EASI SMR

EASI-SMR: Ensuring Assessment of Safety Innovations for SMR

International Workshop on Thermal-Hydraulic Scaling for SMR Safety Demonstration – December 16-18, 2025 – Bologna

Nicolas Sobecki (EDF, France)
Coordinator of the project

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Agenda

- Context and Objectives
- Overview of the Project
- Expected Impacts

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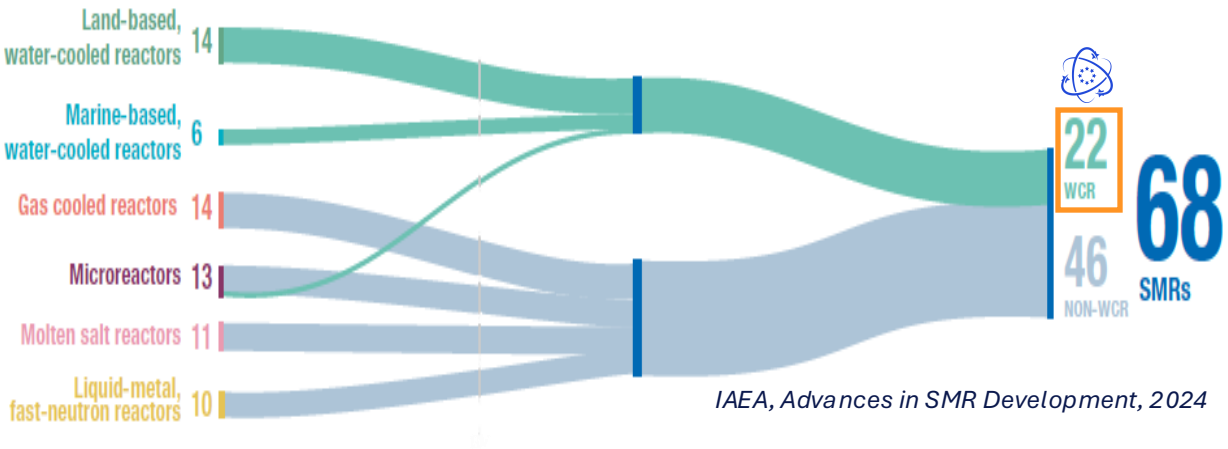
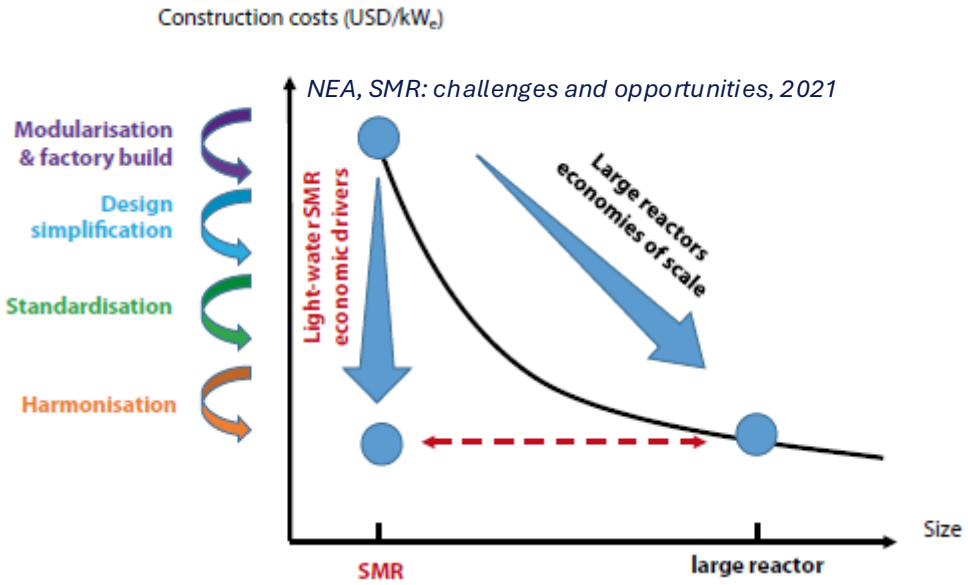
01 Context and Objectives

SMR development worldwide



IAEA, Advances in SMR Development, 2024



NEA, SMR: challenges and opportunities, 2021

SMR:

- **Produce baseload and flexible low carbon electricity and heat**
- **Integrate nuclear technologies into new industrial applications and hybrid energy systems**
- **Suitable to smaller grids and easier to finance**

LW-SMR: most mature technologies

But…

There are still short term R&D efforts required to enable design licensing

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Accelerate commercial deployment of LW-SMRs in the EU by 2030

R&D gaps for LW-SMRs

Advanced safety systems

- Need of **experimental data**
- **Validation** of safety analysis **codes**
- **Performance** and **reliability** demonstration
- **Human factor** adaptation

SCALING

Modularisation

- **Integrate** modularisation into **engineering standards**
- **Interface** standardisation
- **Advanced construction techniques** (SCS,…) and its **qualification**
- **Transportation logistics**

Additive manufacturing and advanced welding

- **Process** and **Materials qualification**
- **Repair** and **maintenance**
- **Adapt** reactor **component** designs for **manufacturability**
- **Size** limitation
- **Regulatory** acceptance

Key innovative research areas to support SMRs in development in the EU

Digitalisation and monitoring tools

- Develoment of **digital twins**
- Develoment of **simulators**
- **Advanced maintenance** development
- **Cybersecurity** of advanced contol systems

Non-electrical applications

- **Process integration** and **coupling**
- **Economic** and **regulatory frameworks**
- **Steam tapping safety** and **performance**

Nuclear fuel cycle

- **Advanced technological fuel**: Accident Tolerant Fuel (ATF)
- **Validation** of **performance** and **safety simulation codes**: uncertainty quantification & experimental data
- **Waste management**: compatibility with LWRs and optimization of storage systems

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Objectives of the EASI-SMR Project

Strategic Alignment with European Industrial Alliance on SMRs Objectives

- Activity program inspired by the EU SMR pre-Partnership R&D&I roadmap
- Early R&D application case of the Alliance, funded by the Euratom Research and Training Programme

3 HIGH-LEVEL OBJECTIVES:

- Ensure the highest level of the safety of LW SMRs based on passive systems
- Assess the safety impact of LW-SMRs designs' specificities
- Address regulatory and societal challenges towards the deployment of SMRs in Europe

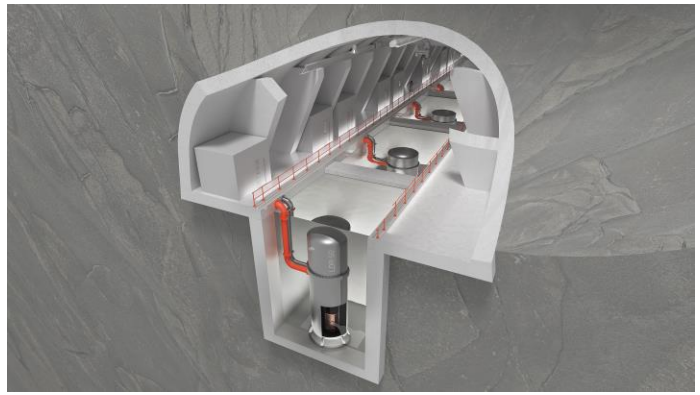
Industrial designs of reference

NUWARD SMR

- Developed by nuward EDF GROUP, an EDF subsidiary
- Technical features:
  - Based on GEN III+ PWR technology
  - 400MWe + 115MWth in cogeneration mode
  - Load following as a complementary solution to renewable energy sources,
  - Supply remote municipalities and energy-intensive industrial sites.
  - Heat & electricity cogeneration, hydrogen production, district heating and water desalinization

LDR-50

- Developed by Steady Energy, a spin-off company from VTT
- Technical features:
  - District heating reactor
  - Maximum heating power 50 MWth per reactor module
  - Low temperature and pressure (150°C and 0.8MPa)
  - Liquid/liquid heat exchanger
  - Reactor hall constructed underground

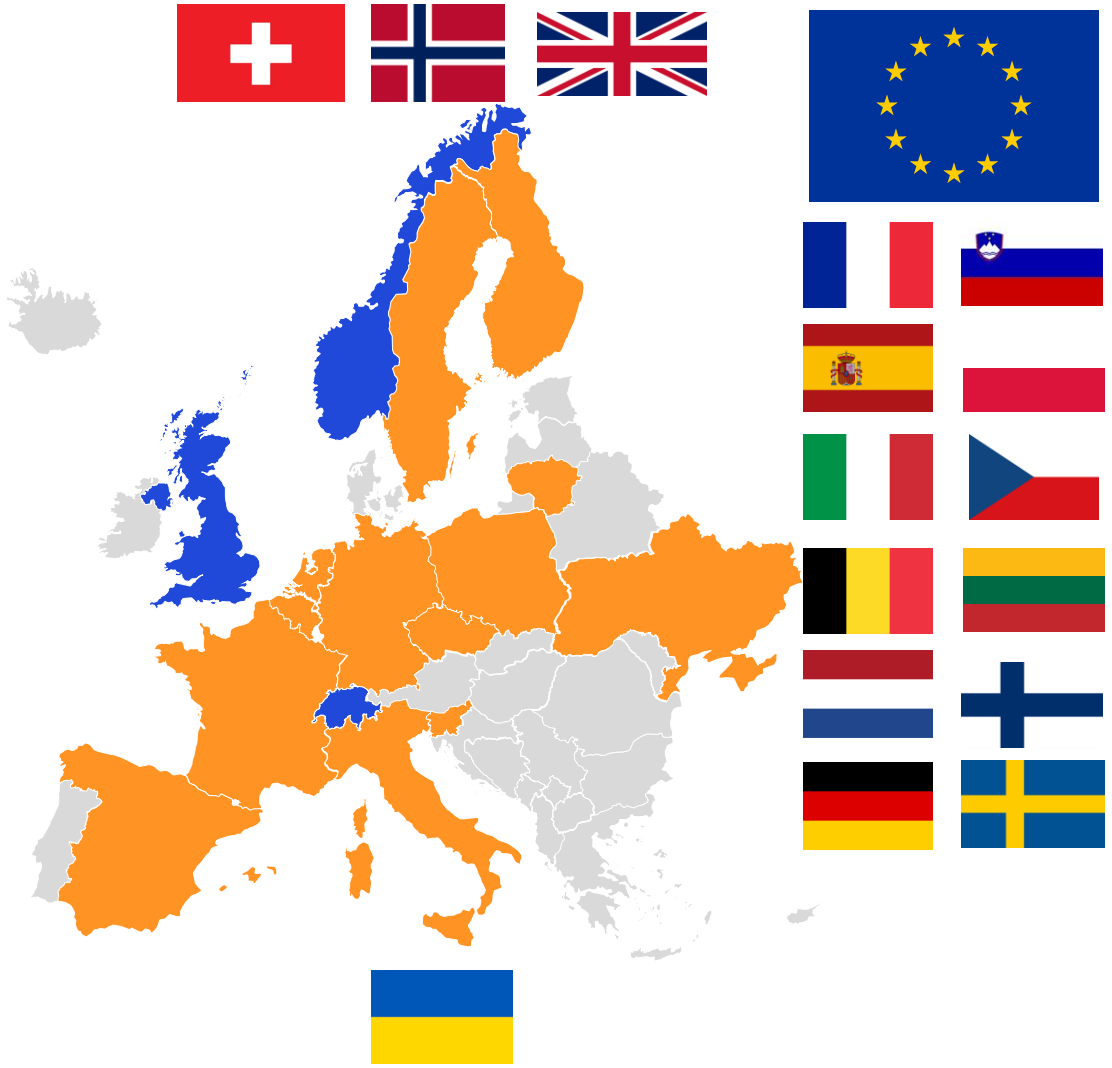


02 Overview of the Project

General overview of the EASI-SMR project

Ensuring Assessment of Safety Innovations for SMR

- **Project start:** 1 September 2024
- **Project duration:** 48 months
- **Budget:** 23,6M€
- **HORIZON-EURATOM-2023 funding:** 15M€
- **Organization leading the project:** EDF
  - Coordination : nicolas.sobecki@edf.fr
- **Partners:** 38 partners from 16 countries
- **For further information:**
  - Browse our website: easi-smr.eu
  - Follows us on LinkedIn: @easi-smr



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Structure of the project

WP1: Transverse topics for LW-SMR acceptability and licensing

VTT

WP4: Reliability of passive systems

ÚJV

WP7: Advanced core physics studies of boron-free SMR-cores

KIT

WP2: Experimental test program

cea

WP5: Human & Organizational Factors

ASNR Autorité de sûreté nucléaire et de radioprotection

WP8: Communication, Education and Training

enen

WP3: Code validation, Scaling

ENEA

WP6: SG Mock-up by additive manufacturing techniques

Ciemat

WP9: Project coordination

eDF

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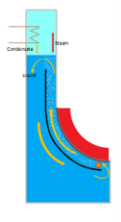
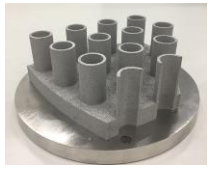
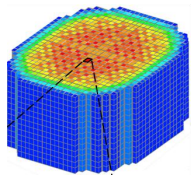
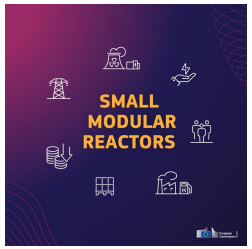
03 Expected Impacts

Expected impacts of the project









- **Increasing knowledge** on passive systems physics to improve their safety assessment.
- **Establishing a qualification guideline** of a SG made by additive manufacturing.
- **Advancing methods and tools** for LW-SMR core analysis to assure efficient and safe operation.
- **Improving understanding of Human & organizational factors** at stake in LW-SMRs operation.
- **Supporting a shared and coherent approach** among regulators regarding safety requirements for LW-SMRs.
- **Improving acceptance and understanding** of LW-SMRs in the EU.

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Thank you

Contact us: contact@easi-smr.eu

Join us on LinkedIn @easi-smr

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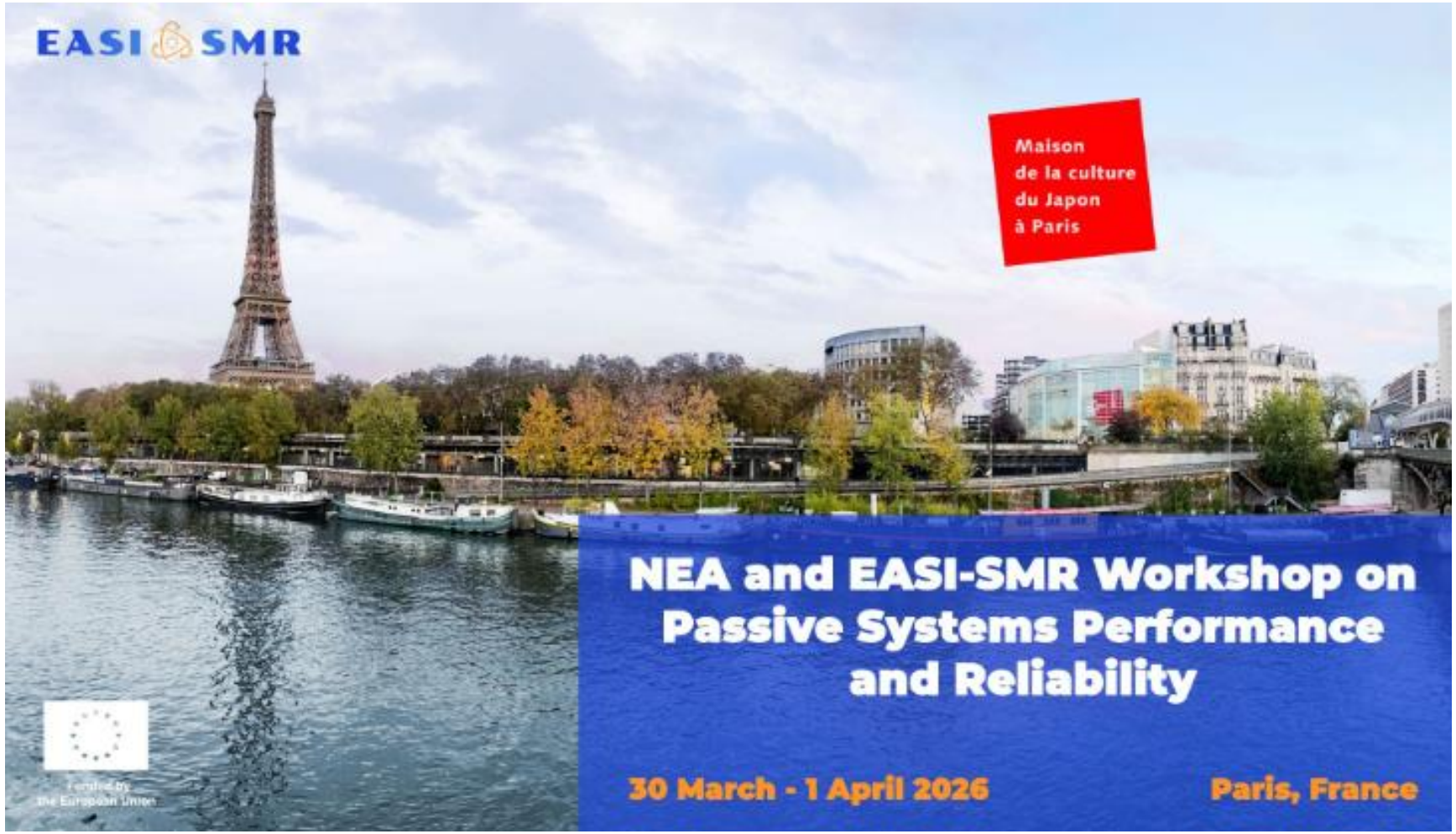
Next Event of the project



https://www.oecd-nea.org/jcms/pl_109806/passive-systems-performance-and-reliability-workshop

Partners

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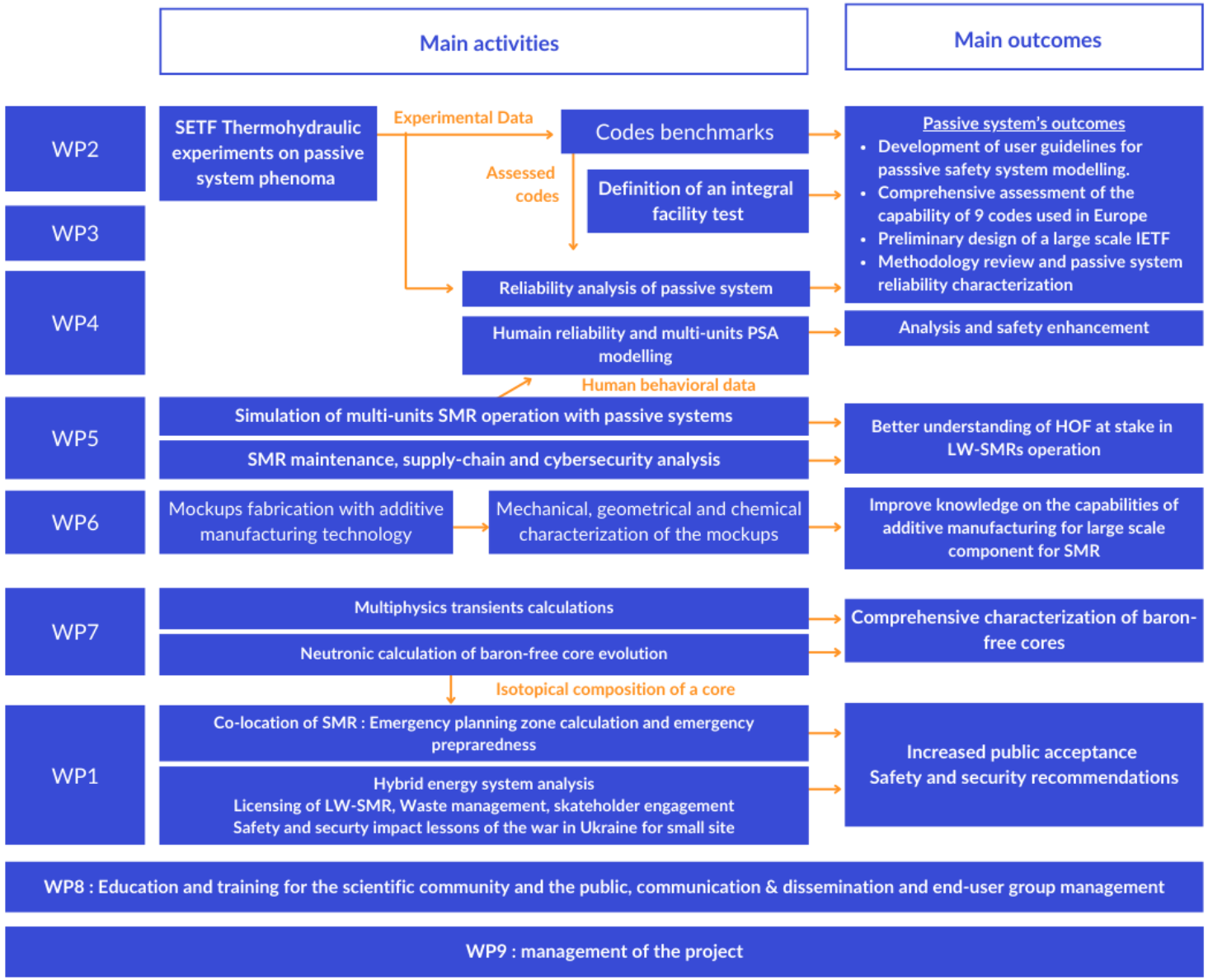
EASI-SMR Project structure



Adaptation of the Work Programme

Innovative design: integrated RPV, CSG, boron-free core, passive safety systems, multi-unit operation capability…

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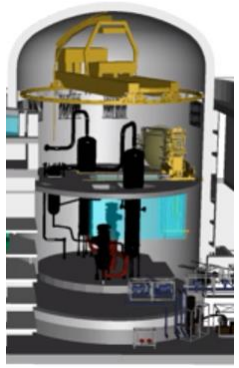
Summer 2024



Design based on proven technology bricks: loop-type RPV, boron-based core, proven passive system technology, and single-module power production.

Modifications of the EASI-SMR Work Programme:

- **Postponement of hybridization activities** to integrate data from NUWARD V2
- **Adaptation of the FHEASIK test facility**, shifting from the tertiary RRP passive system of NUWARD V1 to the study of the **main passive system of the LDR-50**
- **Creation of a public dataset representative of NUWARD V2** for thermal-hydraulic hybridization studies

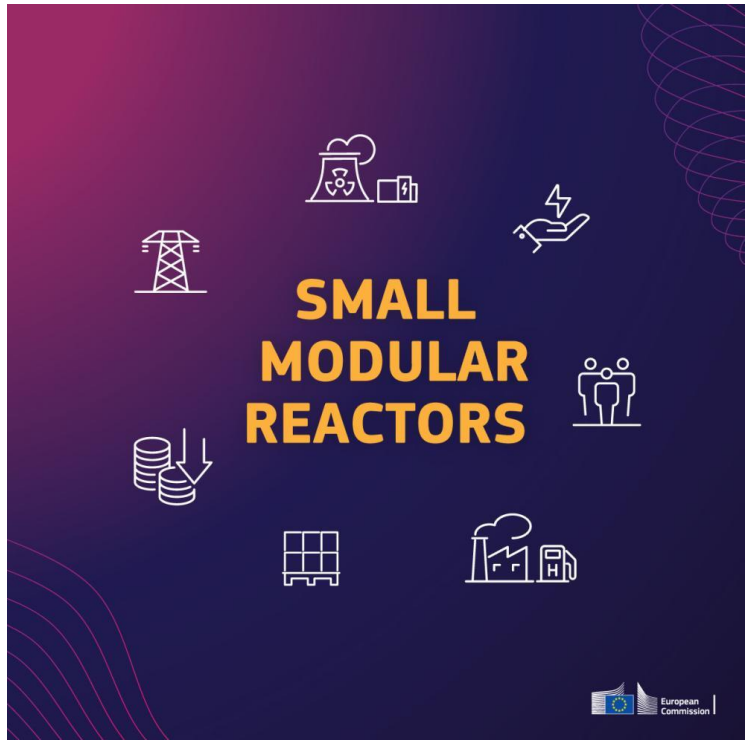
Topics of Interest for NUWARD V2

- **Licensing harmonization** and **acceptability**
- **Cogeneration studies** of a NUWARD V2-type SMR
- **Testing of passive systems** with thermal-hydraulic **code validation**: IVR-LOOP, COSAC, ALCINA and PRECISE (SACO)
- **Human and organizational factors** activities:
  - Impact of passive systems and cogeneration mode on operators
  - Ensuring safety requirements across the supply chain
  - Maintenance automation
  - Cybersecurity

LW-SMR acceptability and licensing

Achievements:

- Creation of a **public dataset representative of the new NUWARD (E-LOOP-SMR)**, in collaboration with the NUWARD teams
- Analysis of **Compatibility** with **High-Power Reactor Waste Management Systems for LW-SMRs**
- Definition of the most relevant **safety assessment approach** for **addressing the colocation challenges of SMR modules**.



Next steps in 2026:

- **Benchmarking** of **accidental transient** simulations for the **LDR-lite and E-LOOP-SMR in cogeneration mode** using various **system codes**.
- Work on **acceptability criteria** and **scaling** of **waste treatment** and **storage capacities**.
- **EPZ calculations: a**nalyze the **impact** of the **multi-module** aspect.
- **Licensing**: identify **regulatory bottlenecks** and **foundational elements transferable** for selected vendors and countries

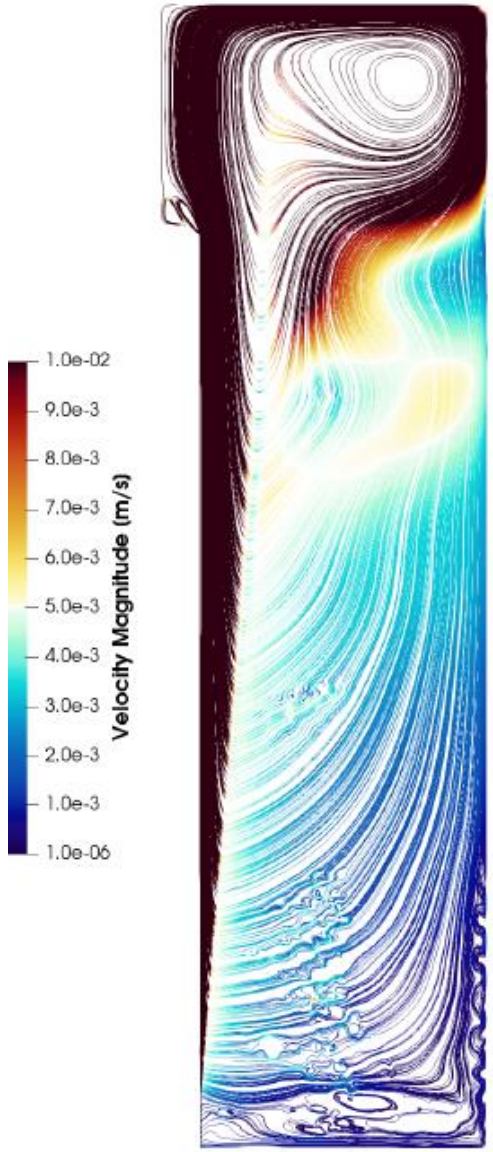
Passive systems

Achievements:

- **Specification** of the **nine test facilities** involved in the EASI-SMR experimental programme.
- Ongoing **construction** or **modification of existing test facilities**.
- Launch of the **pre-test phase** for the **benchmark of 10 European thermal-hydraulic codes** for the modeling of **ELSMOR II and PRECISE**
- Comprehensive **comparison** of existing **methods for passive system reliability (REPAS, RMPS, APSRA, ROAAM+):** online deliverable

Next steps in 2026:

- **Initial test results** of ELSMOR II, PANDA and PRECISE and **launch of experimental campaigns** for COSAC, FHEASIK, IVR LOOP, GRADAC
- Launch of **pre-test** (FHEASIK, IVR LOOP, GRADAC) **and blind-test phases** (PANDA, PRECISE, ELSMOR II) of the **code benchmarking** exercises
- Implementation of **methodologies** for **quantifying** the **failure rate** of **passive systems** (RMPS, REPAS and ROOAM+).



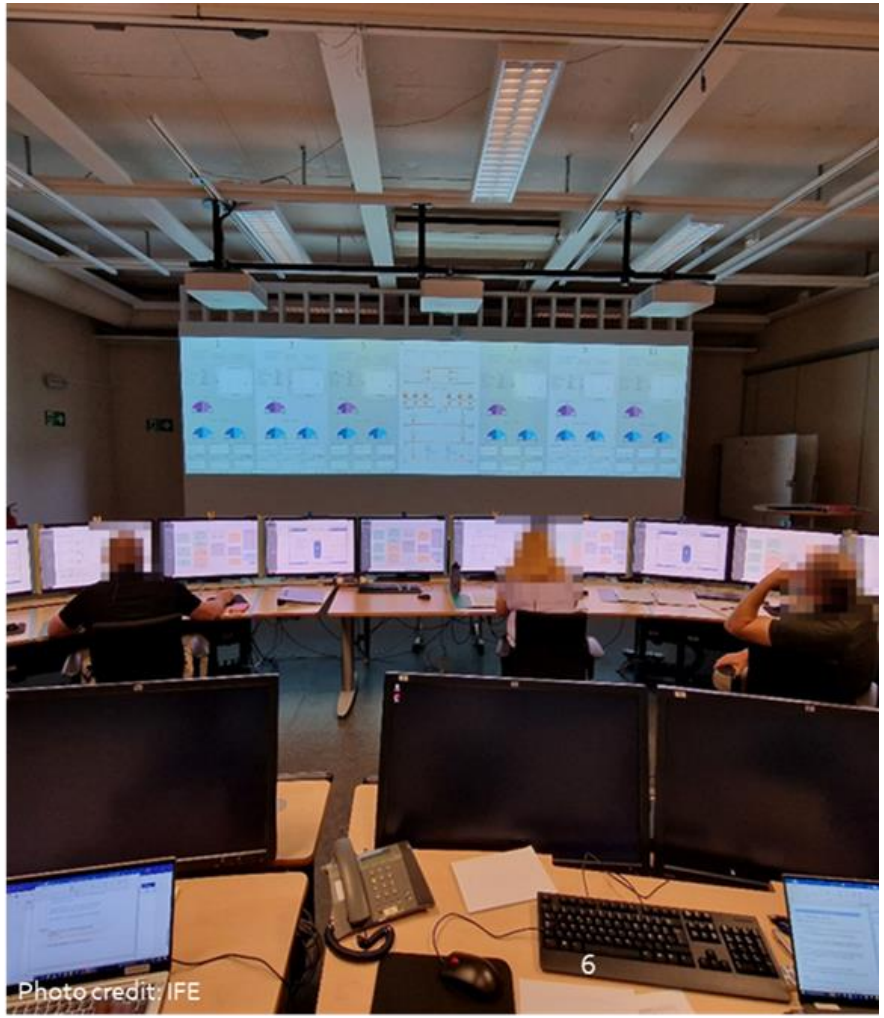
Human & Organizational Factors

Achievements:

- **Literature review** on **cybersecurity regulations, guidelines and standards** for different modes of operations
- Report on main **HOF issues regarding passive systems**
  - 35 interviews (PSS experts, HOF experts, former operators, operators, etc.)

Next steps in 2026:

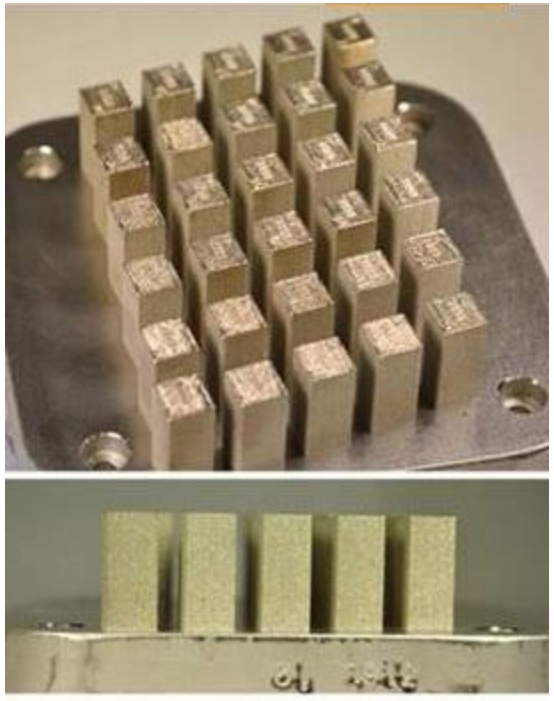
- **Study of a reference situation** (case of existing multi-unit, cogeneration supervision)
- **Simulator tests at IFE (Halden):**
  - Scenarios to be defined to study the impact of a multi-unit control room, passive systems and cogeneration
  - Cybersecurity scenarios
- Studies on the **relationships** between **LW-SMR supply chain configurations** and **safety**

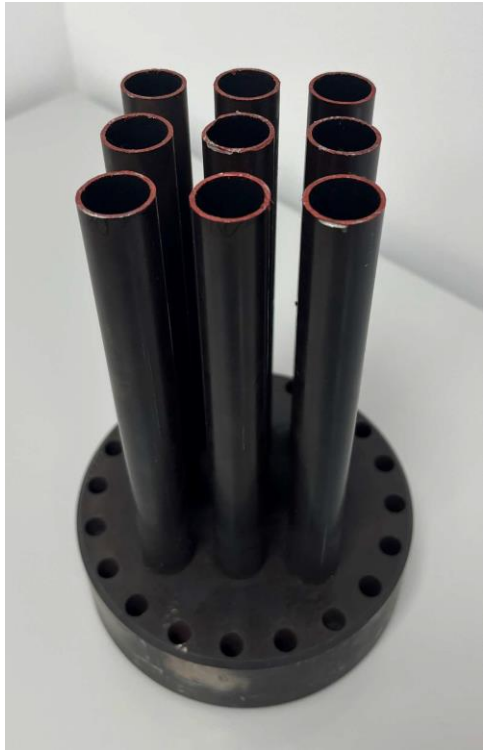


Additive manufacturing

Achievements:

- Development of a **qualification methodology** for the **additive manufacturing processes PBF-LB/M** (Powder Bed Fusion – Laser Beam/Metal) and **DED-LB/Mp** (Directed Energy Deposition – Laser Beam/Metal powder), applied to **Inconel 625 and Alloy 800** materials





Next steps in 2026:

- **Implementation of the validation process**: process stability, repeatability, qualification and product validation
- **Thermal aging tests** and **post-microstructural examination** on PBF-LB/M and DED-LB specimens
- **Design of the steam generator tube mock-up** with tube sheet in **DED-LB** using Inconel 625
- **Design of steam generator-type mock-ups** in **PBF-LB/M** using Alloy 800

Boron-free SMR-cores

Achievements:

- Definition of **neutron physical characteristics** of **LW-SMR fresh boron free cores**: PRATIC and LDR lite

Next steps in 2026:

- **Benchmarking codes** (industry-like and high fidelity Monte Carlo codes) for **static calculations at the beginning of cycle** for PRATIC and LDR lite cores
- **Benchmarking codes** for **multiphysics transient calculations** at the **beginning of cycle** for PRATIC and LDR lite cores
- Launching **multi-cycle depletion calculations** for PRATIC and LDR lite cores