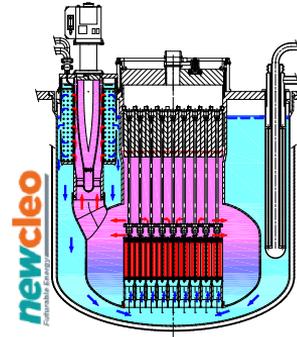
EAGLES
300 MWe, Europe
Under design



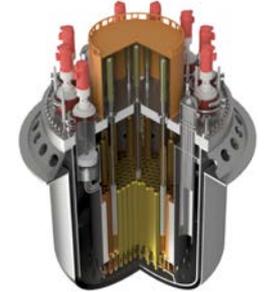
BREST-OD-300
300 MWe, Russia
Under construction



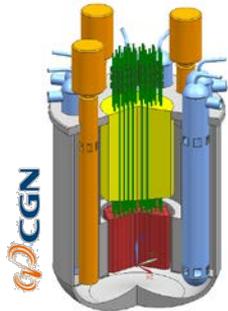
Westinghouse LFR
450 MWe, USA
Under design (suspended)



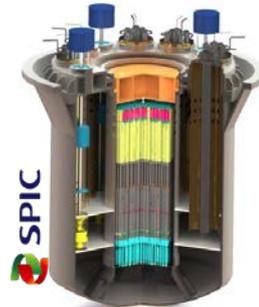
newcleo LFR-AS-200
200 MWe, FRANCE
Under design



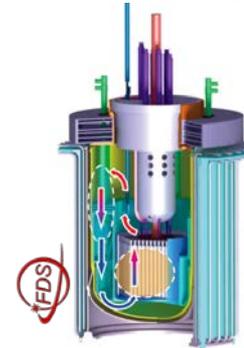
BlyKalla SEALER-55
55 MWe, Sweden
Under design



CLFR-300 and CLFR-10
300/10 MWe, China
Under design



BLESS
100 MWe, China
Under design



CLEAR-1
10 MWth, China
Under design



Micro-Uranus
60 MWth, Korea
Under design

EAGLES

Enlarging the collaboration at European level

SCK CEN

sck cen 17.068 follower

1s • 🌐

🇷🇺 Today marks a major milestone in European nuclear innovation: the Eagles Consortium (formed by [Ansaldo Nucleare](#), [ENEA](#), [RATEN](#) and [SCK CEN](#)) has officially transitioned from a Memorandum of Understanding to a binding collaboration agreement. 🇮🇹

This means we are no longer just planning the future of lead-cooled SMRs. We are building it. ⚡ Together, we are launching the development of EAGLES-300, a Generation IV, lead-cooled Small Modular Reactor designed for flexibility, sustainability and commercial viability.

With demonstrators in Mol ([#LEANDREA](#)) and Pitești ([#ALFRED](#)), we are laying the groundwork for a 2035 prototype and commercial deployment by 2039. 🚀

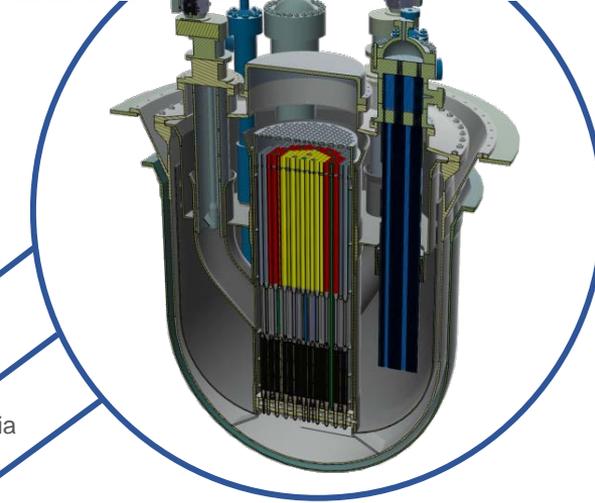
👉 Full press release in the first comment.

[#EAGLES300](#) [#SMR](#) [#GenIV](#) [#nuclearenergy](#) [#SCKCEN](#) [#innovation](#)



EAGLES

- Competitive economics
- Proven passive safety features
- Sustainable closed fuel cycle
- High temperature heat
- Customers oriented
- Commercial fleet deployment by 2040



Reference design

Simplified, robust, modular

Candidate sites

Mol-Belgium and Pitesti-Romania

Shared roadmap

Jointly owned IP



Four leaders, one roadmap



Industrial leader
Architect engineer and Program manager
Delivering nuclear projects since 1966



Operating the TAPIRO research reactor
Experienced in core design and safety
Renowned pool of experts in LFR



Reference host for ALFRED siting since 2011
Operating 2 TRIGA experimental reactor
Experienced in dealing with RO Safety Authority



Operating the BR2 irradiation research reactor
Experienced in dealing with BE Safety Authority
Owner of IP for MOX fuel fabrication

Papers in peer-reviewed journals

400

1200

1000

350

EURATOM funded projects

(#coordinated project | #relevant projects)

1 | 19

7 | 20

1 | 15

5 | 22

Experimental facilities

(existing | under construction)

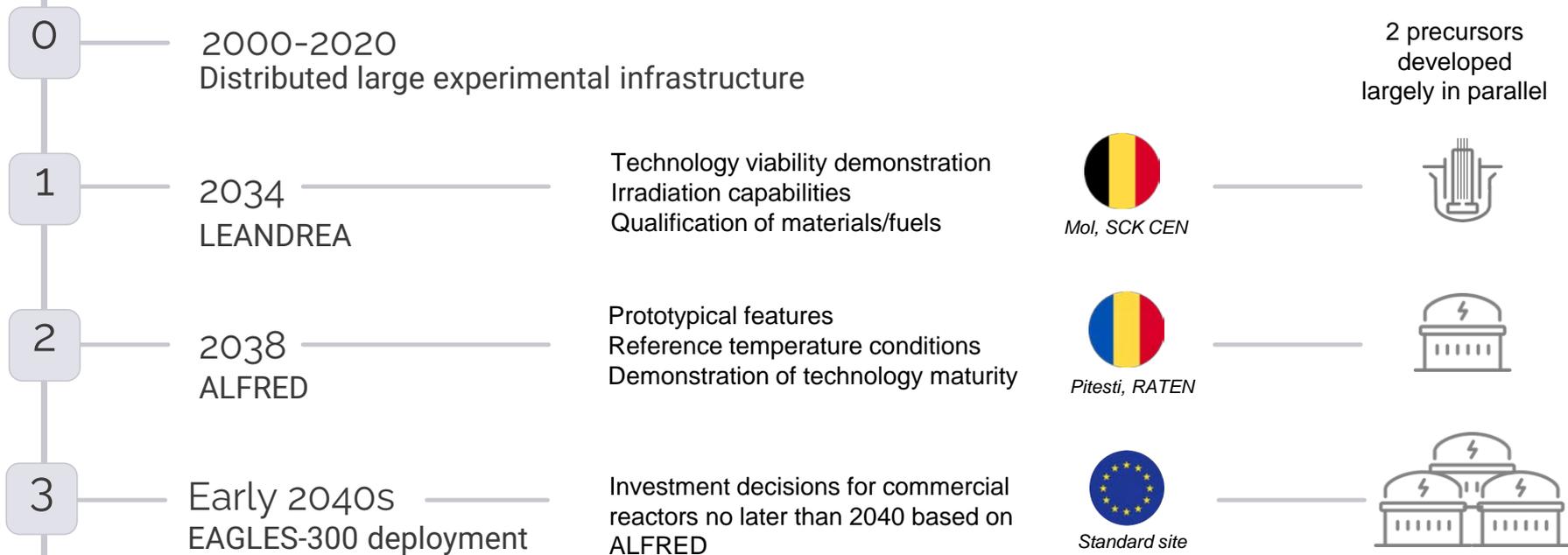
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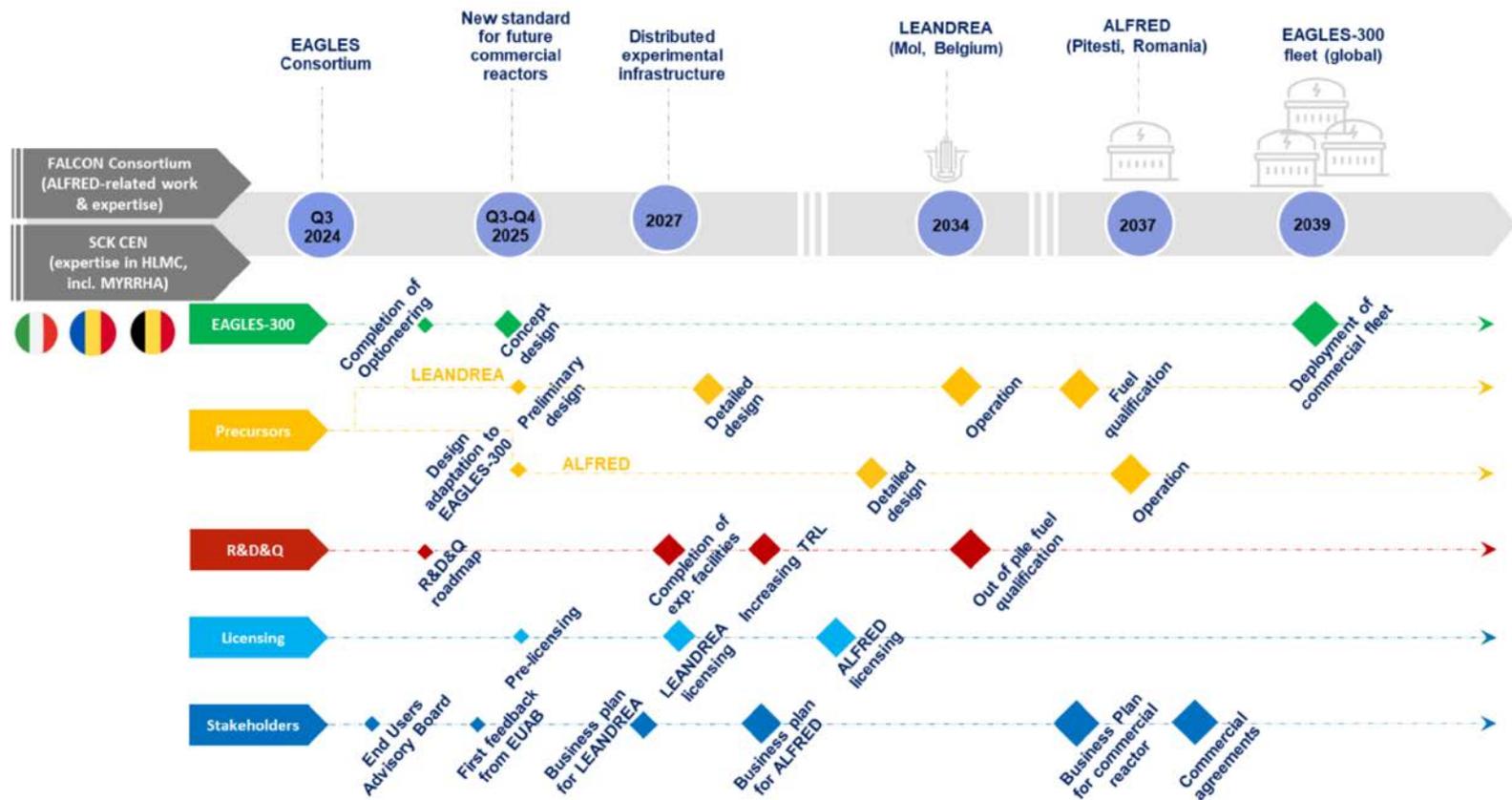
1 | +4

15 | +6

Technology readiness path



Precursors to unlock critical data... private capital to accelerate market entry



A new, innovative player in nuclear energy

REACTOR DESIGN:

Small Modular (SMR) +
Lead-cooled Fast Reactors
(LFR) = AMR

newcleo is working to design, build, and operate Gen-IV Advanced Modular Reactors (AMRs) cooled by liquid lead

FUEL MANUFACTURING:

Mixed Uranium Plutonium
Oxide (MOX)

MOX and Fast Reactors allow the multi-recycling of nuclear waste into new fuel with no new mining for generations

INTRINSICALLY SAFE power production

COMPETITIVE energy cost

CIRCULAR nuclear waste recycling

Operating across the
U.S., Italy, France,
Switzerland, Belgium, Slovakia and UK

with over 900 employees, 13 offices,
3 sites and 3 factories



Launched in
SEPTEMBER
2021



€650 million of private funds
~€70 million revenues in 2024



French first **licensing stage completed** for the reactor in **Chinon** and the fuel production facility in **Nogent**



Selected by **France 2030** and the **European Industrial Alliance on SMRs**



900+
EMPLOYEES
GLOBALLY



30+
YEARS of
leadership
in Lead
Technology



23
PATENTS

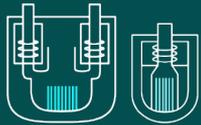
Highly specialised EPCM capabilities

FUCINA ITALIA
A newcleo company

S.R.S.
A newcleo company

RUTSCHI
A newcleo company

A long-term vision centred on safety, costs and sustainability



Reactor technology:
AMR: SMR + Gen-IV LFR

LEAD-COOLED

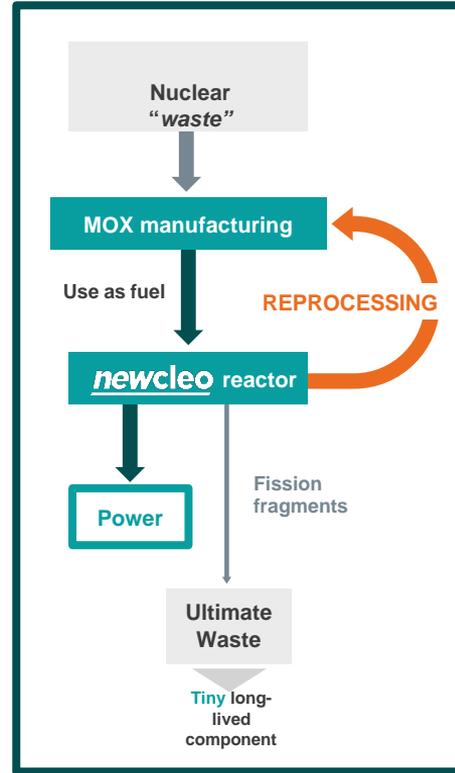
High temperature | Compact and simple | Intrinsic safety

FAST NEUTRON SPECTRUM

Low production of nuclear waste | Able to recycle reprocessed spent fuel

SMALL MODULAR REACTOR

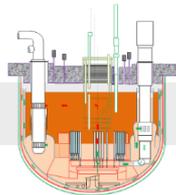
Faster construction | Site flexibility and industrial heat production | Further economies from series and modularisation



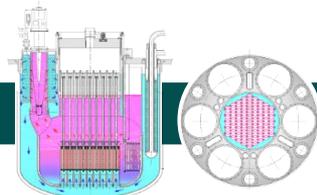
Fuel: MOX

- MOX is made of reprocessed spent fuel. A clean solution to the issue of costly and **long-lasting nuclear waste disposal**, but also a protection against future high, oscillating Uranium costs and availability
- The **long-term strategy** will eliminate the need to mine new uranium, enable **energy independence**, and reduce the volume headed to geological repository
- Spent fuel will be **reprocessed** multiple times. The unavoidable waste is less than **1t of fission fragments** (radioactive for 250y) from one year's generation by a 1GWe of *newcleo* LFRs vs. **200t** of nuclear waste from conventional reactors (radioactive for 250,000y)

newcleo's design: simplification is key



CLASSICAL



newcleo

Pump in the **cold** **hot** collector

Primary fluid inlet in the **upper** **lower** part of the heat exchanger

Vertical **Radial flow** of the primary coolant in the steam generator

Fuel element **fully immersed** in **with heads out** of the primary coolant

Fuel element fixed at the **bottom** **top**

Primary pumps **between** **inside** the steam generators

Inner vessel larger at the **top** **bottom**

INNOVATIVE COMPONENTS/SYSTEM

STEAM GENERATOR, REFUELLING SYSTEM, DHR SYSTEM, CONTROL RODS, FUEL ELEMENT

Compact and dense primary system

~4x less than Superphénix

Short reactor vessel:
only 6.2 m

Compact reactor building

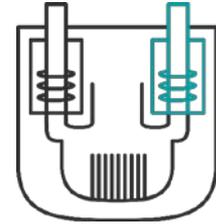
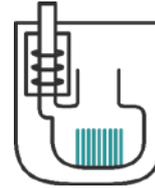
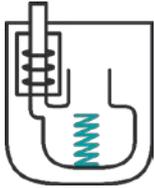
No intermediate
loops

Compact primary
system

No risk of LOCA

newcleo identified technical solutions to minimise the impact of lead's unfavourable characteristics and in some cases has also drawn design advantages. We innovate by reimagining the classical solution, resulting also in the elimination of several components no longer needed.

newcleo's plan-to-market



R&D and Precursor

2026

Several R&D and qualification facilities, and a **10 MW non-nuclear reactor** with turbo-generator (Precursor) built in ENEA-Brasimone

Design, manufacturing and operation in progress

MOX production

2030

FR-MOX production facility, starting from available (separated) material in France

Basic Design in progress
Licensing in progress for both facilities

LFR-AS-30

2031

30 MWe nuclear irradiation reactor with core outlet at 440°C and later 530°C in France

LFR-AS-200

2033

200 MWe FOAK, also for non-electrical uses (e.g. cogeneration and chemicals production)

Basic Design in progress
UK Licensing started in 2024

Ongoing M&A Acquisition programme

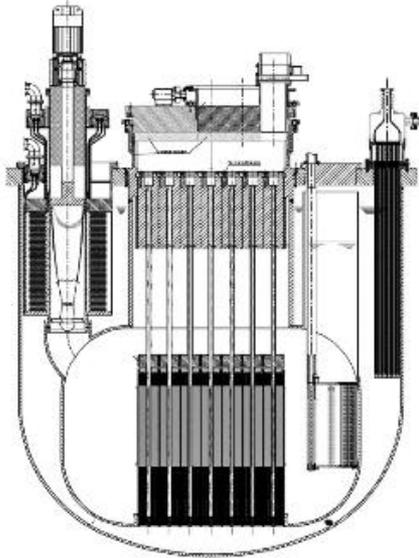
Brasimone: the world's largest centre for lead-cooling technology development

| | Location | Deployment Status | Purpose |
|-----------------------------|---------------------|--|---|
| CAPSULE | Brasimone | Operational Dec 2023 | Corrosion tests in stagnant lead |
| CORE-1, CORE-2 | Brasimone | CORE-1: Operational Apr 2024 CORE-2: Operational Jul 2025 | Corrosion and erosion testing of structural materials in flowing lead |
| MATERIALS TEST LABORATORIES | Brasimone, Turin | Microscopy Lab: Operational May 2025 M-Lab: Installation in progress C-Lab, Metallurgy Lab: Civil works in progress | Infrastructure equipped with state-of-art instruments to support our materials R&D programme |
| SOLEAD | Brasimone | Operational in 2023 | Study and control of lead coolant chemistry and oxygen regulation. |
| NACIE-LHT | Brasimone | Operational Jun 2024 | Qualification of heat-exchanging components and instrumentation |
| CIRCE-NEXTRA | Brasimone | Phase I – Commissioning in progress Phase II – Detailed Design in progress | Thermal-hydraulic characterisation of components with liquid LBE |
| HUSTLE | Brasimone | Operational Apr 2025 | Characterisation of In-Service Inspection & Repair (ISI&R) systems and methods for our LFR |
| HELENA | Brasimone | Design completed | Testing of the first axial pump prototype |
| ADAPT | Brasimone | Design completed | Demonstration of the coolability of the spent fuel assembly along the refuelling phase |
| SHOCK | Brasimone | Detailed Design, Procurement and Manufacturing in progress | Tests on the protective layer between the reactor vessel and the concrete basement |
| MANUT | Florbino, Brasimone | Basic Design in progress | Validation of key mechanical aspects for our LFR operation |
| EFESTO | Rome | Basic Design in progress | Analysis of our LFR primary system behaviour under seismic events |
| DCI | Turin (PoliTO) | Operational Mar 2025 | Testing of our LFR Decay Heat Removal (DHR) systems |
| OTHELLO | Brasimone | Installation in progress | Assessments on performance and behaviour of LFR primary system main components |
| PRECURSOR | Brasimone | Detailed design, Procurement and Manufacturing in progress | Non-nuclear precursor to our LFR-AS-30, including the secondary system and operating at 1:9 scale |



Partnership signed with ENEA in March 2022: unique global know-how and 30 newcleo engineers, with EUR 90 million investment for about 10 years. Renovation works started in June 2022.

LFR-AS-30: Amphora Shaped, 30MWe



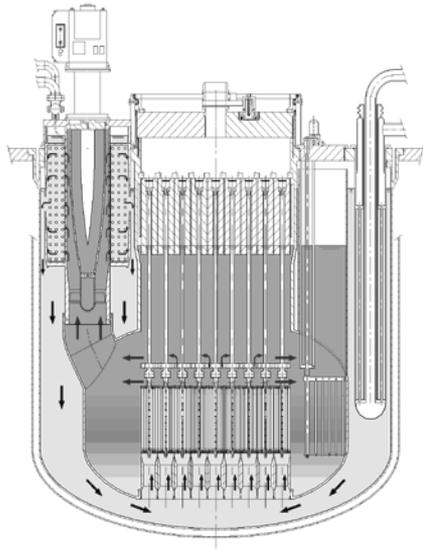
- *newcleo's* irradiation machine used for materials R&D and other uses, offering unique irradiation services based on a hard and intense neutron spectrum
- The plant will have a single AS-30 unit and include hot cells and laboratories
- The reactor is designed to be representative of the LFR-AS-200, and will also be used to validate new components and solutions for our commercial reactors, to increase their operating temperatures and to expand production efficiency and performances
- Reactor conceptual design completed in March 2023, basic design in progress
- **First phase of technical meeting with ASN and IRSN completed in June 2024**

1st phase
Low temp. and power

2nd phase
High temp. and full power

| | | |
|--------------------------|--------------------------------------|--------------------------------------|
| Power | 60MWth | 90MWth |
| Core coolant temperature | inlet 370°C, outlet 440°C | inlet 420°C, outlet 530°C |
| Steam at turbine inlet | 400°C, 150 bar | 500°C, 150 bar |
| Core coolant | Pure lead | |
| Layout | Pool-type | |
| Circulation | Forced: 3 pumps | |
| Spectrum | Fast | |
| Fuel form | Extended-stem fuel assembly | |
| Fuel | MOX | |
| Secondary side fluid | Water | |
| Steam generators | 3 spiral-tube SG | |
| Design life | 60 years | |

LFR-AS-200: Amphora Shaped, 200MWe



- *newcleo's* commercial nuclear reactor to be deployed in multi-unit mode, with the intention to deploy a fleet
- The First-Of-A-Kind (FOAK) unit is expected at the end of 2033
- Basic Design in progress



Jan 2024

Conceptual study for the chemical sector on the production of electrolytic hydrogen, carbon-neutral ammonia, methanol, e-fuels and derivative



Sep 2024

Oil and gas offshore installations and floating nuclear units, connected to the electricity grid on land

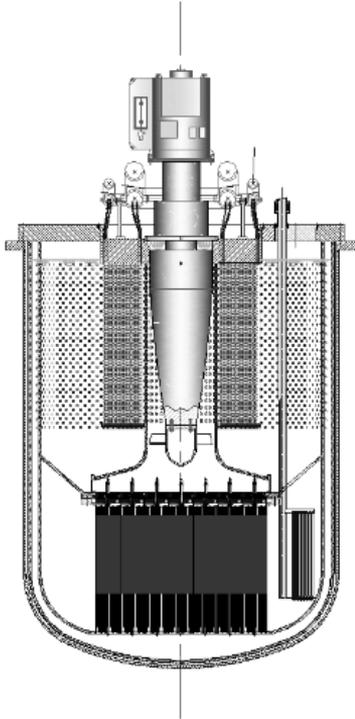


Jan 2025

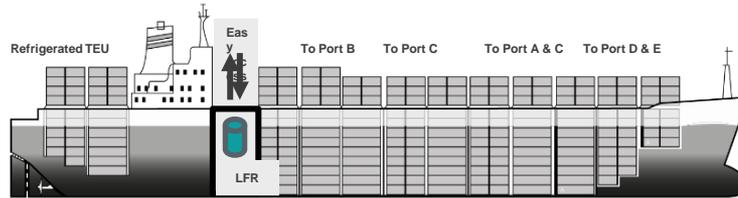
Decarbonise steel production by integrating *newcleo's* lead-cooled fast reactors (LFR) with their steelmaking technology

| | |
|--------------------------|------------------------------------|
| Power | 480 MWth |
| Core coolant | Pure lead |
| Core coolant temperature | inlet 420°C, outlet 530°C |
| Layout | Pool-type |
| Circulation | Forced: 6 pumps |
| Spectrum | Fast |
| Fuel form | Extended-stem fuel assembly |
| Fuel | MOX |
| Secondary side fluid | Water |
| Steam generators | 6 spiral-tube SG |
| Design life | 60 years |
| Lifetime capacity factor | 93% |

LFR-TL-40: Transportable Long-lived, 40MWe



A mini reactor, producing 40MW electric output and having infrequent refuelling (15y) and maintenance: a **closed reactor** to be easily replaced at end of life



In 2023: worked together on feasibility study for nuclear naval propulsion

| | |
|--------------------------|-------------------------------------|
| Power | 100MWth |
| Core coolant | Pure lead |
| Core coolant temperature | inlet 420°C outlet 530°C |
| Layout | Pool type |
| Circulation | Forced: 1 pump |
| Spectrum | Fast |
| Fuel form | Hexagonal fuel assembly |
| Fuel | UO₂ or MOX |
| Secondary side fluid | Water |
| Steam generators | 1 spiral-tube SG |
| Design life | 15 years |

EAGLES – newcleo HoA signature (10th February 2026)



newcleo and the European consortium EAGLES are joining forces on **LEANDREA**, lead-cooled irradiation reactor to be built at SCK CEN in Belgium.

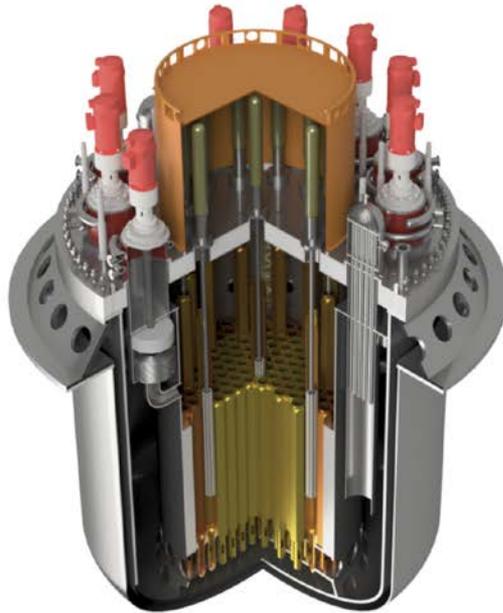
LEANDREA will:

- ◆ Act as a testing facility for materials and fuels
- ◆ Support the development of safe, low-carbon, and commercially deployable reactors
- ◆ Provide significant irradiation capacity to test new materials and fuels, strengthening Europe's nuclear innovation ecosystem

SEALER Project (Blykalla)



SEALER-55 (Swedish Advanced Lead Reactor)

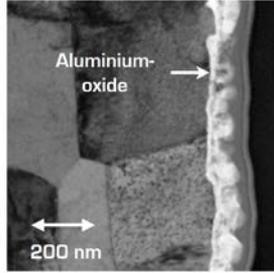


| Item | Value |
|-------------------------------|----------------------|
| Power | 140 MWth/55 MWe |
| Lead coolant mass flow | 7400 kg/s |
| Lead inventory | 800 tons |
| Core inlet/outlet temperature | 420°C/550°C |
| Height | 5.5 m |
| Diameter | 4.8 m |
| Fuel | Uranium nitride (UN) |
| Fuel residence time | 25 years |

SEALER Project (Blykalla)



Corrosion tolerant steel



- Potential show-stopper for commercialisation of lead-cooled reactors: corrosion of stainless steels

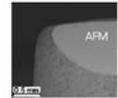
- Blykalla's solution: aluminium alloyed steels:

- Fe-10Cr-4Al-RE (RE = Zr, Ti, Nb, Y)
- Alumina forming austenitic steels (AFA)
- Alumina forming martensitic steels (AFM)

- Form 100 nm thin, ductile and protective alumina film on surfaces exposed to lead with low oxygen content.

- Fe-10Cr-4Al-RE successfully tested at 550°C for 2 years & 850°C for ten weeks.

- 140 Fe-10Cr-4Al tubes fabricated by Kanthal.



Wipeave $\approx 7 \text{ m/s}$
No visible corrosion-erosion



Manufacture of uranium nitride



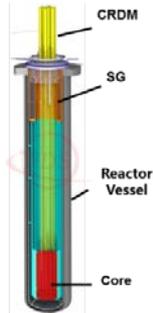
- UN powder to be produced by direct ammonolysis of enriched UF_6 – minimizes process steps and residual impurities.
- KTH has successfully shown that uranium ammonium fluoride compounds can be synthesized by reacting gaseous UF_6 with NH_3 at 200°C
- Raising the temperature to 800°C in a tantalum lined furnace under flow of NH_3 , UN_2 is obtained.
- Denitrating UN_2 at 1100°C in the same furnace under flow of Ar resulted in stoichiometric UN powder with 3% UO_2 impurity.





Update on LFR Technology: China

- **CLEAR series LFR developed by International Academy of Neutron Science (IANS)**
 - **CLEAR-M:** Small modular transportable reactor with 10MWe
 - **CLEAR-400:** Small modular LFR with 400MW_{th}
 - **CLEAR-A:** 1GeV/10mA proton accelerate coupled with 100 MW_{th} LFR
- **Validation platform for CLEAR**
 - **NIRVANA:** Verification Platforms were built to support LFR engineering verification
 - **CLEAR-M0:** pool-type integration verification facility, >5MW_{th}, **started commissioning and core outlet temp. reaches 550°C**



CLEAR-M reactor

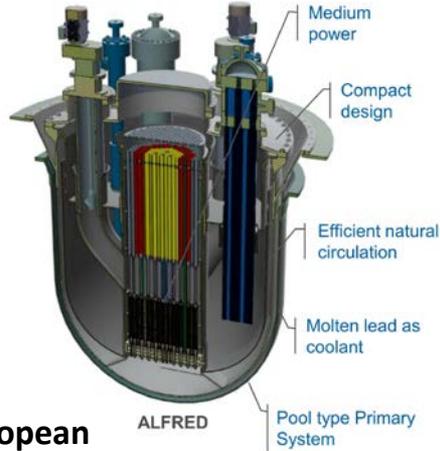


NIRVANA

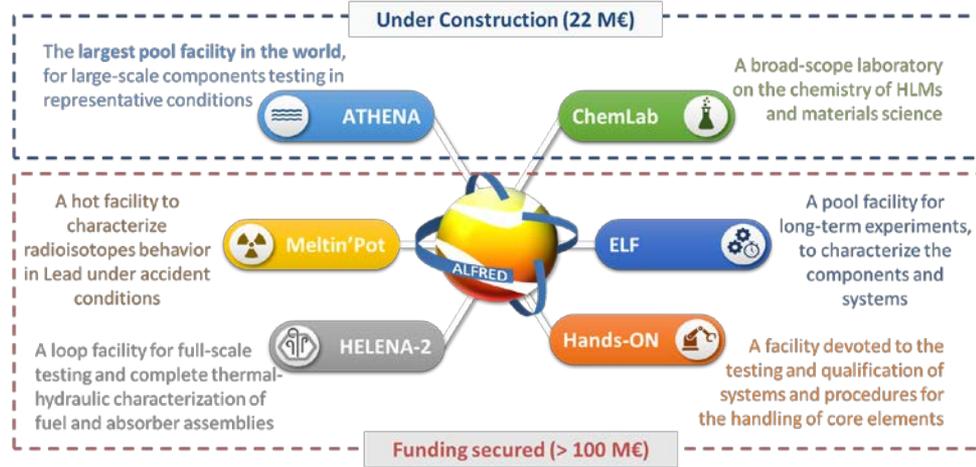




Update on LFR Technology: EURATOM



ALFRED is the European LFR demonstrator developed by the FALCON consortium together with European research organization and industries.



ATHENA, almost completed - the first step of ALFRED experimental infrastructure

- 2.21 MW Core simulator
- Full height bayonet tube heat exchanger
- Main Vessel hosting 800 tons of lead



Update on LFR Technology: Japan

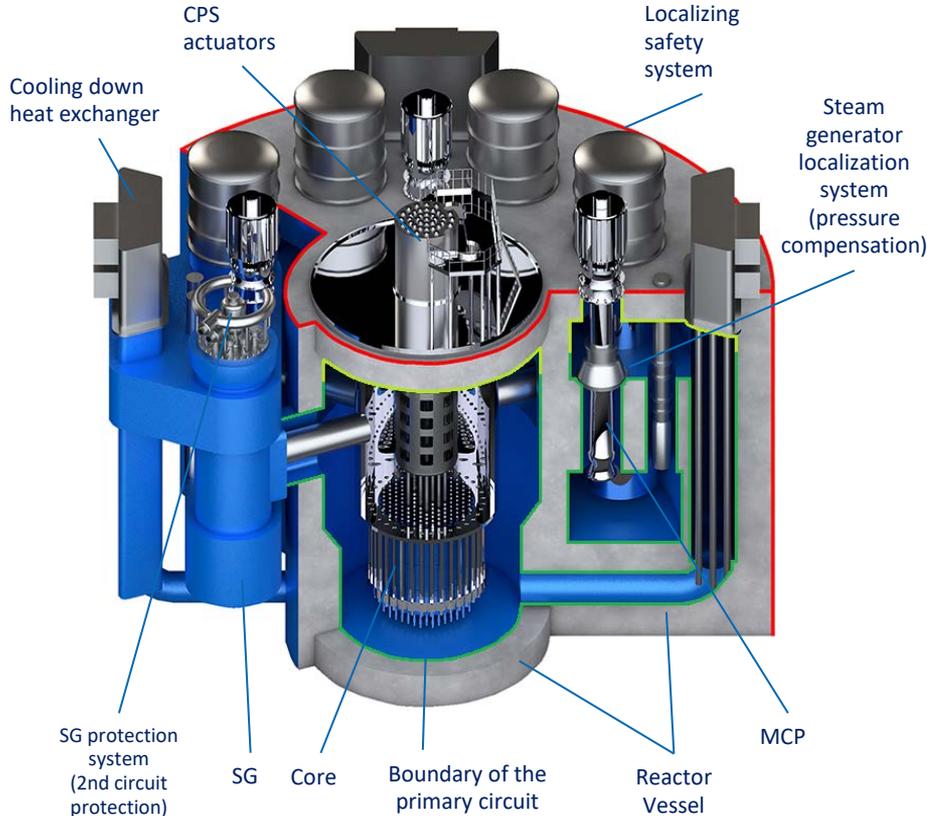
- Fundamental research for LFR in Science Tokyo
 - Design study of innovative LFR
 - Corrosion resistance of FeCrAl steel in flowing LBE
- ADS development study in Japan Atomic Energy Agency
 - ADS concept study
 - CFD analysis
 - LBE corrosion study by OLLOCHI
 - Technology development by IMMORTAL





Update on LFR Technology: Russia

BREST-OD-300: design basis



- Compliance with the requirements of regulatory documentation;
- Integral layout with a multilayer metal-concrete vessel without shut-off valves in the coolant circulation circuit;
- Reservation of normal operation and safety systems;
- Passive protective and localizing safety systems are widely used
- Lead coolant with high boiling point, radiation-resistant, low activation, not entering into violent interaction with water and air in case of circuit depressurization
- Mixed nitride fuel with high density and thermal conductivity, allows ensuring full reproduction of fuel in the core (core reproduction ratio ~ 1.05) and compensation of reactivity at fuel burnout.



Update on LFR Technology: Russia

Construction status at PDEC site (August 2023)



Site (August 2023)
View of the reactor building and turbine hall



Site (August 2023)
Reactor building

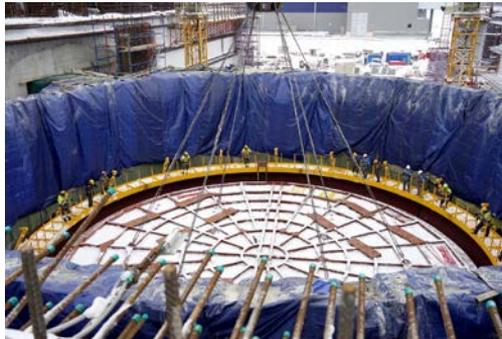


Update on LFR Technology: Russia

Construction status at PDEC site (December 2023)
Mounting of the BREST-OD-300 reactor began



The lower tier of the enclosing structure was immersed in the reactor shaft (December 2023)



Mounting of a steel base plate, weight 165 tons (December 2023)



Construction of electricity transmission lines began: installation of supports and installation of wires (end of December 2023)

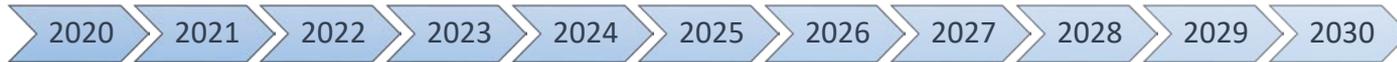


Update on LFR Technology: Russia

“Proryv” project: practical demonstration of all elements of the closed nuclear fuel cycle (CNFC) at the Pilot Demonstrational Energy Complex (PDEC)



Full Generation-IV technology of the Lead-cooled Fast Reactor and the CNFC will be demonstrated on the PDEC site



Construction and commissioning of the Fuel (re-) fabrication module

Equipment manufacturing, construction of the nuclear power plant with the BREST-OD-300 lead-cooled fast reactor

Construction and commissioning of the Reprocessing module



Update on LFR Technology: USA

➤ Westinghouse LFR

- Westinghouse transitioned to a new position in Generation IV space, i.e., from LFR Developer to Top-Tier Service Provider to GenIV and Fusion developers, including LFR developers

➤ Nuclear Energy University Projects

- **Simultaneous Corrosion/Irradiation Testing in Lead and LBE** - Massachusetts Institute of Technology (MIT)
 - *Status:* Completed triple-beam (He/Fe³⁺/protons) irradiation testing of Fe-25Ni-16Cr-5Al-1Nb, FeCrAl, and Fe-20Cr. Post-test analysis is being finalized. Final report is in preparation.
- **Development of Versatile Liquid Metal Testing Facility for Lead-cooled Fast Reactor Technology** - University of Pittsburgh
 - *Status:* NEUP project completed. The new testing facility was installed at the University of Pittsburgh. Further collaborative research (ULV sensor testing, SAM code development) is on-going in collaboration with ANL and WEC.

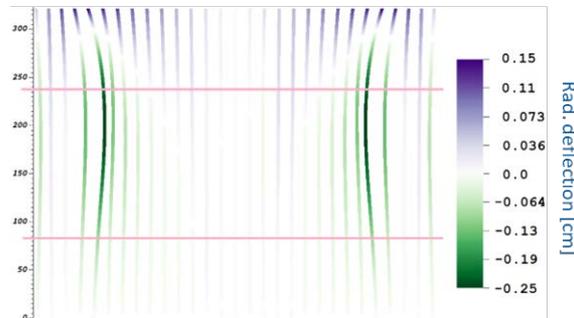


Update on LFR Technology: USA

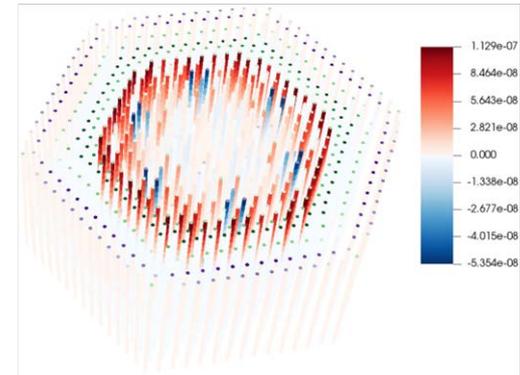
➤ Technology Commercialization Fund projects

- **SAS4A/SASSYS-1 Improvements for Lead Fast Reactors** – Argonne National Laboratory/WEC
 - *Status:* Project completed. Performed the required testing for the recently developed oxide fuel model (OFUEL). Extended the SAS user interface to facilitate mechanistic source term analysis.
- **Enhancement of PyARC for Westinghouse LFR Design and Modeling** – Argonne National Laboratory/WEC
 - *Status:* Major reorganization and improvement to NUBOW-3D (core deformation) code to streamline coupling with DASSH (sub-channel thermal hydraulics) and PERSENT (perturbation theory). Initial demonstration on the Westinghouse LFR.

NUBOW-3D results of LFR core bowing



Corresponding LFR bowing reactivity worth



LFR provisional SSC Update -Initiatives: New webinar series

GIF talks with industry series #1 newcleo, #2 Blykalla, #3 Ansaldo Nucleare (Nov.7)

Around 90 people participated in each of 1st and 2nd webinar mainly from industry.

Webinar
GIF talks with industry series #1
LFR Developers: newcleo
 Hosted by the GIF LFR provisional SSC

Join us on June 20, 2024, 14:30 CEST (UTC+2)

newcleo's R&D Programme in support of Small Modular Lead-cooled Fast Reactor Technology Development and Deployment

Discover the developments in MOX-fueled SMR-LFRs by newcleo. They aim to commission a MOX production plant and a demonstrator in the early 2030s, followed by a 200MWe First-Of-A-Kind and a fleet.

newcleo highlights safety, simplicity, compactness, and cost competitiveness in their reactor design. These qualities are attributed to lead properties and innovative solutions, streamlining their design. Their broad R&D program supports an incremental strategy to refine technologies and address gaps.

Join us to learn more about newcleo's R&D focus areas that include structural materials and coatings, primary components integrity and performance, handling systems, ISI&R and integral testing in large-scale facilities. Learn how specific R&D needs are addressed by newcleo through the refurbishment of existing ENEA infrastructure, and several new test facilities (e.g. CAPSULE, CORE, OTHELLO, DCI, MANUT). Challenges and successes in developing and bringing Generation IV reactor technologies to the market will be discussed as well as how organizations such as GIF can support those efforts. A Q&A session will provide you with opportunities to learn more and listen to firsthand insights on what making a Gen IV reactor a reality requires.

This webinar is the first of three where GIF will be discussing with representatives of the industry to link national and international R&D programs, industry needs and challenges, and work to identify ways for the GIF community to foster new avenues for fruitful cooperations with the industry.

Dr. Mariano Tarantino from ENEA, the co-chair of GIF LFR provisional steering committee, will facilitate this webinar.

Free webcast!

Register NOW at:
<https://www.youtube.com/watch?v=85G8e3t8e30&list=PL85G8e3t8e30>
85G8e3t8e30@protonmail.com



Or scan the code

June 20 – 2024
 14:30 CEST (UTC+2)

Who should attend:
 policymakers, industry professionals, regulators, researchers, students, general public

Speaker **Dr. Fabio Moretti**, Nuclear Engineer with a PhD in Nuclear and Industrial Safety, is the Head of newcleo's R&D Thermal Hydraulics Unit, which carries out engineering studies relevant to the design and operation of experimental test facilities, as well as in support of design and safety assessment of the LFR.

Since 2014 he has been involved (as TH/CFD/FEM analyst, team leader, project manager, etc.) in many projects dealing with nuclear fission reactor safety assessment, nuclear power plant licensing, computer code validation, design and building of test facilities, etc., both in academic R&D frameworks and under industrial contracts, always in internationally oriented environments.

He has always been looking forward to a nuclear renaissance, as a breakthrough toward a cleaner and healthier environment and a really sustainable management of the world's energy resources.

For more information, please visit the GIF website www.gif-icc.org

Webinar
GIF talks with industry series #2
LFR Developers: Blykalla
 Hosted by the GIF LFR provisional SSC

Join us on July 17, 2024, 14:30 CEST (UTC+2)

Status of Blykalla's commercial LFR development in Sweden

Join us for a GIF hosted webinar to discover the latest advancements in corrosion tolerant steels and uranium nitride fuel for Small Modular Reactors (SMR) and Lead-cooled Fast Reactors (LFRs) by Blykalla. Learn about their innovative SEALER-One reactor design, comprehensive safety analysis, licensing process, and ongoing siting studies.

Blykalla is focusing its efforts on designing, licensing and building its first nuclear reactor, SEALER-One on a site in Sweden. This reactor, with an intended 70MWh of power, will utilize uranium nitride fuel with 9.9% enriched uranium. It will produce high quality heat for biomass pyrolysis as well as for production of hydrogen in high temperature electrolyzers.

This webinar will give you the opportunity to:

- Gain insights into Blykalla's research and development initiatives, including their industrialization program for corrosion tolerant steels and methods for qualifying uranium nitride fuel fabrication.
- Understand the process and challenges of licensing SEALER-One in Sweden and the current status of siting studies.
- Discuss the challenges and successes in developing and bringing Generation IV reactor technologies to market and how organizations like GIF can support these efforts.

A Q&A session will provide the room to build upon the initial presentation to further understand how Blykalla is working to bring a Gen IV reactor to reality.

This webinar is the second of a series where GIF engages with industry representatives to bridge national and international R&D programs, industry needs and challenges. It is also aimed at and exploring new avenues for fruitful cooperation within the GIF community.

Dr. Mariano Tarantino from ENEA, the co-chair of GIF LFR provisional steering committee, will facilitate this webinar.

Free webcast!

Register NOW at:
<https://www.youtube.com/watch?v=85G8e3t8e30&list=PL85G8e3t8e30>
85G8e3t8e30@protonmail.com



Or scan the code

July 17 – 2024
 14:30 CEST (UTC+2)

Who should attend:
 policymakers, industry professionals, regulators, researchers, students, general public

Speaker **Prof. Janne Wallenius**, professor of Reactor Physics at KTH Royal Institute of Technology, as well as cofounder and CTO of Blykalla.

His competence areas include lead-cooled reactor design and safety analysis, as well as advanced nuclear fuel development. He has more than 100 publications in peer-reviewed journals and an h-index of 27. He has written text-books on transmutation of nuclear waste and Fast neutron Generation-IV reactors.

In 2013 he co-founded Blykalla in order to commercialize the outcome of his research. In 2022 he was selected for the KTH Innovation Award, for his creativity, grit and courage in making innovations for a better society.

For more information, please visit the GIF website www.gif-icc.org

Webinar
GIF talks with industry series #3
LFR Developers: Ansaldo Nucleare
 Hosted by the GIF LFR provisional SSC

Join us on November 7, 2024, 14:30 CET (UTC+1)

Ansaldo Nucleare leading a joint European roadmap towards a competitive LFR

Join us for a GIF hosted webinar to explore the development for a commercial EU-SMR-LFR through the European international collaboration at European level towards the construction of ALFRED, the Advanced LFR European Demonstrator, by Ansaldo Nucleare, as leader of the FALCON Consortium.

- ALFRED is a pool type LFR leveraging mature design choices and proven materials. This webinar will present how ALFRED project is implementing a staged approach in order to achieve operating conditions representative of a competitive commercial reactor. It will also discuss a set of existing experimental infrastructure supporting ALFRED and new facilities complementing existing ones under construction in Romania.
- FALCON is also engaging with SKC CEN (Belgium). Learn how the partners are combining expertise to define the reference design of a commercial EU-SMR-LFR. The webinar will explore the roadmap to deployment, supported by two precursors: LEANDREA in Belgium, devoted to material and fuel qualification for the following units, and ALFRED in Romania, demonstrator and prototype of the commercial reactor.
- EU-SMR-LFR: Discover how designers are striving for enhanced competitiveness through improved operating temperature, passive safety features and simplified design. The webinar will also discuss the importance of this development in terms of the closure of the fuel cycle for improved sustainability and security targets.

A Q&A session will follow the presentation, providing an opportunity to further understand how Ansaldo Nucleare and its partners are working to bring a Gen IV reactor to reality.

This webinar is the third of a series where GIF engages with industry representatives to bridge national and international R&D programs, industry needs and challenges. It is also aimed at and exploring new avenues for fruitful cooperation within the GIF community.

Dr. Mariano Tarantino from ENEA, the co-chair of GIF LFR provisional steering committee, will facilitate this webinar.

Free webcast!

Register NOW at:
<https://www.youtube.com/watch?v=85G8e3t8e30&list=PL85G8e3t8e30>
85G8e3t8e30@protonmail.com



Or scan the code

November 7 – 2024
 14:30 CET (UTC+1)

Who should attend:
 policymakers, industry professionals, regulators, researchers, students, general public

Speaker **Dr. Michele Fignanti** entered Ansaldo Nucleare in 2007 and is currently Head of Nuclear Technologies and Product Development. He covered multiple roles in the company, from technical coordination to management responsibilities of increasing complexity. He is now supporting the strategic plan, including the interface and synergies with the Ansaldo Group.

With 15+ years of experience in the nuclear field and 10+ years in coordination of innovative projects, he developed most of his career in bridging the gap between academia and industrial sector, with a focus on the management of engineering and testing programs for advanced reactor concepts and small modular reactors.

He has a PhD in Nuclear Engineering at University of Bologna, and recently attended the Key Manager High Education program by CdP Academy at SDA Bocconi, Headsprings and IESE Campus. With more than 30 publications in journals, he is also invited speaker at various international events on energy and nuclear technology.

For more information, please visit the GIF website www.gif-icc.org

LFR provisional SSC Update -Initiatives: GLANST workshop-

45 participants, 28 contributions including 8 invited talks from several industry players.

- Date: **30 September – 2 October, 2024**
- Venue: **ENEA, Brasimone, Italy.**
- Target: **Experts** and **graduate students.**
- Technical program

| Day | Program |
|-----|---|
| 1 | <ul style="list-style-type: none">• Opening Remarks and Introductory Lectures• Technical Tour of ENEA and <i>newcleo's</i> facilities. |
| 2 | <ul style="list-style-type: none">• Session1: Modelling and Simulation• Session2: Coolant, Materials and Fuel |
| 3 | <ul style="list-style-type: none">• Session3: Experiments and Code Validation• Session4: Design of Systems & Components |

