



BNLA Conference on Small Modular Reactors

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The Euratom Research funded Projects on SMRs

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Outline

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1. Selection procedure for the Euratom Research funded Projects

The Euratom Research funded Projects are selected via a competitive process:

- The EC-DG RTD representing Euratom drafts a Euratom Research and Training Programme (5+2 years) containing topics of research
- Euratom Work Programme 2023-2025 and call for proposals open until 8 November 2023
- Potential beneficiaries apply proposing research Projects
- These research projects are evaluated by independent Experts panels

2. SMRs-LWR and AMR-GenIV development

The current Technology Readiness Level (TRL) of the different kinds of reactors implemented in the SMR form are different:

- In the short term, next decade, LWR SMRs could be deployed
 - In the late '30 High Temperature Gas Cooled Reactor (HTGR)
 - In the medium-long term (after 2040) Advanced Modular Reactors GenIV could see their demonstrators built:
 - VHTR, SFR, GFR, LFR, SCWR, MSR
-
- ❑ LWR SMRs are based largely on existing proven technologies but still require R&D
 - ❑ AMR are based on innovative GenIV concepts still to be proven and are seen as option to close the nuclear fuel cycle or to provide Very High Temperature Heat for H₂ production

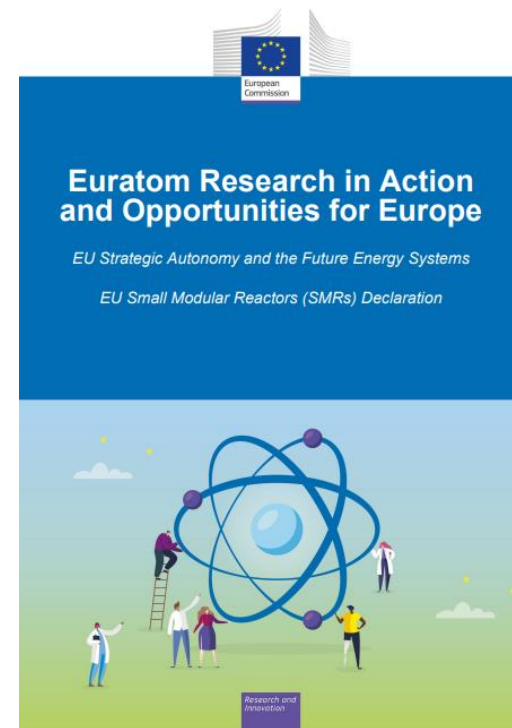
3. Euratom Research in Action and Declaration on SMRs – R&I, E&T (4.04.2023)



3. Declaration on EU SMR 2030 – Safety, R&I, E&T

- ***Stressed the R&I needs for SMRs***
- ***Committed to jointly continue R&I, E&T***
- ***Full brochure with the Declaration (in EN, FR and DE) and the key messages from the speakers:***

<https://op.europa.eu/en/publication-detail/-/publication/e7c3556c-d29d-11ed-a05c-01aa75ed71a1/language-en/format-PDF/source-284290695>



4. New Commissioner for innovation, research, culture, education and youth.

- *Ms. Iliana Ivanova was nominated to replace Ms. Mariya Gabriel, who resigned on 15 May to become Deputy Prime Minister and Foreign Affairs Minister of Bulgaria.*
- *On 12 September, the plenary of the European Parliament confirmed Ms. Iliana Ivanova as the new Commissioner for Innovation, Research, Culture, Education, and Youth.*
- *Ms. Iliana Ivanova has started her position from 18 September.*



5. Horizon Europe & Euratom

HORIZON EUROPE

EURATOM

SPECIFIC PROGRAMME: EUROPEAN DEFENCE FUND

*Exclusive focus on
defence research
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actions

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SPECIFIC PROGRAMME IMPLEMENTING HORIZON EUROPE & EIT*

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- Culture, Creativity & Inclusive Society
- Civil Security for Society
- Digital, Industry & Space
- Climate, Energy & Mobility
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Joint Research Centre



**Pillar III
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Council

European innovation
ecosystems

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WIDENING PARTICIPATION AND STRENGTHENING THE EUROPEAN RESEARCH AREA

Widening participation & spreading excellence

Reforming & Enhancing the European R&I system

Fusion

Fission

Joint
Research
Center

* The European Institute of Innovation & Technology (EIT) is not part of the Specific Programme

5. Euratom research and training programme RTD (2021-'25)



EU adopted Euratom Research and Training Programme on 12 May 2021

The programme has a budget of €1,38 billion for 5 years (€1,98 b. in 7 y. MFF)

***€583 million for
indirect actions
in fusion
research and
development***

***€266 million for
indirect actions
in nuclear
fission, safety
and radiation
protection***

***€532 million for
direct actions
undertaken by the
JRC***

5. Euratom research and training programme 2023-2025



Euratom WP 2023-'25

EUR 132 Millions

Publication on 17.3.2023

**Call deadline on 8.11.2023 at 17:00
(Brussels time)**

5. Euratom Work Programme 2023-25

Nuclear safety of current and future systems

- **HORIZON-EURATOM-2023-2025-NRT-01-01: Safety of operating nuclear power plants and research reactors.** Total indic. budget EUR 20.00 m.
- **HORIZON-EURATOM-2023-25-NRT-01-02: Safety of Light Water Small Modular Reactors (LWR-SMRs).** Total indic. budget EUR 15.00 m.
- **HORIZON-EURATOM-2023-25-NRT-01-03: Safety of advanced and innovative nuclear designs and fuels.** Total indic. budget EUR 12.00 m.
- **HORIZON-EURATOM-2023-25 NRT-01-04: Co-funded European Partnership for research in nuclear materials.** Total indic. budget EUR 20.00 m.
- **HORIZON-EURATOM-2023-25 NRT-01-05: Partitioning and Transmutation of minor actinides towards industrial applications.** Total indic. budget EUR 5.00 m.
- **HORIZON-EURATOM-2023-25 NRT-01-06: Improved nuclear data for the safety of energy and non-energy applications of ionising radiation.** Total indic. budget EUR 4.00 m.

6. Euratom Projects on SMRs (AMR) recently funded

In terms of technologies the projects on SMRs (AMR) Euratom Research currently funds cover:

- ☐ Light Water (LW)
- ☐ High Temperature Gas cooled Reactor (HTGR)
- ☐ Super Critical Water Reactor (SCWR) GenIV
- ☐ Lead Fast Reactors (LFR) GenIV
- ☐ Sodium Fast Reactor (SFR) GenIV
- ☐ Molten Salt reactors (MSR) GenIV

6. Projects on SMRs (AMR) recently funded

❖ <u>Licensing for (LW)</u>	ELSMOR	EC cont. ~ € 3.5 m.
❖ Light Water (LW)	McSAFER	EC cont. ~ € 4.0 m.
❖ Light Water (LW)	SASPAM-SA	EC cont. ~ € 2,9 m.
❖ Light Water (LW)	TANDEM	EC cont. ~ € 3,3 m.
❖ <u>Licensing for inn. NPP</u>	HARMONISE	EC cont. ~ € 2,5 m.
❖ <i>SCW (GenIV)</i>	<i>ECC-SMART</i>	<i>EC cont. ~ € 4.0 m.</i>
❖ <i>HTGR</i>	<i>GEMINI+</i>	<i>EC cont. ~ € 4.0 m.</i>
❖ <i>HTGR</i>	<i>GEMINI 4.0</i>	<i>EC cont. ~ € 3,1 m.</i>
❖ <i>Lead Fast Reactor (GenIV)</i>	<i>ANSELMUS</i>	<i>EC cont. ~ € 3,4 m.</i>
❖ <i>Sodium Fast Reactor (GenIV)</i>	<i>ESFR-SIMPLE</i>	<i>EC cont. ~ € 3,3 m.</i>
❖ <i>Molten Salt Reactors (GenIV)</i>	<i>MIMOSA</i>	<i>EC cont. ~ € 5,7 m.</i>

Total

EC cont. ~ € 39,7 m.

❖ ELSMOR (LWR)

<https://cordis.europa.eu/project/rcn/223419/factsheet/en>

- Project ELSMOR (**towards European Licencing of Small MOdular Reactors**) aim was to create methods and tools for the European stakeholders to assess and verify the safety of light water small modular reactors (LW-SMR) that would be deployed in Europe.
- ELSMOR focused only on safety related aspects mainly on core cooling safety functions of integral LW-SMRs with experimental campaigns and numerical simulation methods.
- Safety analysis methods and tools for containment safety functions were also partially developed with numerical simulation methods.
- From the Euratom Work Programme (WP) 2018
- Duration 42 months, Start date 1 September 2019, End date 28 February 2023
- EC contribution **€ 3.5 million circa** - Overall budget € 4 279 581
- Coordinated by Teknologian Tutkimuskeskus VTT Oy (Finland)

ELSMOR impact

- ELSMOR project aim was to reach a detailed understanding within the European community of the LW-SMR specificities when it comes to safety considerations and licensing.
- ELSMOR developed methodologies suited to LW-SMR specificities (such as an enhanced use of passive systems, installation of several reactors within a same building) that provide guidance in the design orientation from a safety point of view, in the safety assessment and further in the licensing process.
- ELSMOR aim was to share a common view with key stakeholders of how such methodologies can be used in the LW-SMR development in Europe.

❖ **Licensing process for innovative NPP** **HARMONISE**

EC contribution € 2,5 m. circa - Overall budget € 2,5 m. circa

Coordinator: LIETUVOS ENERGETIKOS INSTITUTAS (Lithuania)

Start: 1.06.2022-End: 31.05.2025

Towards harmonization in licensing of future nuclear power technologies in Europe

Keywords: Fission, Fusion, Licensing, Codes and Standards, Risk Informed Performance Based

- *Holistic approach is put forward to study the body of knowledge required to accomplish harmonization and standardization of methodologies, codes/standards as well as the assessment of nuclear reactor components.*
- *To contribute towards the development of distinct performance-based licensing methodologies for innovative fission and fusion designs.*
- *The departure from a performance-based to a prescriptive-based approach in nuclear regulatory regimes is to be examined under the prism of conformity with the safety objectives of innovative fusion and fission devices.*

- *The basis for the activities will be the outcomes of relevant research and cooperation activities in standardization and nuclear safety taking also under consideration the lessons learnt from the stress tests performed in the EU.*
- *A coherent consortium that involves research organizations, technical safety organizations and safety regulators is being built to examine issues related to qualification, standardization, V&V as well as licensing of fission and fusion installations.*
- *In the framework of the proposed activities, the benefits of adopting during the design phase digital twins of nuclear installations – addressing also issues related to accident modelling – will be reviewed.*
- *The outcome will address a number of issues related to the:*
 - *Implementation of a performance-based regulatory approach using desired and measurable outcomes*
 - *Harmonization and standardization of component assessments.*

7. Euratom Research cooperation with International Organizations on SMRs

- **IAEA Technical Working Group on Small and Medium Sized Modular Reactors (TWG-SMR):**
 - 4th Meeting of the Technical Working Group for Small and Medium-sized or Modular Reactor (TWG-SMR), 5-8 September 2022, Vienna.
 - 5th Meeting of the Technical Working Group for Small and Medium-sized or Modular Reactor (TWG-SMR), 11-14 September 2023, Vienna.

- **NEA-OECD Expert Group on Small Modular Reactors (EGSMR):**
 - 3rd EGSMR meeting 3-4 November 2022, Paris, FR.
 - 4th EGSMR meeting 27-28 March 2023, Copenhagen, DK.
 - 5th EGSMR meeting 4-6 October 2023, Ottawa, CA.

8. Key strategic topics and high priority issues for SMR technology development for near-term deployment

- Safety (potential of SMRs to even enhance NPP safety)
- Shared approach in Licensing
- Cogeneration of electricity and process heat (H₂ production)
- Complementarity with renewables in the electrical grid

Thank you for your attention!

5. WP 2023-25

Safety of spent fuel and radioactive waste management, decommissioning

- **HORIZON-EURATOM-2023-25-NRT-01-07: Innovative technologies for safety and excellence in decommissioning including robotics and AI.**
Total indic. budget EUR 4.00 m.
- **Co-funded European Partnership on Radioactive Waste Management – EURAD.** Total indic. budget EUR 20.00 m

5. WP 2023-25 - Nuclear science and ionising radiation applications

- **HORIZON-EURATOM-2023-25-NRT-01-08: Safety of low enriched fuel for research reactors - securing the supply of medical radioisotopes.** Total indic. budget EUR 7.00 m.
- **HORIZON-EURATOM-2023-25-NRT-01-09: Nuclear and radiation techniques for EU strategic autonomy, circular economy and climate change policies.** Total indic. budget EUR 7.00 m.
- **HORIZON-EURATOM-2023-25-NRT-01-10: Harnessing innovation in nuclear science, technology and radiation protection.** Total indic. budget EUR 7.00 m.
- **HORIZON-EURATOM-2023-25-NRT-01-11: Preparatory phase for a European production capability to secure a supply of High-Assay Low Enriched Uranium Fuel (HALEU).** Total indic. budget EUR 1.00 m.

5. Other WP actions

FISA-EURADWASTE 2025

Education, training, capacity building and networking actions to strengthen Ukrainian and EU nuclear research. EUR 0.75 m.

SOFT (Fusion Prizes) and Nuclear Innovation Prize 2025 (Safety of reactor systems, Radioactive waste management, Radiation protection). EUR 0.50 m.

Contribution to OECD/NEA Secretariat for GIF. EUR 0.45 m.

Support to MSCA in nuclear research and training – EUR 1.00 m. /year.

❖ McSAFER (LWR)

<https://cordis.europa.eu/project/id/945063>

- Project McSAFER (**High-Performance Advanced Methods and Experimental Investigations for the Safety Evaluation of Generic Small Modular Reactors**) focuses on safety aspects for LW-SMRs and in particular on technical challenges for the core and for the Reactor Pressure Vessel (RPV).
- Experimental campaigns are foreseen and development of numerical tools.
- CNEA from Argentina participates in this project. CNEA currently contract an SMR prototype in Argentina.
- Ongoing from the Euratom Work Programme (WP) 2019-2020
- Duration 42 months, Start date 1 September 2020, End date 29 February 2024
- EC contribution **€ 4 million circa** - Overall budget € 4 045 133,75
- Coordinated by KARLSRUHER INSTITUT FUER TECHNOLOGIE (Germany)

UNDER DISCUSSION

European
Commission

IAEA and McSAFER

Workshop on the Simulation of Fuel Behaviour in Light Water Reactor Based Small Modular Reactors

Vienna International Centre

Hybrid Event

27 February – 29 February 2024

- *IAEA Technical Working Group on Fuel Performance and Technology (TWG-FPT) during its 21st meeting in April 2023, recommended to organize a Workshop on LWR SMR fuel behaviour simulation jointly with the Euratom Research project McSAFER.*
- *The Joint IAEA – EU McSAFER Project – ORNL workshop is planned to foster the exchange of information on approaches, challenges and specific experiences regarding the wide range of aspects related to multi-physics and multi-scale simulations of the SMR-cores (loaded with and without ATF-fuel) and integral plant behaviour using different computation approaches, to compare results of SMR fuel behaviour simulation and to perform common analysis.*

❖ Light Water (LW)

SASPAM-SA

EC contribution € **2,9 m. circa** - Overall budget € 3,8 m. circa

Coordinator: ENEA (Italy)

Start: 1.10.2022-End: 30.09.2026

Safety Analysis of SMR with PAssive Mitigation strategies – Severe Accident

Keywords: SMR, iPWR, Severe accident, IVMR (In-Vessel Melt Retention), Containment Integrity, Source Term, Emergency planning zone

- In Europe growing interest towards the deployment of SMRs
- Many countries preparing for possible licensing needs.

Integral Pressurized Water Reactor (iPWR) ready to be licensed as new builds because they start from the well-proven and established large Light Water Reactor (LWR) technology, incorporate their operational plant experience/feedback, and include moderate evolutionary design modifications to increase the inherent safety of the plant.

- However, despite the reinforcement of the first three levels of the Defence-in-Depth (DiD), e.g., with the adoption of passive safety systems, a sound demonstration of iPWR ability to address Severe Accidents (SA) should be carried out (DiD levels 4-5).

- The main objectives of the project will be to transfer and adapt such knowledge and know-how to iPWR, in view of the European SA and Emergency Planning Zone (EPZ) analyses.
- The main elements considered are:
 1. The identification of plausible SA scenarios for iPWRs with the related conditions in the vessel and in the containment,
 2. The study of the applicability of the existing experimental databases to iPWR and identify new experimental needs,
 3. The assessment of the capability of internationally recognized European and Non-European computational tools (largely used in Europe) to describe the behavior of the most promising iPWR designs during SA scenarios, and
 4. The prediction of the resulting radiological impact on- and off-site, taking into account special SA mitigation/management strategies.
- The expected outcomes of the project will help speeding up the licensing of iPWRs in Europe, as well as the siting processes of these reactors in light of their possible use near densely populated areas.

❖ **Light Water (LW)**

TANDEM

EC contribution **€ 3,3 m. circa** - Overall budget € 3,6 m. circa

Coordinator: CEA (France)

Start: 1.09.2022- End:31.08.2025

Small Modular Reactor for a European safe and Decarbonized Energy Mix

Keywords: SMR, hybrid energy system, safety

- Small Modular Reactors (SMRs) can be hybridized with other energy sources, storage systems and energy conversion applications to provide electricity, heat and hydrogen.
- SMR technology thus has the potential to strongly contribute to the energy decarbonization in order to achieve climate-neutrality in Europe by 2050.
- The integration of nuclear reactors, particularly SMRs, in hybrid energy systems is a R&D topic to be investigated to provide assessments and tools to facilitate the safe, secure and efficient integration of SMRs into smart low-carbon hybrid energy systems.
- Safety issues of SMRs related to their integration into hybrid energy systems, involving specific interactions between SMRs and the rest of the hybrid systems
- New initiating events will have to be considered in the safety approach.

- An open-source model library of hybrid system components will be developed to build a hybrid system simulator.
- Focus on two main study cases corresponding to hybrid system configurations covering the main trends of the European energy policy and market evolution:
 - District heating network and power supply in an urban area
 - Energy hub serving energy conversion systems, including hydrogen production, in a regional perspective.
- Assessments on SMR safety, hybrid system operationality and techno-economics.
- Societal considerations will also be encased by analyzing the European citizen engagement regarding SMR technology safety.
- The work will result in technical, economic and societal recommendations and policy briefs on the safety of SMRs and their integration into hybrid energy systems for industry, R&D teams, TSOs, regulators, NGOs and policy makers.

❖ ECC-SMART (SCW) GenIV

- Project ECC-SMART (<https://cordis.europa.eu/project/id/101019523>) **Joint European-Canadian-Chinese Development of Small Modular Super-Critical Water-cooled Reactor Technology** aims at assessing the feasibility and identification of safety features of an intrinsically and passively safe small modular reactor cooled by supercritical water (SCWR-SMR).
- ECC-SMART objective is to collect the experience gained on the development of SCWR (Supercritical Water-cooled Reactor) in Europe, Canada and China to derive a joint design requirement document that will be a basis for a future conceptual design project of a supercritical water -small modular reactor (SCW-SMR).
- ECC-SMART has an important international cooperation aspect with the participation of CNL from Canada and of 3 entities from China (Nuclear Power Institute of China-NPIC, a subsidiary to China National Nuclear Corporation-CNNC).
- Ongoing from the Euratom Work Programme (WP) 2019-2020
- Duration 48 months, Start date 1 September 2020, End date 31 August 2024
- EC contribution **€ 4 million circa** - Overall budget € 8 911 950
- Coordinated by CENTRUM VYZKUMU REZ SRO (Czech Republic)

❖ GEMINI+ (HTGR)

<https://cordis.europa.eu/project/rcn/211038/factsheet/en>

<http://www.gemini-initiative.com/about/>

- Project GEMINI+ will provide a **conceptual design for a high temperature nuclear cogeneration system (HTGR) for supply of process steam to industry, a framework for the licensing of such system and a business plan for a full scale demonstration.**
- GEMINI+ has an important international cooperation (INCO) aspect with the participation of the JAEA from Japan, KAERI from Korea and NGNP INDUSTRY ALLIANCE from the USA.
- Closed project from the Euratom Work Programme (WP) 2016-2017
- Duration 42 months, Start date 1 September 2017, End date 28 February 2021
- EC contribution **€ 4 million circa** - Overall budget € 4,5 million
- Coordinated by NARODOWE CENTRUM BADAN JADROWYCH (Poland)

❖ HTGR

GEMINI 4.0

EC contribution € 3,1 m. circa - Overall budget € 3,1 m. circa

Coordinator: FRAMATOME

Start: 1.06.2022- End: 31.05.2025

HTGR for zero CO2 emissions

Keywords: nuclear cogeneration, polygeneration, decarbonization, high temperature reactor, TRISO

- In Europe, electricity represents only ¼ of CO2 emissions.
- The European decarbonization objectives cannot be met without addressing the other sources of emissions mainly industry and transport.
- High Temperature Reactor systems can provide a competitive and safe solution for the CO2 free cogeneration of the process heat and electricity needed by industry.
- Many industrial processes require not only heat (e.g. in the form of steam) but also large amounts of hydrogen or other energy products.
- Beyond CO2 free process heat, provide a global solution for competitive and safe decarbonization of industrial activities.

- To confirm that this new form of poly-generation of various energy products has no negative effect on the safety of the combined plant.
- To clear the way towards safety demonstration and subsequent deployment of this solution:
 - Consolidate the system safety demonstration and have its licensing readiness assessed by regulators and TSOs including when used in poly-generation mode
 - Develop the capability of the system to operate in a cost-effective way in poly-generation mode
 - Plan for the development of a European consistent fuel cycle for this type of reactor with respect to fissile resources and to a safe and acceptable back-end
 - Launch an ambitious communication plan towards political and industry stakeholders, as well as towards the public, aimed at removing obstacles to nuclear solutions for decarbonization of industry.

❖ Liquid Metal LFR ANSELMUS

EC contribution € 3,4 m. circa - Overall budget € 4,3 m. circa

Coordinator: SCK-CEN (Belgium)

Start: 1.09.2022- End: 31.08.2026

Advanced Nuclear Safety Evaluation of Liquid Metal Using Systems

Keywords: Nuclear Safety, GenIV, Lead, LBE, LFR

- The importance of low carbon energy sources in the efforts against rapid climate change makes nuclear energy part of a sustainable energy mix. Fundamental improvement, particularly regarding intrinsic safety and reduced nuclear waste generation is possible using advanced nuclear designs.
- Heavy metal cooled systems such as the lead fast reactor (LFR) combine the advantages of a fast reactor system that reduces waste with the intrinsic safety related properties such as the high boiling point, chemical inertia and improved heat transfer.
- Objective is to contribute significantly to the safety assessment of heavy-liquid-metal (HLM) systems, in particular ALFRED and MYRRHA as these are included in the roadmap for the development of advanced systems in Europe.

- It will use the maturity of both designs to create two detailed phenomena identification and ranking tables (PIRT) that identify all verification and validation needs and are used for further safety evaluation.
- The project will also experimentally validate key safety related sub-systems including the safety rods, failed fuel pin detection and the coolant chemistry control system.
- Improve the validation of numerical models describing the fuel assembly through experiments and simulations and work on reactor safety monitoring and inspection of HLM systems focusing on high temperature vessel inspection.
- Societal impact of HLM reactors by assessing the integration of LFR in a mixed energy landscape, including economical aspects, and by addressing social and ethical considerations of advanced nuclear technologies.

❖ Sodium Fast Reactor ESFR-SIMPLE

EC contribution € 3,3 m. circa - Overall budget € 5,5 m. circa

Coordinator: CEA (France)

Start: 1.10.2022 – End: 30.09.2026

European Sodium Fast Reactor - Safety by Innovative Monitoring, Power Level flexibility

Keywords: SFR, SMR

- To facilitate the integration of the future nuclear reactors into the European energy system, it is necessary to demonstrate that the reactors have uncompromised safety and meet the future societal needs.
- Challenging the current European Sodium Fast Reactor (ESFR) design to improve its safety and economics through implementation of innovative technologies in accordance with the ESNII roadmap.

- 5 specific objectives:

1. Rethink the ESFR design in order to simplify it and make it more cost-competitive, while still achieving resource sustainability and having safety reinforced by intrinsic behavior. This can be accomplished through reducing the size of the reactor, which will also allow taking advantage of Small Modular Reactor features such as transportability, modularization, standardization, and flexible operation, all ultimately leading to improved economics.
2. Assess impact of alternative technologies, such as metallic fuel and compact secondary system design, for the large-size ESFR on the economics and safety.
3. Propose, develop and assess advanced methods of monitoring and processing operational data using Artificial Intelligence, e.g., to optimize fault detection in steam generators at an early stage.
4. Produce new experimental data in order to assist in qualification of innovative components, such as expansion bellows, core catcher and thermo-electric pumps.
5. Ensure that the knowledge generated in the project is shared not only among the project partner institutions, but also with a wide range of stakeholders in Europe and internationally. The project activities will also be informed by the public and other stakeholders' perception of risks and benefits of ESFR technology. Close interactions with European regulatory authorities will enable continued review and recommendation of the solutions proposed and developed in the project.

❖ Molten Salt Reactors

MIMOSA

EC contribution € 5,7 m. circa - Overall budget € 5,7 m. circa

Coordinator: ORANO (France)

Start: 1.06.2022- End:31.05.2026

Multi-recycling strategies of LWR SNF focusing on MOlten SAlt technology

Keywords: Molten Salt Reactor, Advanced Fast reactor, Chloride Salt, LWR Spent Nuclear Fuel, Multi-recycling, Isotopes valorization, Sustainable energy system, Circular economy, Closed fuel cycle, Reprocessing

- Multi-recycling in LWRs is a tangible solution enhancing further the circular economy and moving towards the closure of the fuel cycle.
- However, this option presents some limitations related to the degradation of the Pu isotopic composition and the generation of minor actinides (MA), leading to an increase of vitrified high-level waste when compared to multi-recycling with FRs, thus limiting its benefits from a repository footprint perspective.
- Significant improvement in converting all the Pu isotopes and MA into fission products with shorter half-lives can be achieved with the introduction of advanced reactor systems, among which the molten salt reactor (MSR) using Chloride salt is particularly promising.
- In this reactor, the fuel is a fluid, eliminating the major technological bottlenecks of refabrication of solid **fuels** with high transuranic content.

- There is no experience of Chloride MSR (CI MSR) in operation, but it was studied and tested on experimental set-ups, showing a great improvement in the conversion rate of actinides.
- To develop an accessible, cost/risk optimized multi-recycling strategy of LWR spent fuels, based primarily on multi-recycling of Pu (and REPU) in LWRs combined with the CI MSR, and using already available infrastructure in the EU such as the French reprocessing plant, not only for its existing LWR fuel treatment capabilities, but also for its Pu partitioning and waste conditioning capabilities, its compatibility with chloride salts, and in the future, for its potential additional capabilities in MA separation and salt management.
- Strategy to be also compared with other multi-recycling scenarios.
- Focus more specifically on the demonstration of several key aspects of technical feasibility and performance of CI MSRs, that will contribute to accelerating the deployment of this advanced technology, on Pu and MA conversion respectively and on production of valuable isotopes for other applications