NET ZERO CITIES

EU MISSION PLATFORM

CLIMATE NEUTRAL AND SMART CITIES

NetZeroCities has received funding from the H2020 Research and Innovation Programme under grant agreement n°101036519.

WORKSHOP: Small Modular Reactors (SMRs) for district heating

22 October 2025

NetZeroCities has received funding from the H2020 Research and Innovation Programme under grant agreement n°101036519.

Welcome introduction

Philippe Froissard

European Commission, the Directorate General for Research and Innovation

Head of the "Strategy, Policy Coordination and Urban Transitions"

NetZeroCities has received funding from the H2020 Research and Innovation Programme under grant agreement n°101036519.


Climate KIC
EURO CITIES
ICLEI
Local Governments for Sustainability
EUROPE
LGi
sustainable innovation
AIT
AUSTRIAN INSTITUTE OF TECHNOLOGY
BANKERS WITHOUT BOUNDARIES
Climate Alliance
CARTIF
Cerema
CLIMAT & TERRITOIRES DE DEMAIN
00
Dm
DEMOS HELSINKI
democratic society
eit Urban Mobility
ENERGYCITIES
ERRIN
European Regions Research and Innovation Network
Frankfurt School of Finance & Management
Bankakademie | HfB
Fraunhofer
Institute for European Environmental Policy
MATERIAL ECONOMICS
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OPEN & AGILE SMART CITIES
POLITECNICO MILANO 1863
RESILIENT CITIES NETWORK
REGEA
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Forschung & Beratung GmbH
south pole
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www.netzerocities.eu

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European Commission

Net Zero Cities

Small Modular Reactors (SMRs) for District Heating

Brussels, 22 October 2025

Domenico ROSSETTI di V. and Angelgiorgio IORIZZO
Unit C.4–Euratom Research

Political, technological and licensing issues

- MS debate on nuclear, Alliance of MS, Russian invasion?
- Large vs Small Reactors?
- EU sovereignty vs fast deployment (EU designs vs US and UK ones)?
- Results of the on-going IPCEI discussions on nuclear?
- Standardized licensing of SMRs and (long) safety authorities procedures?

European Commission

Small Modular Reactors (SMRs)

- **Small:** up to 300 MWe (less than 10 MWe = micro modular reactors MMRs)
- **Modular:** Modularity-series production-simple design
- **Reactors:** Nuclear power reactors

The reduced size allows:

- New and **enhanced inherently safety features**.
- **Series deployment** that will only be realised if SMRs can take advantage of a global supply chain and global customer basis, which **require a streamlined multinational licensing framework** and co-ordinated international codes and standards for the manufacture of systems and components.

Designs and technologies of SMRs

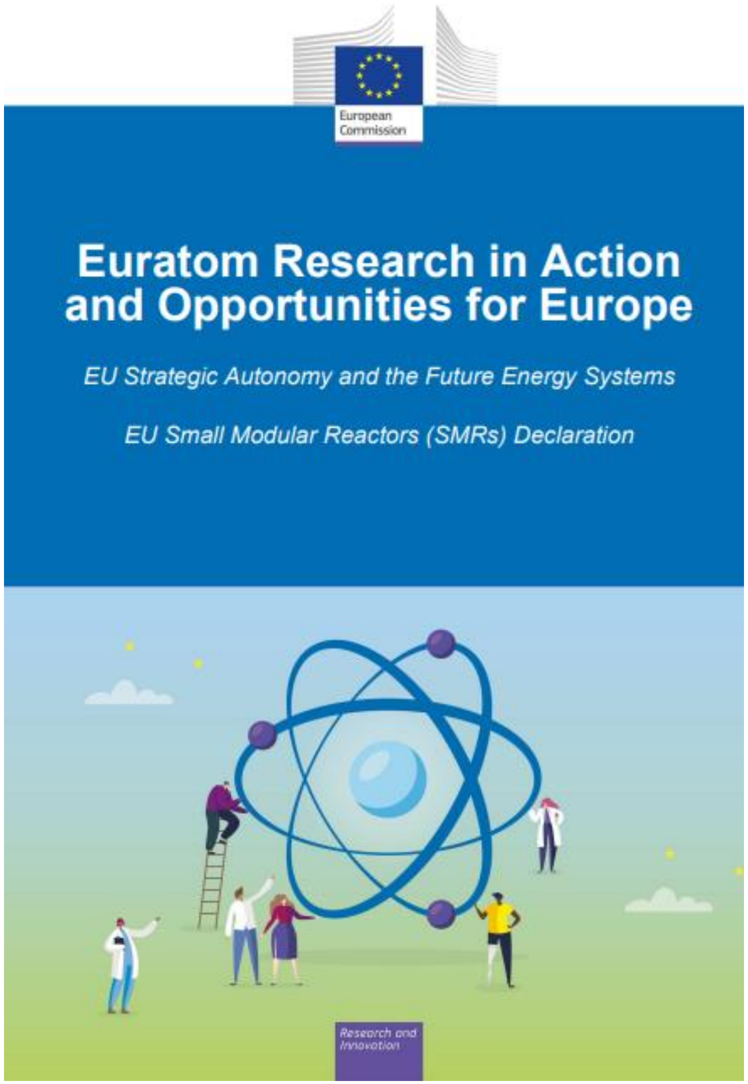
- **Light Water (LW-SMRs):** the most mature designs, deployable in the 2030's
- **Advanced Modular Reactors (AMR) – GEN IV**, i.e. Molten Salt Reactors, Gas Cooled Reactors, Liquid Metal Cooled Reactors (Sodium and Lead) able to close the nuclear fuel cycle, expected in the 2040's
- "Maturity of the design": knowledge and level of preparedness-readiness of regulatory bodies to examine licensing demands of given technology

European policy developments and Euratom R&I initiatives

- NZIA, CID, Affordable Energy AP, IPCEI
- Europe's 2040 climate target
- EU SMRs Industrial Alliance
- Electricity market design
- Revamped SET-Plan
- Green taxonomy

When we speak about our energy, we have to produce more of our own energy – more renewables, more nuclear, more efficiency

Europe needs to be active because [it] cannot be behind the curve on modular reactors


European Commission
Euratom Research in Action and Opportunities for Europe
EU Strategic Autonomy and the Future Energy Systems
EU Small Modular Reactors (SMRs) Declaration
Research and Innovation


European Commission
nuclear europe
SNETP
Sustainable Nuclear Energy Technology Platform
European Industrial Alliance on SMALL MODULAR REACTORS
Strategic Action Plan 2025-2029
Towards the development and deployment of SMRs in Europe
European Industrial Alliance on SMRs 2025

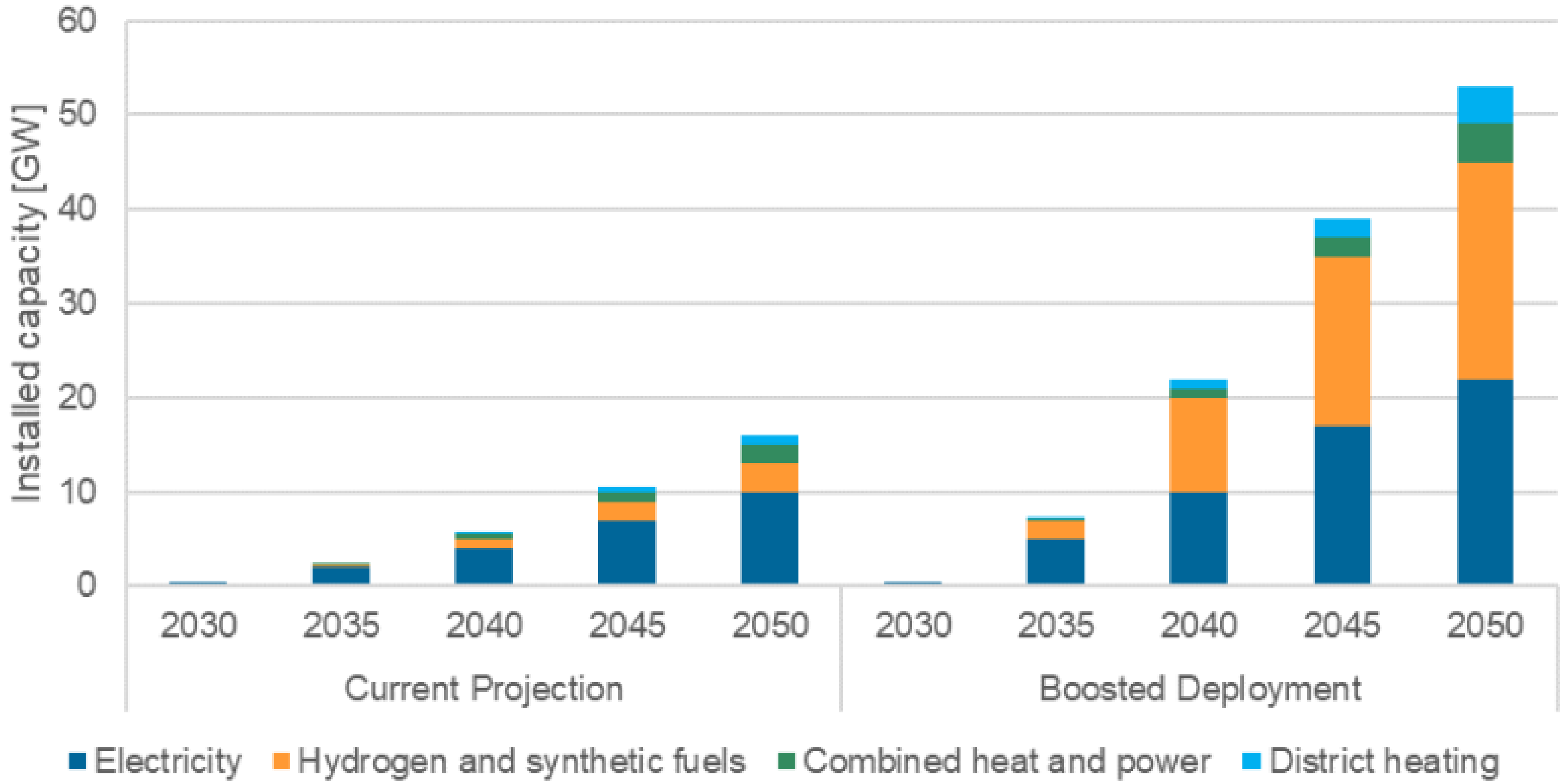
European Commission

SMR potential

- Improved safety features, such as passive safety systems
- Better financing options - reduced construction schedules
- Lower investment needs
- Fewer components

- Replacing old coal power plants
- Complementing & facilitating the penetration of RES
- Being flexibly used for: District heating; Generation of process heat for energy-intensive industries; Desalination; Production of hydrogen

SMRs deployment scenario in the EU



European Industrial Alliance on SMRs

The main objective of the European Industrial Alliance on SMRs is to facilitate and accelerate the development, demonstration, and deployment of the first SMRs projects in Europe in the early 2030s, by assisting emerging SMRs projects to reach the demonstration and deployment phase.

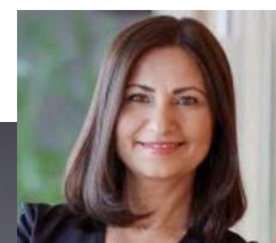
European Commission

European Industrial Alliance on Small Modular Reactors

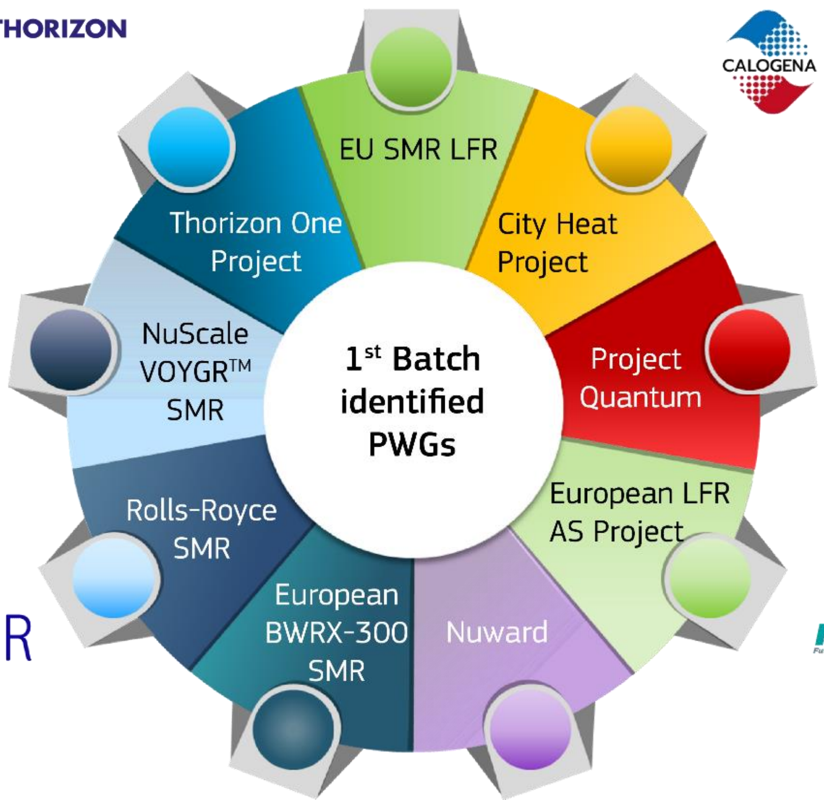
Previous and current Commissioners








European IA on SMRs



*Announced on 11 October 2024
https://ec.europa.eu/docsroom/documents/62274

European IA on SMRs – TWGs

European Commission

TWG1: Industrial Applications

Chair: N.Rega (CEFIC)
Vice Chair: A.Georgescu (Eurometaux)

TWG2: Technology and R&D&I

Chair: P.Baeten (SCK-CEN)
Vice Chair: M.Pasquet (Framatome)

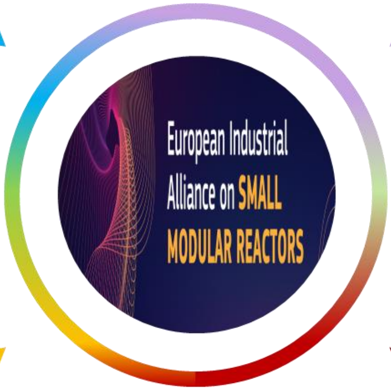
TWG3: Supply Chain

Chair: V. Ramany (EDF)
Vice Chair: M.Tacconelli (Walter Tosto)

TWG4: Skills

Chair: M.E. Ricotti (POLIMI, CIRTEN)
Vice chair: O. Bard (GIFEN).

June 2024
October 2024



TWG5: Public Engagement

Chair: : M. Martell (GMF)
Vice Chair: M. Ilnicki (SGE)

TWG6: Nuclear Safety & Safeguard

Chair: O.Kymäläinen (FORTUM)
Vice Chair: R.Arsene (Nuclearelectrica)

TWG7: Fuel cycle & waste management

Chair: H.Baars (URENCO)
Vice Chair: T.Louvet (ORANO)

TWG8: Financing

Chair: M.Jedlička (ČEZ)
Vice Chair: C.Töpfer (Vattenfall)

SMRs Hot Topics (OECD/NEA)

Hot topic 1 - SMR siting plans: proximity to population and industrial processes

Hot topic 2 – Design maturity and confidence prior construction

Hot topic 3 – Safety considerations for batteries and micro-reactors

Hot topic 4 – Reliability of passive systems

Hot topic 5 – Demonstration of Safety Case

European Commission

Small Modular Reactors (LW-SMRs and AMRs) European projects

European Commission

Small Modular Reactors (LW-SMRs and AMRs)

European projects

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Co-funded by the Euratom Research and Training Programme

Date : 19-09-2024

Research and Innovation

Euratom SMR projects

ELSMOR

McSAFER

PASTELS

harmonise
Harmonising Fission & Fusion Reactor Licensing

SASPAM-SA

TANDEM

EASI SMR

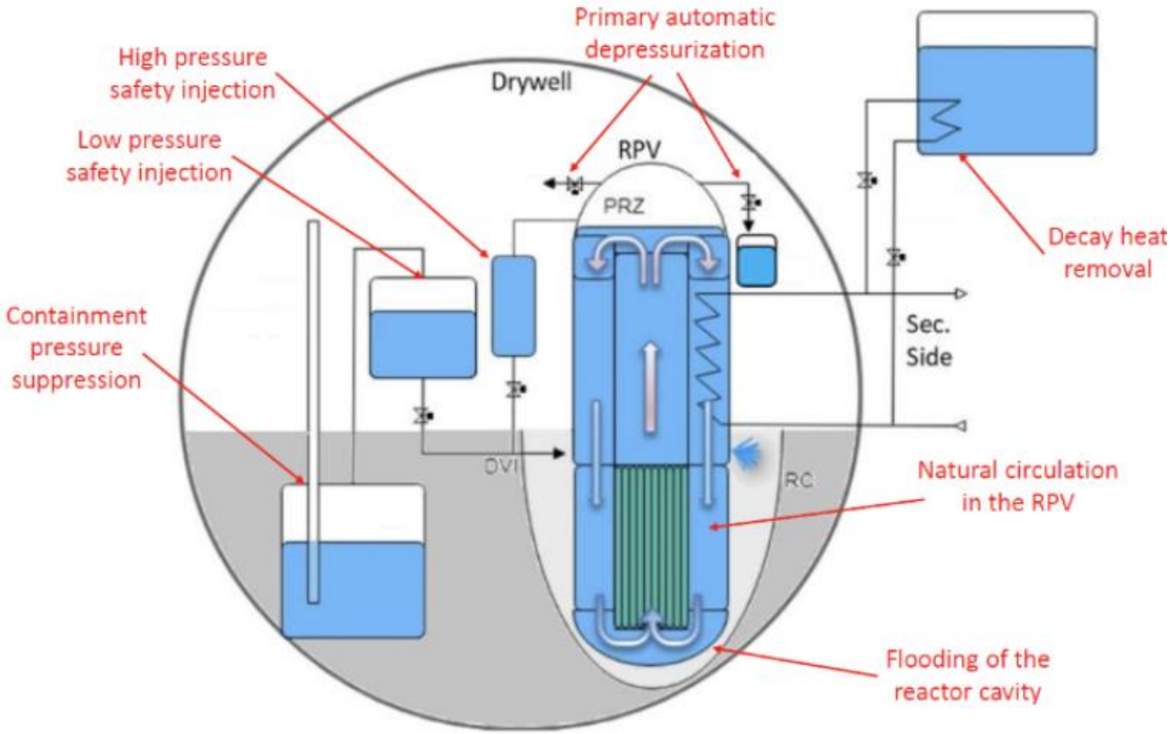
SANE

ENDURANCE

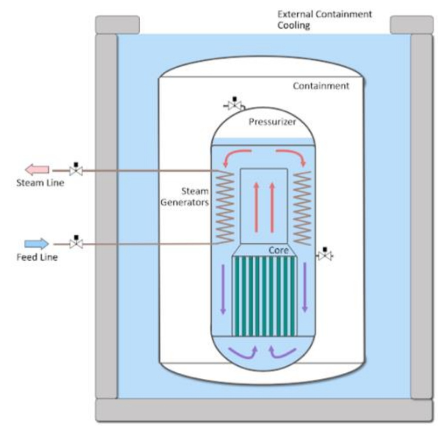
TREASURE

LESTO

LW-SMRs



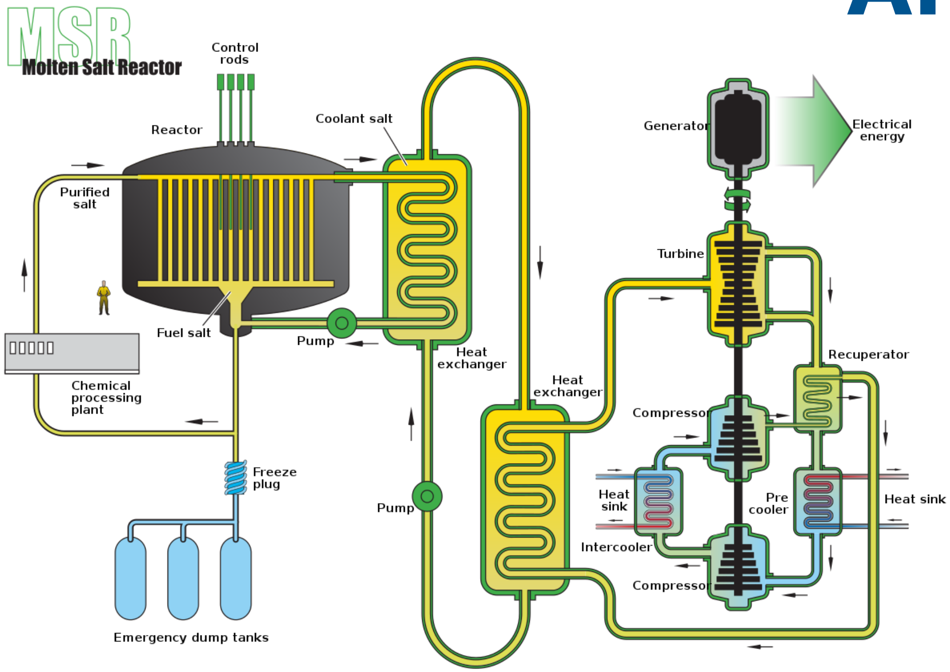
Primary automatic depressurization
High pressure safety injection
Low pressure safety injection
Drywell
RPV
PRZ
Containment pressure suppression
DVI
RC
Sec. Side
Decay heat removal
Natural circulation in the RPV
Flooding of the reactor cavity



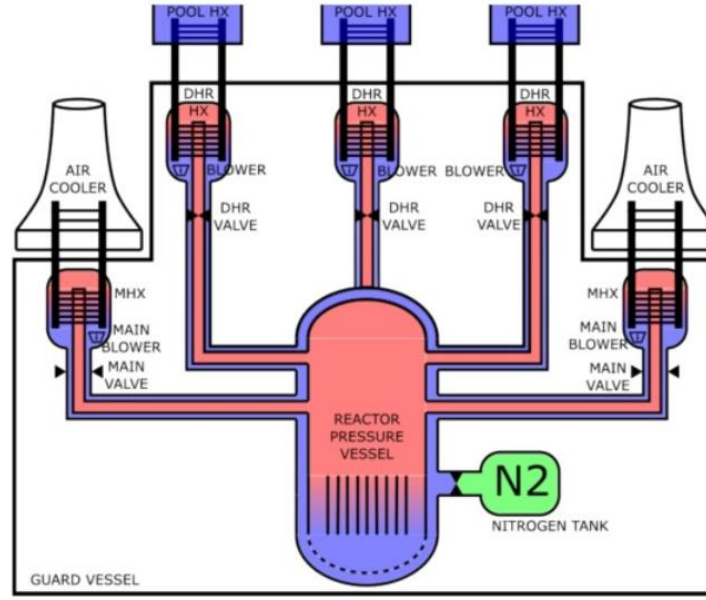
External Containment Cooling
Containment
Pressurizer
Steam Line
Steam Generators
Feed Line
Core

VTT

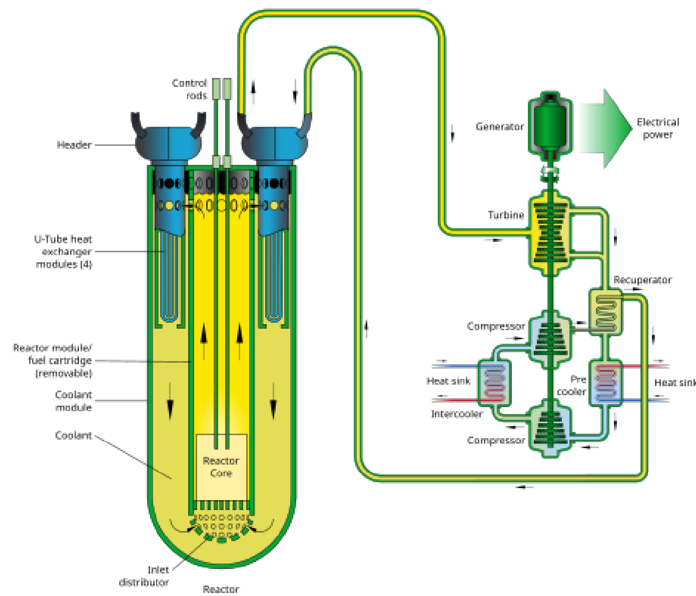
AMRs



Gas Cooled Reactor



Lead Fast Reactor



SMR projects in EU 27 (July 2025)

[Table from JRC]

Finland
- B LDR-50 SMR (District Heating)
- D Fortum: Rolls-Royce SMR

Sweden
- D Rolls-Royce SMR
- D GE Hitachi BWRX-300 SMR
- D Blykalla SEALER LFR

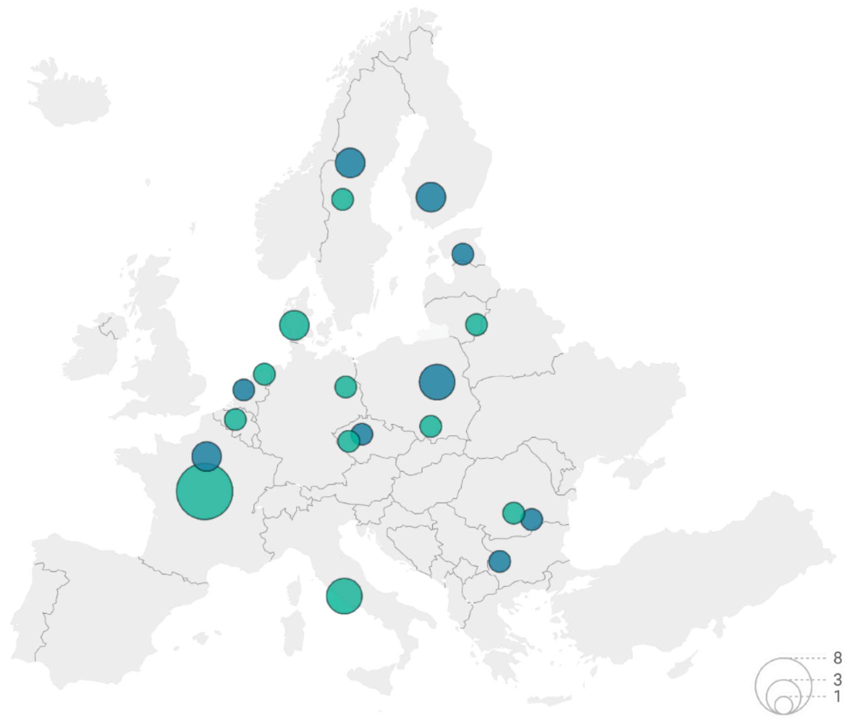
Denmark
- D Saltfoss MSR
- D Copenhagen Atomics MSR

Netherlands
- D Rolls-Royce SMR
- B Thorizon MSR

Belgium
- D EAGLES 300

France
- D Nuward - LW SMR
- D Calogena - District Heating
- B JIMMY HTGR
- D NAAREA MSR
- D Thorizon MSR
- D STELLARIA MSR
- D HEXANA SFR
- D newcleo LFR
- D BLUE CAPSULE Na-HTR

@JRC



LW-SMRs AMRs

Estonia
- B GE Hitachi BWRX-300 SMR

Lithuania
- D newcleo LFR

Poland
- B OSGE GE Hitachi BWRX-300 SMR
- B Last Energy Quantum (PWR-20)
- B NuScale VOYGR
- D HTGR POLA

Germany
- D Dual Fluid Reactor

Czechia
- B Rolls-Royce SMR
- D Energy Well MS HTR

Romania
- B RoPower NuScale VOYGR
- B EAGLES 300

Bulgaria
- B NuScale VOYGR

Italy
- B newcleo LFR
- D SMR SOLO MMR (HTGR)
- B EAGLES 300

Identified by the Industrial Alliance on SMRs

B EoI to built

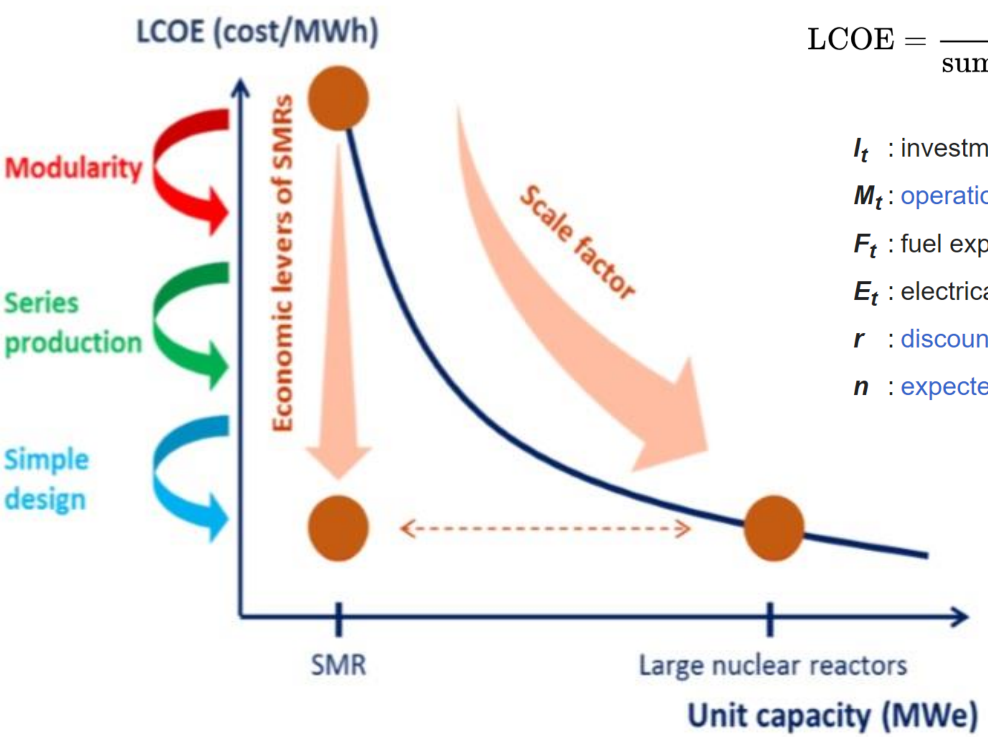
D Development & Analysis

Light Water SMR (LW SMR)

Advanced Modular reactors (AMR) Gen IV

SMRs Levelized Cost Of Electricity (LCOE)

measure of the average net present cost of electricity generation for a generating plant over its lifetime



$$\mathrm{LCOE} = \frac{\text{sum of costs over lifetime}}{\text{sum of electrical energy produced over lifetime}} = \frac{\sum_{t=1}^{n} \frac{I_t + M_t + F_t}{(1+r)^t}}{\sum_{t=1}^{n} \frac{E_t}{(1+r)^t}}$$

I_t : investment expenditures in the time interval t

M_t : operations and maintenance expenditures in the time interval t

F_t : fuel expenditures in the time interval t

E_t : electrical energy generated in the time interval t

r : discount rate

n : expected lifetime of system or power station in number of time intervals of t

Focus on TANDEM

Small Modular ReacTor for a European sAfe aNd Decarbonized Energy Mix

C. Schneidesch (Engie-Tractebel, Belgium)

Workshop on Small Modular Reactors (SMRs) for District Heating, online, October 22, 2025.

TANDEM

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The energy trilemma

The EU ambitious targets to achieve the decarbonization are driven by the energy trilemma (**environmental sustainability, energy security, energy equity**)

The ENERGY trilemma

Sustainability

The **decarbonized energy mix** must be diversified to be **robust and versatile**

Security of supply

Security of supply and **sovereignty** are strategic features

Affordability

The **total system costs** must be such that it allows competitiveness of the industry

.... Which also drives the energy market

Energy market trends

- Decarbonized energy production CO_2
- Variable renewable energy
- Decentralized energy production
- Emerging sectors/countries

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Analysis of the energy context: EU energy needs

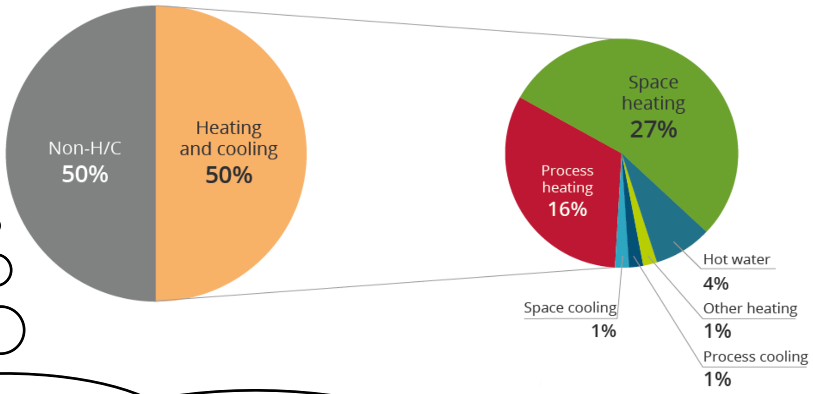
Energy market in EU

(from the European Industrial Alliance on SMRs)

Electricity	Hydrogen	Industrial heat	District heat
1600 TWh/y EU Low carbon electricity production to be deployed by 2040	**>20 Mt H_2/y** REPowerEU Market Estimate for 2030	**~1250 TWh_{th}/y** Iron – Steel, Non-metallic minerals and chemicals heat demand in EU	**~500 TWh_{th}/y** Current district heat demand in EU
80GW European Nuclear capacity to be replaced by 2050 (end of life)	**1000 TWh/y** Equivalent additional clean electricity demand	**> 45% market** Heat < 400°C	**> 2/3 fossil- fueled** Assets to be retired and replaced in the coming two decades
	>125 GW Equivalent nuclear capacity		

Heating and cooling: current needs

(from Heat Roadmap Europe)



The demand for low-carbon heat is enormous!
Order of magnitude: EPR2: ~14 TWhe/y
or ~40 TWhth/y

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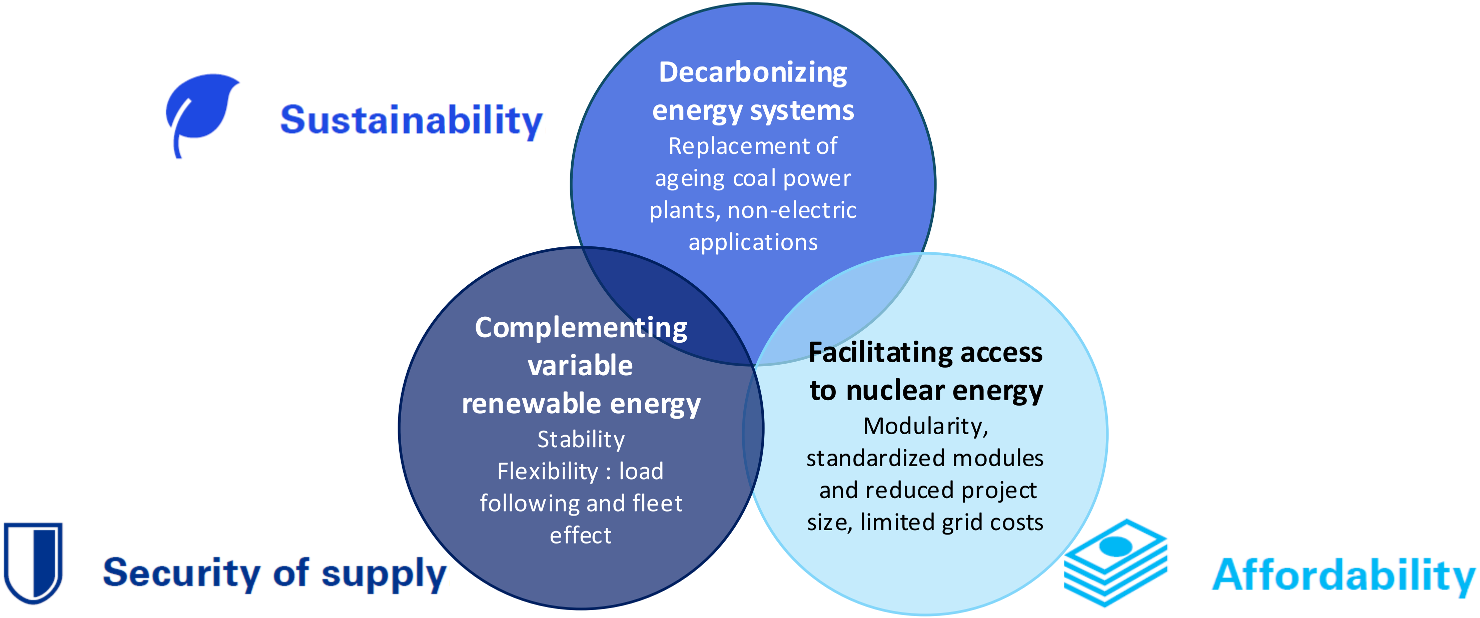
Nuclear for energy transition

Nuclear power generation technologies and SMRS in particular offer overarching carbon-neutral opportunities to be cornerstones of tomorrow's energy ecosystems



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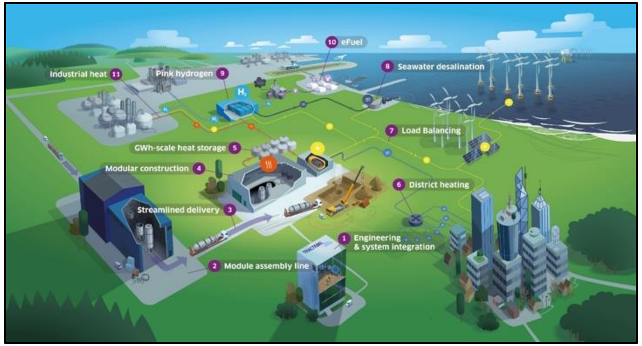
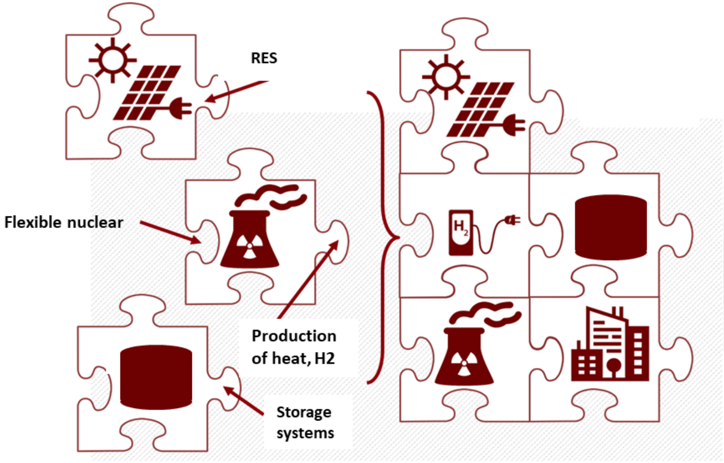
TANDEM project to support the safe and cost-effective integration of SMRs within low-carbon hybrid energy systems

Urban area



Industrial zone

How can all low-carbon energy sources, thermal and electrical storage systems and the production of energy carriers ***be combined to meet the energy demand*** *in the future EU sustainable, reliable and affordable energy mix ?*



Courtesy of Tractebel

TANDEM

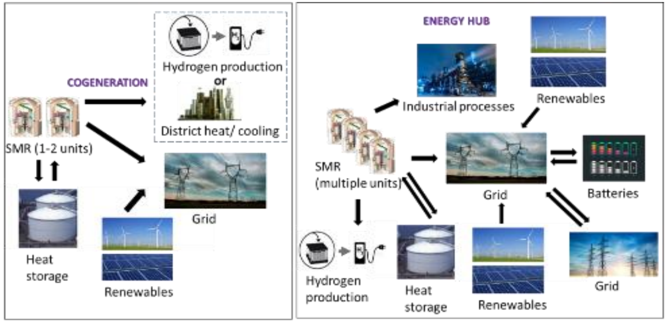
TANDEM project (2022-2025)

Website: https://tandemproject.eu/

TANDEM: Small Modular ReacTor for a European sAfe aNd Decarbonized Energy Mix

High-level objectives:

- Assess the **safety compliance** of **SMRs** to be **integrated** in the future European energy mix
- Provide **guidance in a deployment perspective** for the future integration of SMRs and AMRs into well-balanced hybrid energy systems
- **Create an enabling environment** for the development of hybrid energy systems based on SMRs and AMRs



Ambitions of TANDEM:

- **Promote versatile SMRs integrated within hybrid energy systems** as reliable, resilient, and affordable clean energy options in Europe
- **Become a pioneering initiative** in gathering efforts and expertise on the development of SMR integration within hybrid energy systems in Europe

TANDEM

Overall methodology implemented in TANDEM

Identification of Hybrid Energy Systems (HES) incorporating SMRs to be used as demonstration cases

→ **Harbour-like energy hub and two district heating configurations based on EU scenarios**

Development and implementation of tools for HES-SMRs assessment

→ **TANDEM models library for configuring HES simulators**

Safety and feasibility studies for HES-SMRs assessment
Citizen engagement cases

→ **Techno-economics, operational and safety analysis leading to recommendations, policy briefs**

Building enabling environment for future projects and initiatives

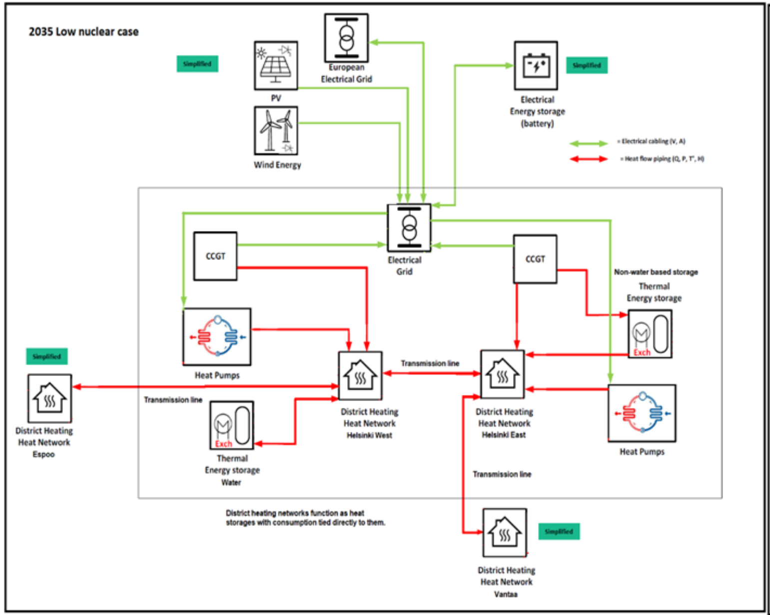
→ **Scientific and industrial collaboration**
Approaches for public acceptance and stakeholders awareness

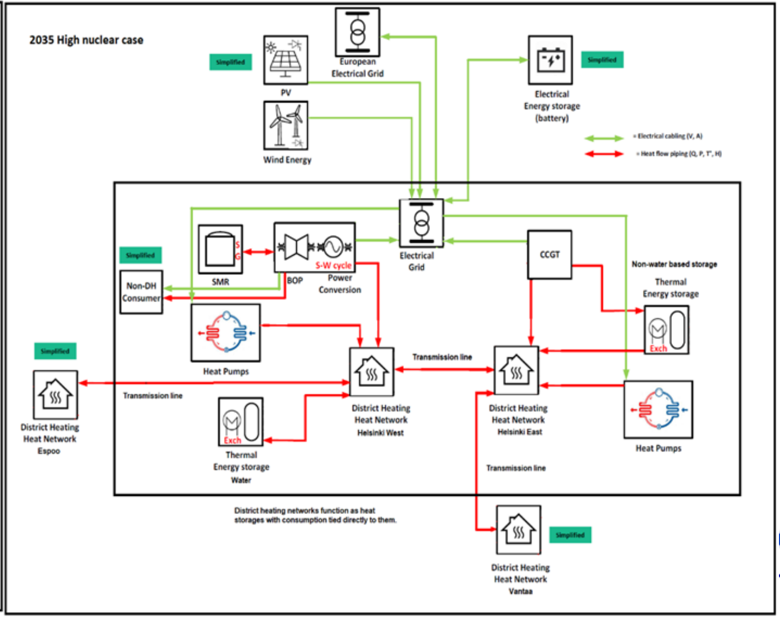
TANDEM

Main TANDEM outcomes for district heating application (1/3)

Website: https://tandemproject.eu/

- **Definition of two use-cases: 1/ Metropolitan area of Helsinki in Finland and 2/ Moravian-Silesian region in the Czech Republic**





Main TANDEM outcomes for district heating application (2/3)

Website: https://tandemproject.eu/

- **Results of the demonstration cases on SMR integration within hybrid energy systems:**

Technical performances

- ✓ Nuclear reactors providing district heating network: not a new concept !
- ✓ Different SMR design working for heat-only production or cogeneration mode: choice of the design depends on the needs and the local context
- ✓ Benefit in term of flexibility for the energy supply (dispatchable energy)

Safety

- ✓ SMRs providing district heating: same safety perspective as SMRs producing only electricity

Techno-economics

- ✓ SMR economic viability possible for application in district heating

Environmental impact

- ✓ Minimization of CO2 emissions possible

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Main TANDEM outcomes for district heating application (3/3)

Website: https://tandemproject.eu/

- **Contribution to Citizen engagement:** organisation of three workshops with citizen panels in Finland and the Czech Republic

- **Synthesis of the project:**
  - ✓ **Delivery of policy briefs**: on financing and economics, public acceptance, regulatory requirements and for policy-makers at different levels (European, national, local)
  - ✓ **Delivery technical recommendations** for the industrial and R&D communities
    - ✓ Importance of input data in the problem definition, cross-check and benchmarking are paramount
    - ✓ KPIs should include all components of the trilemma and no only economical factors

TANDEM consortium

Belgium: nucleareurope TRACTEBEL ENGIE enen European Commission

Czech Republic: ÚJV

Finland: VTT fortum

France: cea EDF ASNR Autorité de sûreté nucléaire et de radioprotection

Germany: GRS

Italy POLITECNICO MILANO 1863 UNIVERSITÀ DI PISA ENEA ansaldo nucleare

Spain: EMPRESARIOS AGRUPADOS

Ukraine: ENERGORISK

18 partners from 8 European countries, composed of: universities, RTOs, TSOs, industrials and engineering organizations

TANDEM

Get in touch for more information:

Christophe Schneidesh and Claire Vaglio-Gaudard

WP1 leader and Coordinator of the TANDEM project

[christophe.shcneidesch@tractebel.engie.com / claire.vaglio-gaudard@cea.fr](mailto:christophe.shcneidesch@tractebel.engie.com)

https://tandemproject.eu/

https://www.linkedin.com/company/tandem-project-eu/

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TANDEM

EASI-SMR:
Ensuring Assessment of Safety Innovations for SMR

SMR for district heating workshop – October 22, 2025 – Online

Nicolas Sobecki (EDF, France)
Coordinator of the project

FUNDED BY

Co-funded by the European Union

UK Research and Innovation

The Research Council of Norway

Project funded by

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Swiss Confederation

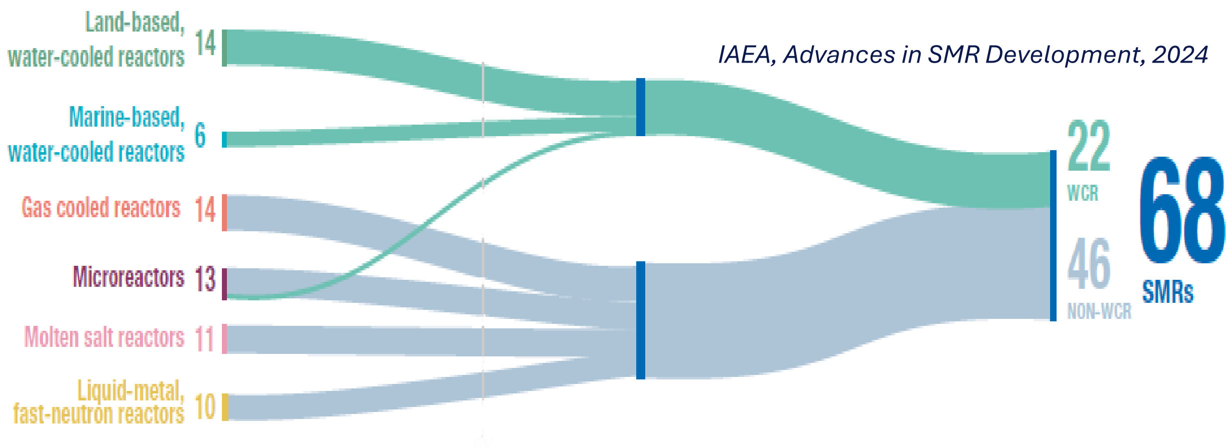
Federal Department of Economic Affairs, Education and Research EAER
State Secretariat for Education, Research and Innovation SERI

POWERED BY

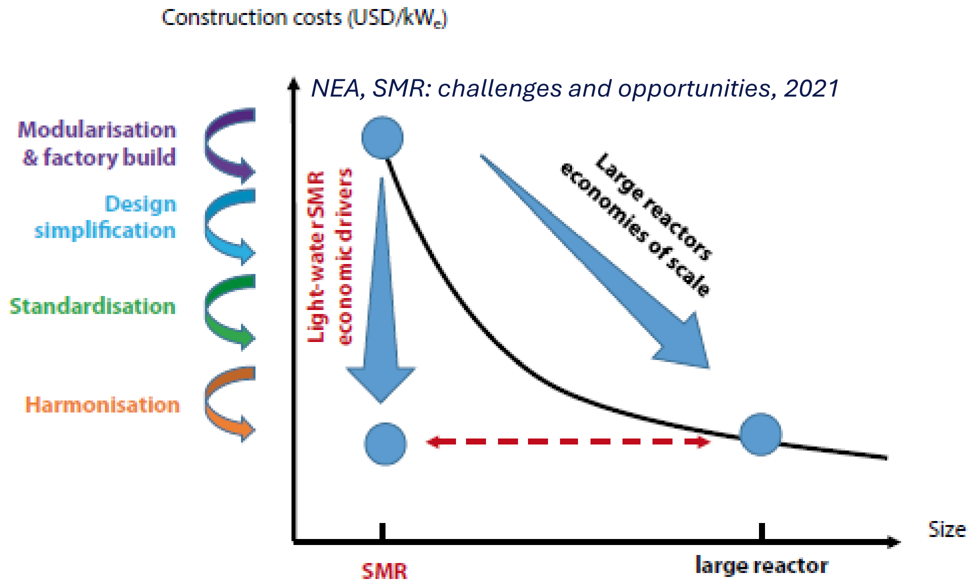
nuward SMR

Steady Energy

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

EASI SMR

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

Modularisation

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

Additive manufacturing

- **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

- Delevoment of **digital twins**
- Delevoment 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

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

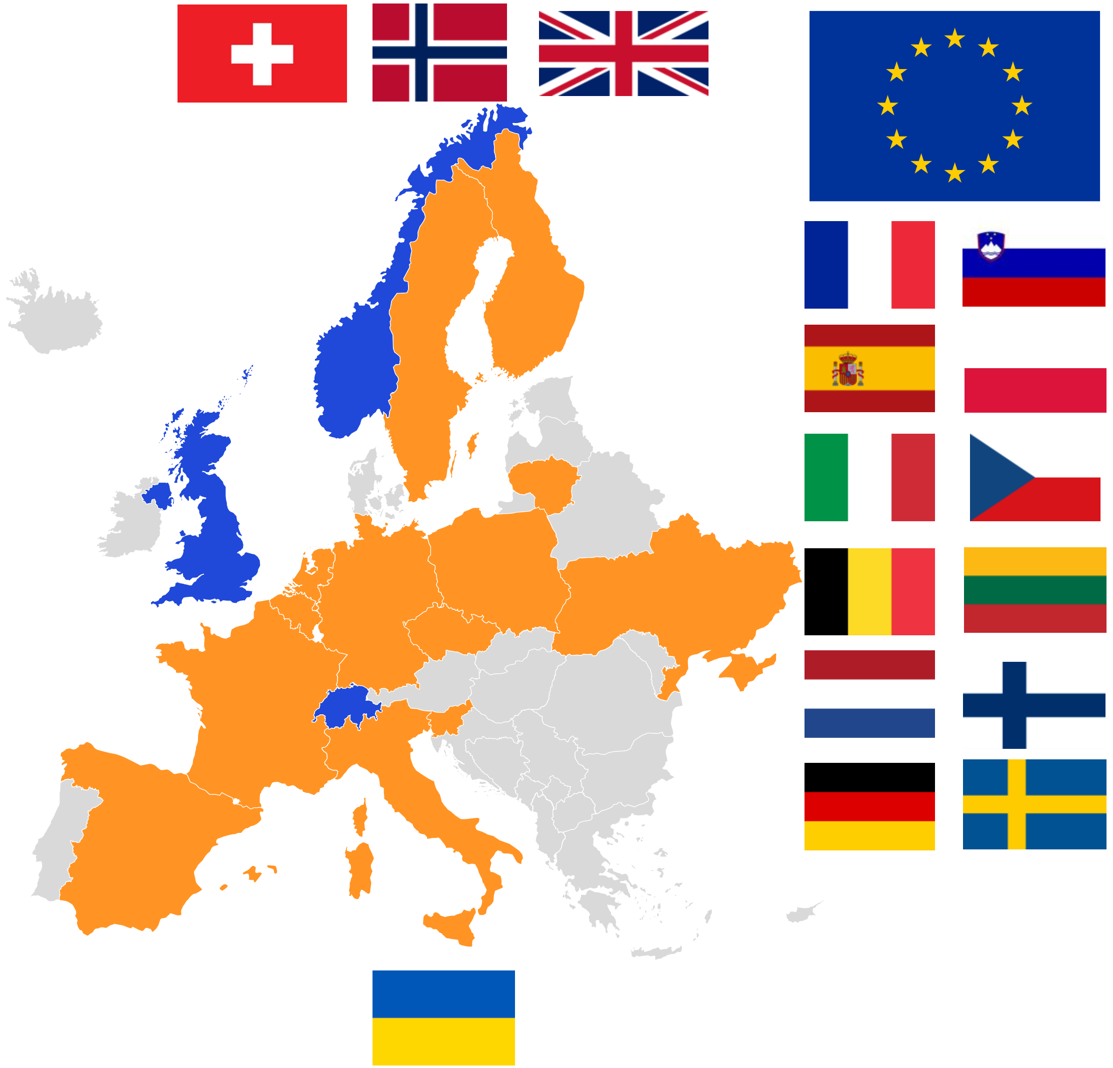
3 HIGH-LEVEL OBJECTIVES:

- 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

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



Industrial designs of reference

NUWARD SMR nuward SMR

- Developed by nuward EDF GROUP, an EDF subsidiary
- Technical features:
  - Based on PWR technology
  - 400MWe + 100MWth 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

Overview of the project

WP1: Transverse topics for LW-SMR acceptability and licensing

- Licensing, waste management, stakeholder engagement
- Co-location of SMR
- Hybrid energy system analysis

WP8: Communication, Education and Training

- Dissemination of the project results
  - 4 workshops and 2 schools

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

- Neutronic calculation of boron-free core evolution
- Multiphysics transient calculations

WP2: Experimental test program

- SETF Thermohydraulic experiments on passive systems phenomena

WP9: Project coordination

WP6: SG Mock-up by additive manufacturing techniques

- Mockups design and fabrication
- Mechanical, geometrical and chemical characterization of the mockups

WP3: Code validation, scaling

- Code benchmarks
- Definition of an integral facility test

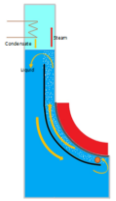
WP4: Reliability of passive systems

- PSA and DSA of passive systems
- Human reliability and Multi-units

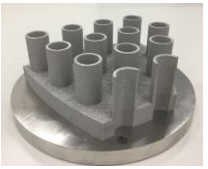
WP5: Human & Organizational Factors

- Simulation of multi-units SMR operation with passive systems
- Supply-chain, cybersecurity analysis, SMR maintenance

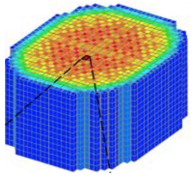
Expected impacts of the project



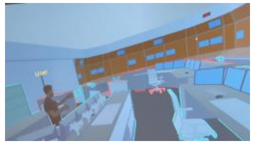
- **Increasing knowledge** on passive systems physics to improve their safety assessment.



- **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.

Partners

aimen TECHNOLOGY CENTRE
ARB Analytical Research Bureau
ansaldo nucleare
University of Sheffield / AMRC Advanced Manufacturing Research Centre
BEL V Belgian TSO
cea
Ciemat Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas
CIRTEN
LOR
EDF
enen
ENEA
ENERGORISK
ETH zürich
European Commission
framatome
GRS
HZDR HELMHOLTZ ZENTRUM DRESDEN ROSSENDORF
ASNR Autorité de sûreté nucléaire et de radioprotection
IFE Institute for Energy Technology
Jožef Stefan Institute
JÜLICH Forschungszentrum
KIT Karlsruher Institut für Technologie
KTH VETENSKAP OCH KONST
LEI LITHUANIAN ENERGY INSTITUTE
LUT University
NCBJ
N.IN.E.
NRG PALLAS Nuclear. For Life.
ÚJV NUCLEAR RESEARCH INSTITUTE
PSI
RUHR UNIVERSITÄT BOCHUM RUB
SSTC NRS STATE ENTERPRISE STATE SCIENTIFIC AND TECHNICAL CENTER FOR NUCLEAR AND RADIATION SAFETY
SIET sperimentiamo le tue idee
SWERIM
TRACTEBEL engie
VTT

Co-funded by the European Union
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The Research Council of Norway
Project funded by
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State Secretariat for Education, Research and Innovation SERI

Funding acknowledgment

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Co-funded by
the European Union

EASI SMR

Thank you

Contact us: contact@easi-smr.eu

Join us on LinkedIn @easi-smr

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The Research Council of Norway

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Confederazione Svizzera
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POWERED BY

nuward SMR

Steady Energy

R&D&I roadmap based on EU SMR pre-Partnership

CORE AND FUEL (INCL CRDM)

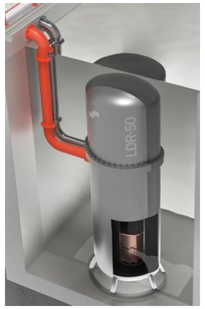
- Fuel assembly and reflector design
- **Boron free core:** use of burnable poisons, long term insertion of CR
- Accident tolerant fuels
- Critical heat flux performance evaluation
- Fuel, cladding limits and safety rules
- **Innovative multiphysics and multiscale modeling and V&V**

NSSS AND ITS INTERNALS

- Reactor internal hydraulics (incl vibrations)
- In-service inspection
- Specific components and materials (CRDM, pumps, **CSG), advanced manufacturing**

PASSIVE SAFETY SYSTEMS

- **Lack of experimental data**
- **Validation of safety analysis codes**
- **Reliability:** adapt safety assessment methodologies
- Investigate performance and maintenance



R&D gaps for LW-SMR
Expand NUWARD and LDR-50 knowledge base

SEVERE ACCIDENTS

- Experimental and analytical needs for SA scenarii
  - RPV integrity (**IVR**)
  - Containement integrity (H2, inertization)
- Dose calculation (**EPZ**)

USES BEYOND ELECTRICITY

- **Hybridization**
- **Co-location**
- Technical-economic analysis
- **Public acceptance**

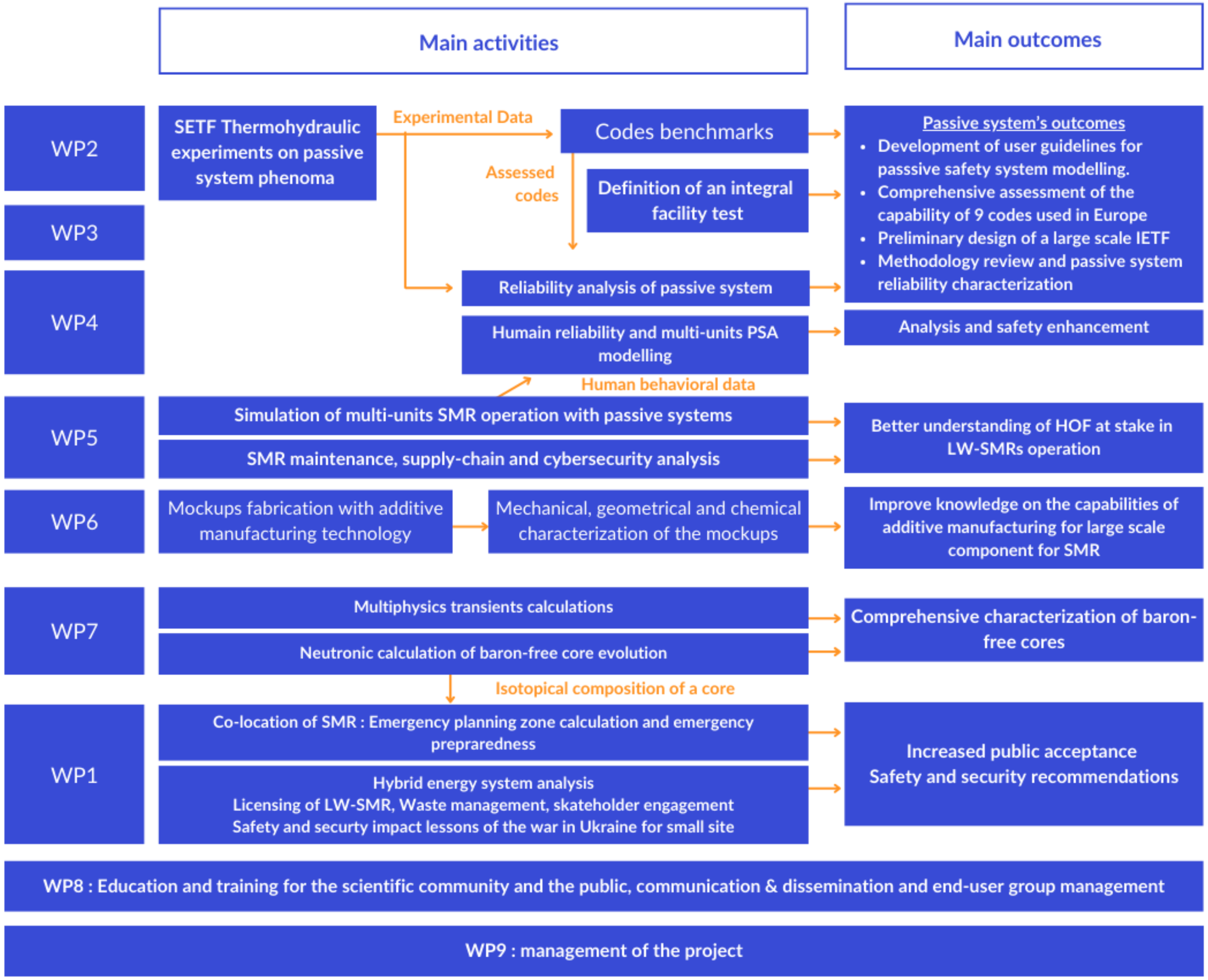
HUMAN FACTORS

- **Multi-unit operations**
- **Passive safety systems**
- Operating multiple processes (hybridization)
- **Human reliability analysis methodologies**

MODULARIZATION

- Advanced construction techniques (SCS,…) and its qualification
- Transportation
- Interface management

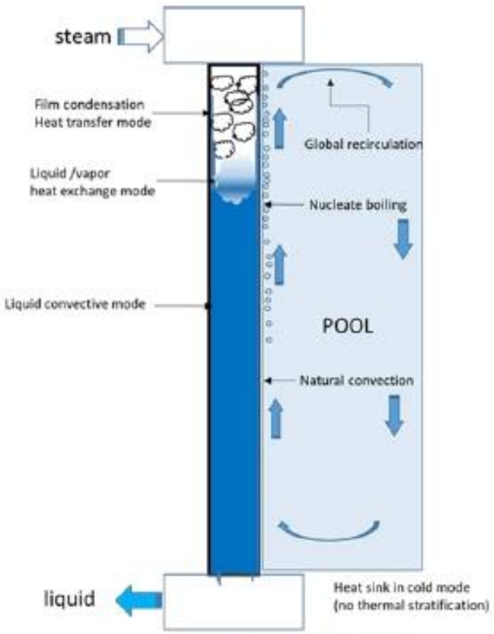
EASI-SMR Project structure



EASI SMR

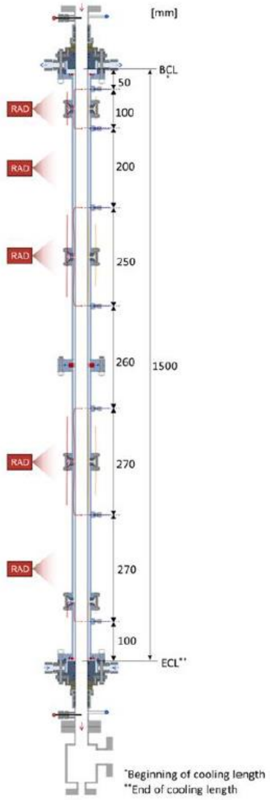
Experimental test program

COSAC:
- SET
- **Condensation** in **SACO** tube

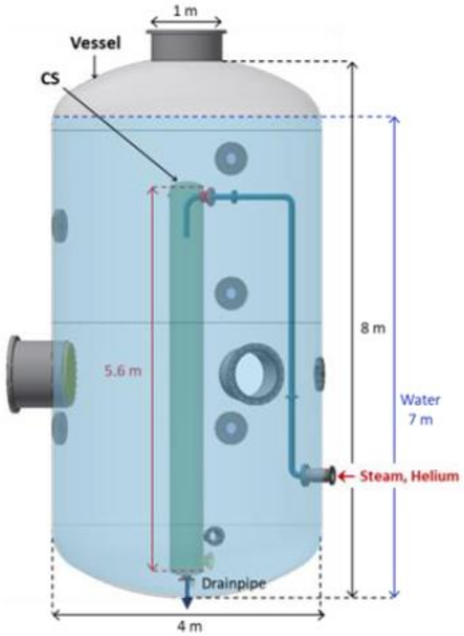


Single tube configuration

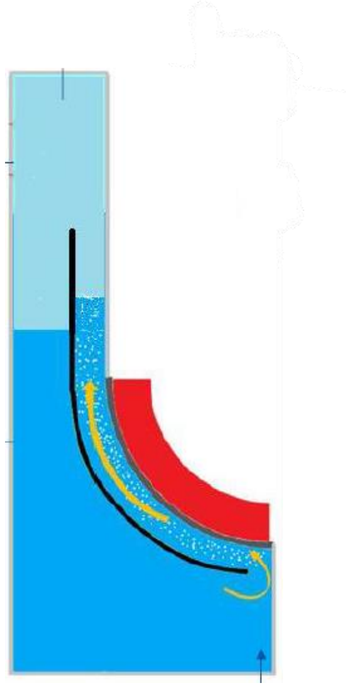
PRECISE:
- SET
- **Condensation** in **SACO** tube (CFD approach)



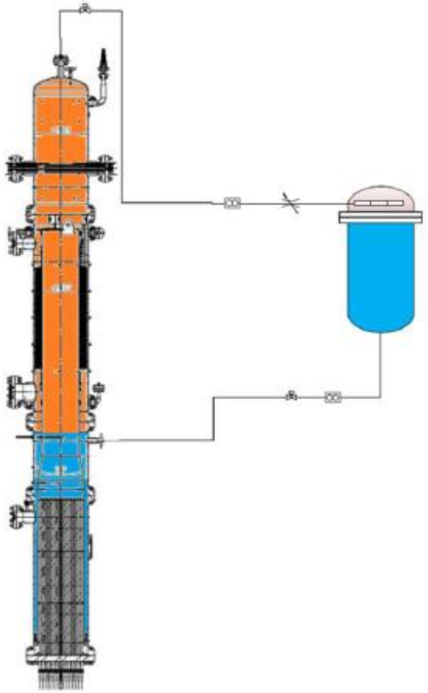
PANDA:
- SET
- **High Ra natural convection** in heat sink



IVR LOOP:
- SET
- **IVR**: thermosiphon and pool boiling mode



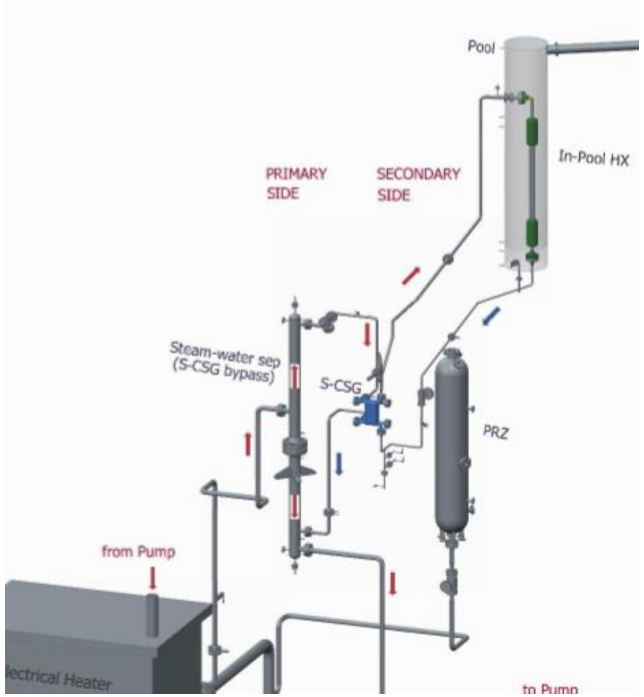
GRADAC:
- SET
- Pressurization and injection phase of a **gravity accumulator**



EASI SMR

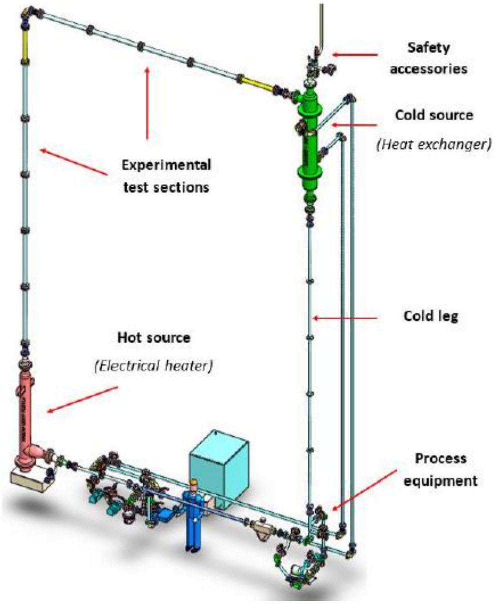
Experimental test program

ELSMOR II:
- sIET
- **SBO transient** and **NCG effect** in the **S-CSG**

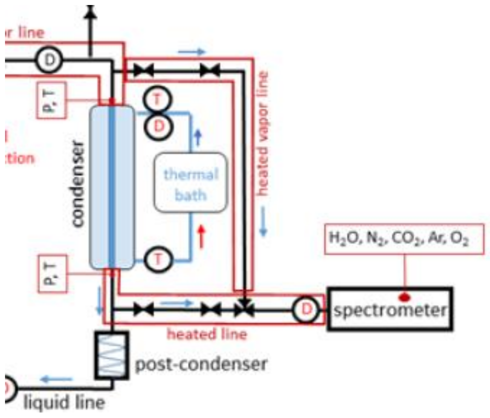


FHEASIK:
- sIET
- **DHRS performance** of the **LDR50**

ALCINA:
- SET
- **Thermosiphon** performance of Safety Condenser



ECRINS:
- SET
- **Condensation** heat transfer in **Mini channels with NCG**



EASI SMR

SANE

Safety Assessment of non-electric uses of nuclear (SANE)

Workshop: Small Modular Reactors (SMRs) for District Heating

Oct. 22, 2025

Atte Helminen (VTT), Manager of SANE project

Funded by the European Union

Project funded by

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Swiss Confederation

Federal Department of Economic Affairs, Education and Research EAER
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The objectives of SANE

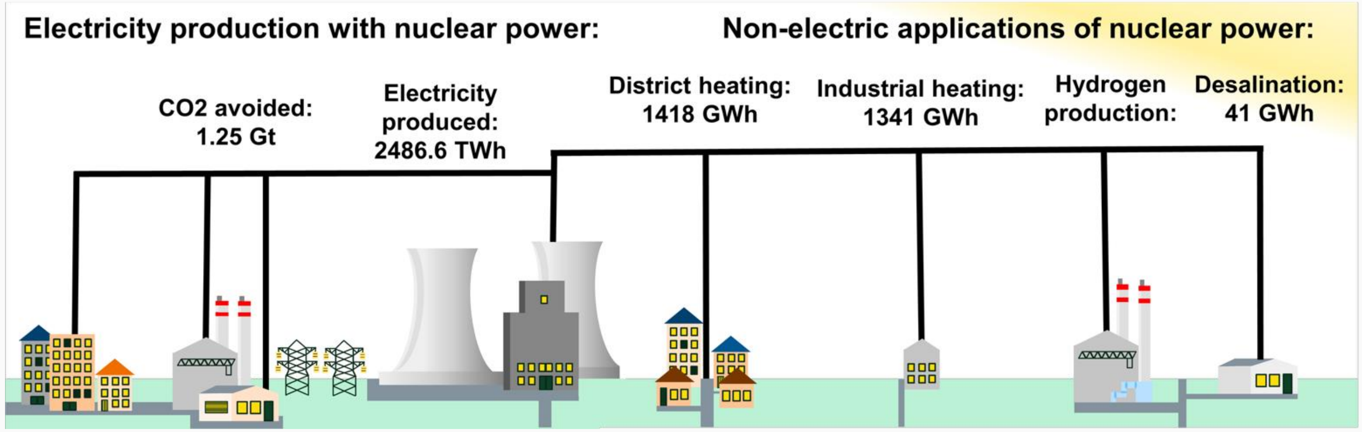
The main objective of SANE is to investigate the potential of nuclear energy to supply services other than electricity

Specific objectives:

- Increasing understanding of non-electrical uses of nuclear energy
- Improving safety assessment methodologies of nuclear reactors meant for non-electric uses
- Producing information to support radioprotection of population
- Assessing the performance, and improving the safety assessment methodologies, of nuclear reactors coupled to non-electric end-uses
- Development of risk communication strategies related to non-electric applications of nuclear energy

Project started on Sept.1, 2024; Duration 36 months; 11 participating organizations from 9 European countries; EU contribution approx. 3.5 M€

Non-electric applications exist but are rare



SANE aims to facilitate path towards their potential

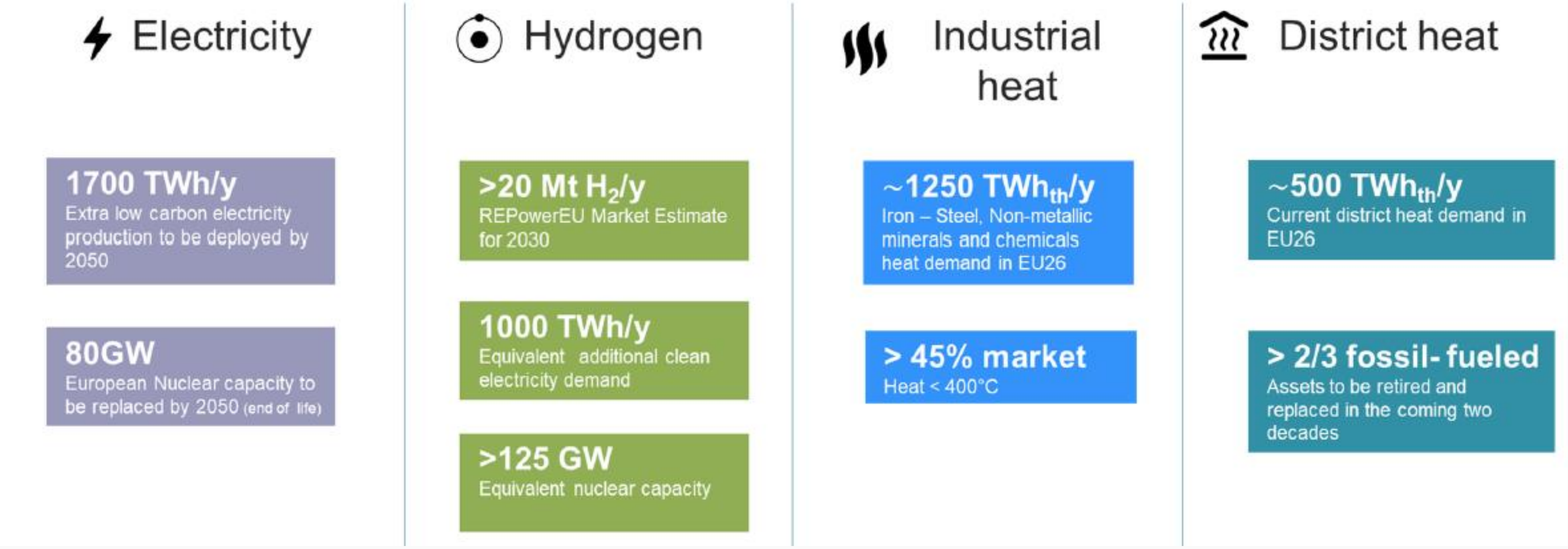
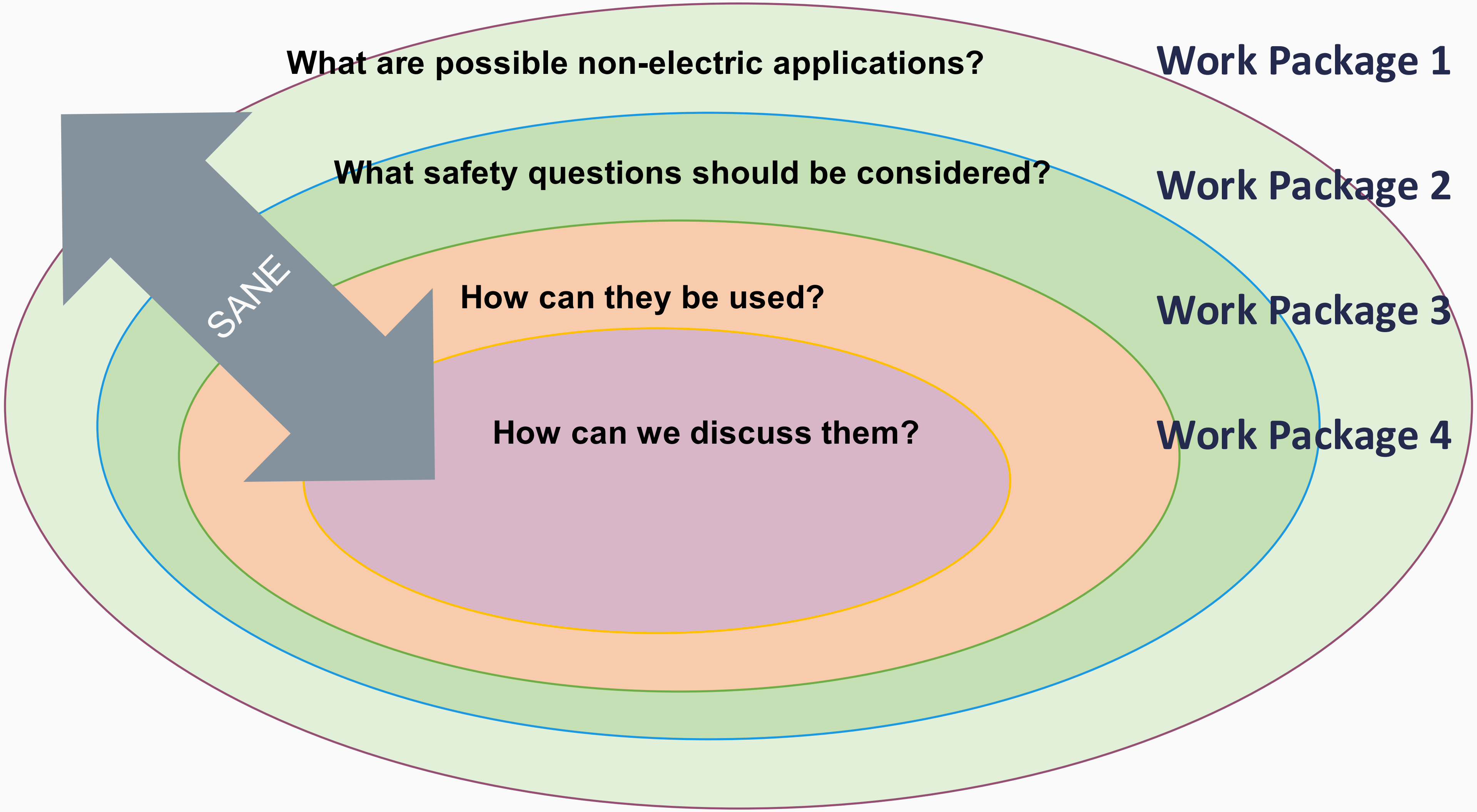


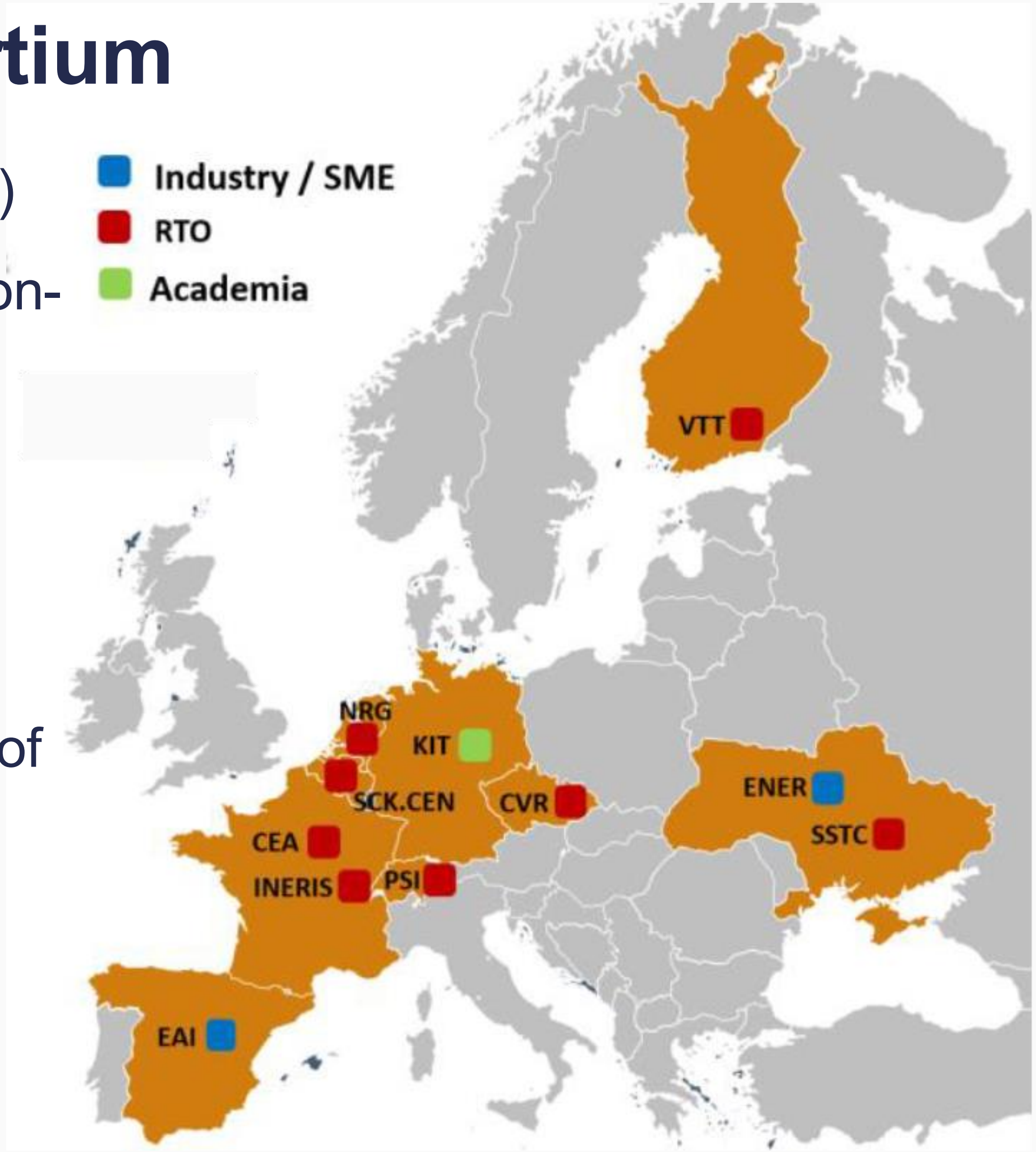
Figure from European SMR pre-Partnership – Workstream 1 – Market Analysis report

Research questions



SANE WP Structure and Consortium

- WP1: Feasibility of non-electric uses (lead: PSI)
- WP2: Safety of nuclear reactors intended for non-electric uses (lead: VTT)
- WP3: Performance and safety of non-electric end-use cases (lead: NRG)
- WP4: Risk communication (lead: KIT)
- WP5: Training, Dissemination and Exploitation of Results (lead: CVR)
- WP6: Project Management (lead: VTT)



Work Package 1

What are possible non-electric applications?

Feasibility of non-electric uses

The main objective is to assess potential of non-electric uses of nuclear energy over a wide range of future applications.

- A high-level overview of potential non-electric uses of nuclear energy and its integration with renewables.
- Case studies of selected applications considered to be of high importance for Europe in the middle and long term, e.g. e-fuels, process industry, ***district heating***, desalination, hydrogen production, direct air capture of CO_2, and propulsion for ship and space applications.

Work Package 2

What safety questions should be considered?

Safety of nuclear reactors intended for non-electric uses

Safety of non-electric uses of nuclear energy is studied through case studies centered around a low temperature district heating reactor concept.

- Suitability of conventional safety assessment tools for analysis of Design Basis Accidents and Severe Accidents in a non-electricity-producing nuclear reactor.
- The scope is generalized from the district-heating use case by consideration of safety concepts, criteria and terminology, and how they differ from conventional nuclear power plants.

Work Package 3

How can they be used?

Performance and safety of non-electric end-use cases

The objective is to assess the safety of non-electric end-uses of nuclear energy and the feasibility of the coupling between a nuclear power plant and its non-electric use by for instance process industry plant

- Different couplings to be investigated, for example district heating, hydrogen production, direct air capture, and synthetic fuel generation.
- Various NPP designs will be investigated in order to cover both low temperature processes as well as high temperature processes.

Work Package 4

How can we discuss them?

Innovations in risk communications

General objective is exploring and identifying the ways to improve communication of risk arising from the operation of a nuclear power plant “in your backyard” by

- Using safety study information for communicating the risk associated to the novel reactors.
- Through case studies in three different countries (Finland, Belgium, Netherlands) studying the needs of stakeholders and public, when new nuclear technologies are announced to be deployed.
- The lessons learned from crisis and emergency risk communication related to ZNPP in Ukraine and abroad during 2022-2023.

Work Package 5

Dissemination, exploitation and training

Aim of the work package is to handle the communication, dissemination, exploitation, and training activities, such as

- Communications activities to increase awareness of non-electric applications,
- Dissemination and exploitation activities to increase impact of research results
- Fostering of industrial end-user group to provide important insight to research, and
- Organizing workshops and training.

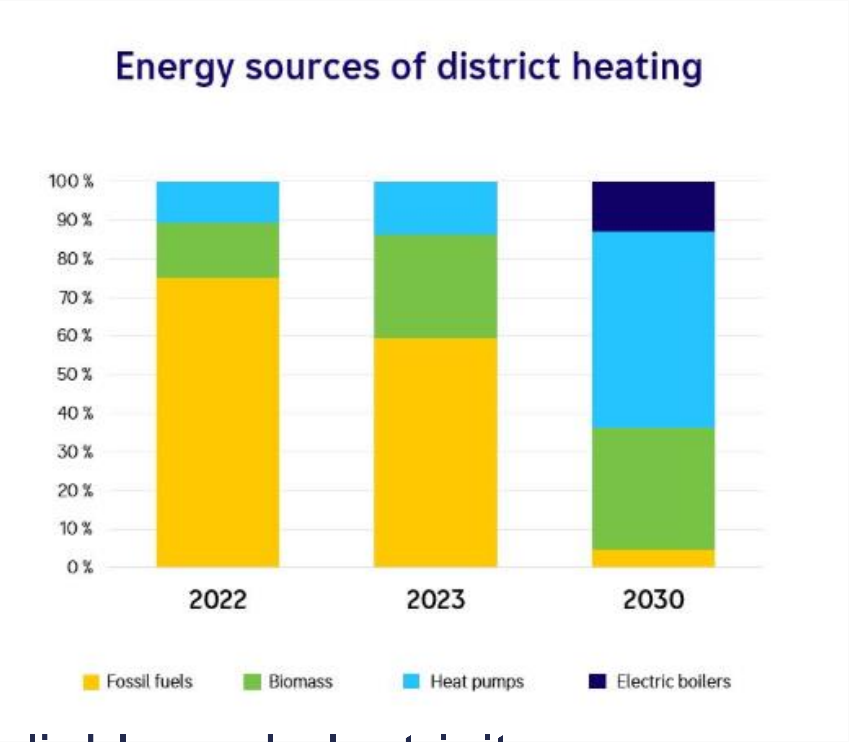
Finnish Case Study: District heating SMR in capital area

After shutdown of Salmisaari power plant in the heart of Helsinki on April 1, 2025, Finland practically stop using coal for electricity and heat production.

The Hanasaari B power plant was commissioned in 1974 as a coal-fired power plant. Photo by Matti Mattila via Wikimedia Commons under CC BY 2.0

Case study: Finland

- Helen Ltd - owned by the City of Helsinki- provides electricity, heating and cooling to its customers
  - Helen's ultimate goal is to achieve non-combustion energy production by 2040.
  - To achieve this goal, use of SMRs are investigated in Helen’s nuclear energy programme.
  - Negotiation with potential partner shareholders, evaluate plant suppliers and determine potential plant sites.
  - The first phase of is due to be completed in 2026.



- Replacement of combustion energy requires a steady, reliable and electricity-independent heat source that can be located near the district heating network.
- Helen is one of the Industrial End User Group members of SANE project.

Reference: https://www.helen.fi/en/about-us/sustainability/carbon-neutrality-programme

Case study: Finland

May 6, 2025

Steady Energy to build small nuclear pilot plant inside a former coal plant in central Helsinki

Reference: https://www.steadyenergy.com/news-article/steady-energy-to-build-small-nuclear-pilot-plant-inside-a-former-coal-plant-in-central-helsinki

Picture source: Wikipedia.org

Regulatory reform creates space for new plant solutions

The starting points of the reform are to modernize legislation, **develop licencing and regulation to become more risk-informed and enable the adoption of new technologies and business models.** The Ministry of Economic Affairs and Employment's objective is to process the law during the current Parliament. STUK's regulations are prepared in the same schedule.

"Addressing the issues related to small modular reactors is linked to STUK's regulatory work. The reform takes into account the issues raised with the **small modular reactors, such as their location close to settlements, possible remote use, new operating models for the use of plants and applications other than electricity generation, for example, district heating**. When developing the regulations, we engage in active discussions with our stakeholders, other authorities and the industry," says Jussi Heinonen, Director responsible for the regulation reform

Reference: https://stuk.fi/en/stuk-makes-preparations-for-the-arrival-of-small-modular-reactors

SANE

Thank you

Follow SANE project: https://www.sane-euratom.eu/

Funded by Euratom Research and Training Programme.
The Associated Partner PSI is funded by the Swiss State Secretariat for Education, Research and Innovation (SERI).
Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union, Euratom Research and Training Programme.

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WORKSHOP: SMRs FOR DISTRICT HEATING
October 22d, 20225

A. AL MAZOUZI

nucleareurope
SNETP
Sustainable Nuclear Energy
Technology Platform

EU Energy & Industrial Policies

EU Climate Neutrality Objective

The EU sets a goal to achieve climate neutrality by 2050.

REPowerEU Roadmap

A strategy to phase out Russian oil and gas, restrict nuclear materials imports, and accelerate the clean energy transition.

Competitiveness Compass

A roadmap to revitalise Europe's economic dynamism and foster sustainable growth

Clean Industrial Deal

An initiative to support the reduction of carbon emissions in energy-intensive sectors

Affordable Energy Action Plan

A plan to lower energy prices and reduce overall energy costs

EU Start-up & Scale-up Strategy

A strategy to promote innovation-friendly regulation and enhance access to finance.

Amendment to EU Climate Law

A proposal to establish a 2040 target to reduce net greenhouse CO_2 emissions by 90%.

Net-Zero Industry Act

A legislative tool to strengthen and revitalise the nuclear supply chain

Nuclear Illustrative Programme (PINC)

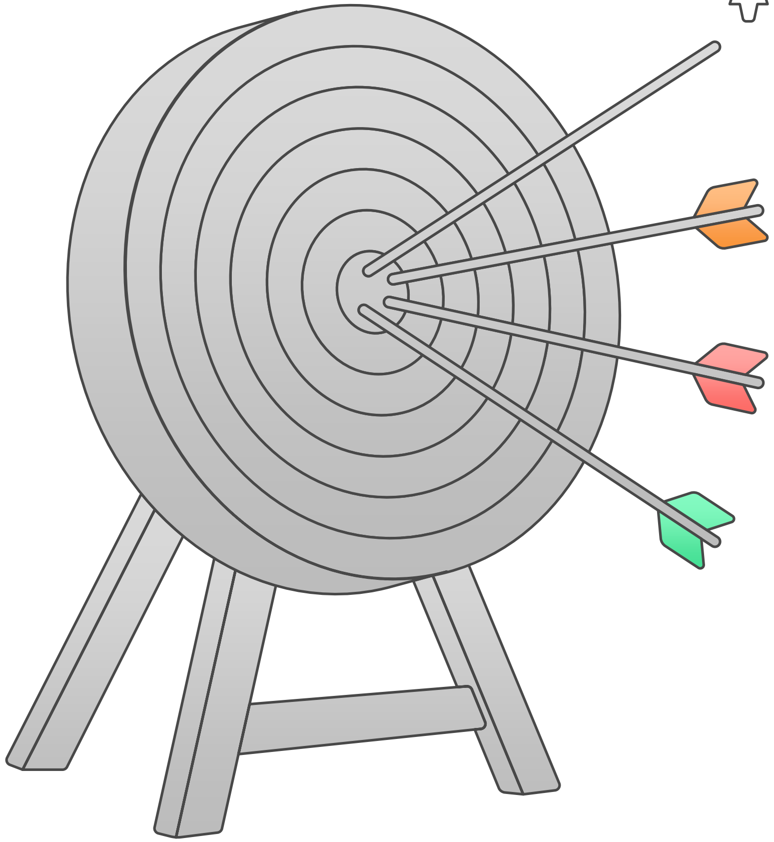
A comprehensive overview of nuclear energy investments across the EU.

SMRs Strategy

A strategy expected to be adopted in 2026 to promote small modular reactors

nucleareurope SNETP Sustainable Nuclear Energy Technology Platform

Towards SMRs in the EU



Key Stakeholders

Involved in SMRs

Nuclear Alliance (14 MS+, Feb' 23)

Strategic and regulatory framework

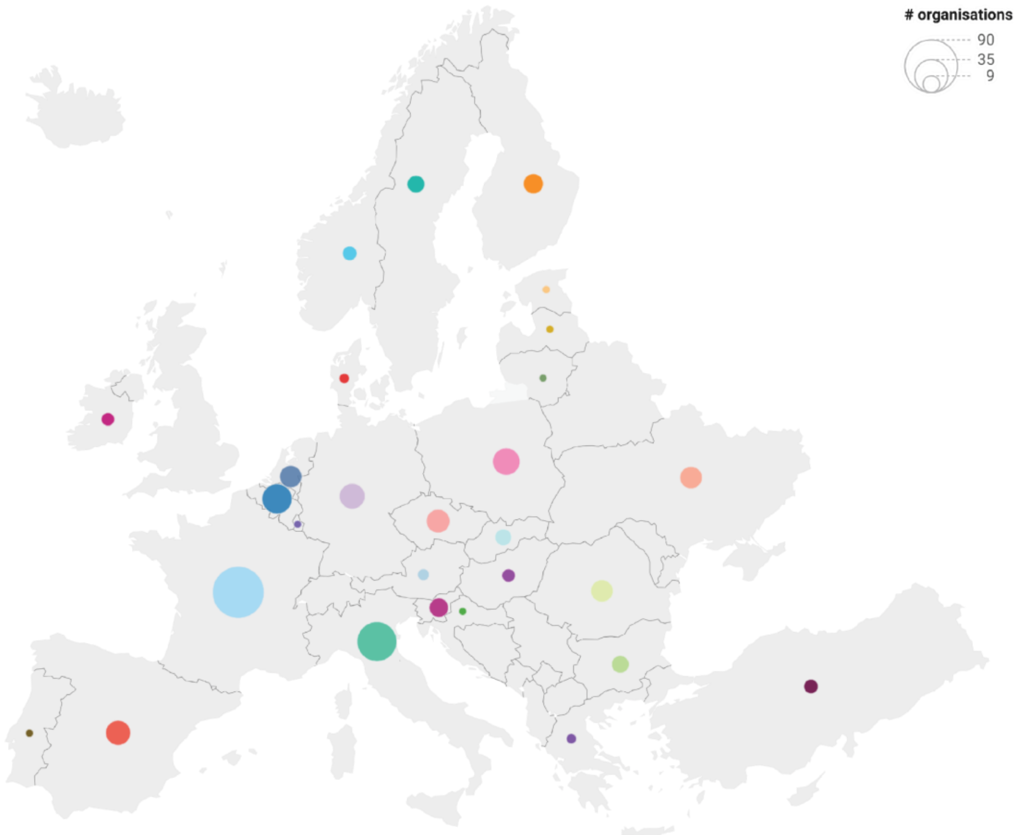
Business Alliance (14 federations, Feb'25)

Market creation, investment mobilization, commercial viability

Industrial Alliance (members, May 24)

Technical development, supply chain readiness, innovation

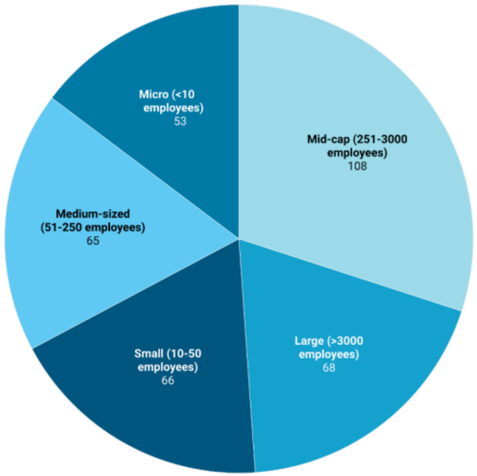
[Country distribution, members] August 2025



Members

360

[Size of Organisation] (August 2025)

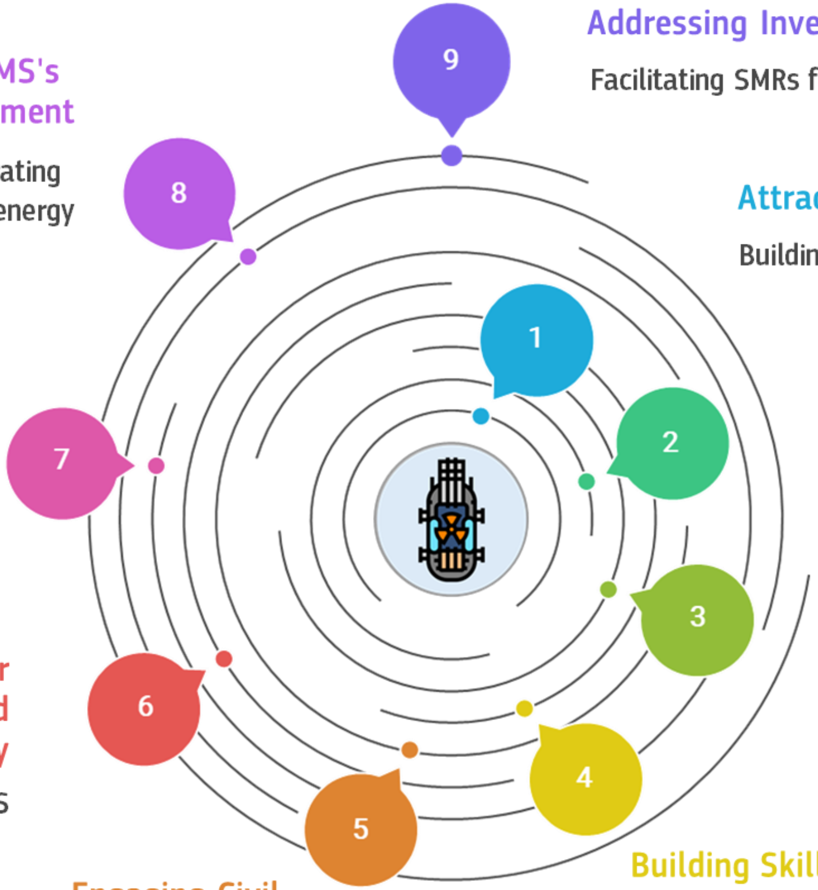


5 Technologies

LW-SMR, AMR

30 Designs

Key Challenges for SMR deployment in the EU



Addressing Investment Barriers
Facilitating SMRs financing

EC & MS's engagement
Simplifying & accelerating processes for nuclear energy

Attracting End-Users
Building market demand in Europe

Advancing Fuel and Waste Management
Developing new fuels and circularity

Ensuring Leadership in Research and Innovation
Maintaining world-class research and innovation

Developing Strong Supply Chain Capacity
Sustaining SMR developments

Ensuring Nuclear Safety, Safeguards and Security
Maintaining high 3S standards

Engaging Civil Society
Fostering open and transparent dialogue

Building Skilled Workforce
Creating a robust and resilient workforce

Published on 12 September 2025

European IA on SMRs
1st batch PWGs*

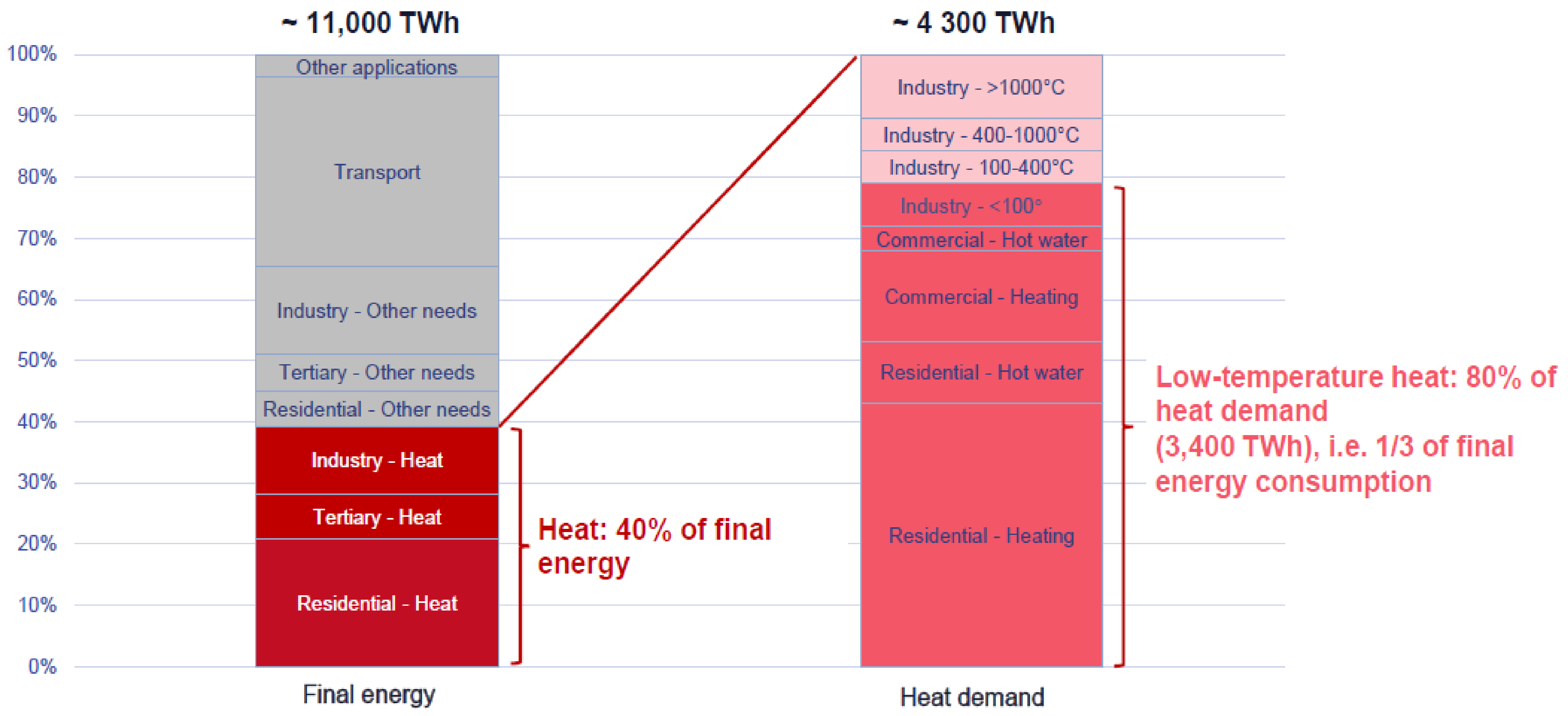
Based on:

- **Added value to the European economy**
- **Support from diverse European Stakeholders**
- **Compliance with EU legislative framework**
- **Addressing NET-ZERO objectives**

*Announced on 11 October 2024
https://ec.europa.eu/docsroom/documents/62274

Low-temperature heating accounts for a third of final energy demand in Europe

Final energy and heat demand EU-27, 2019



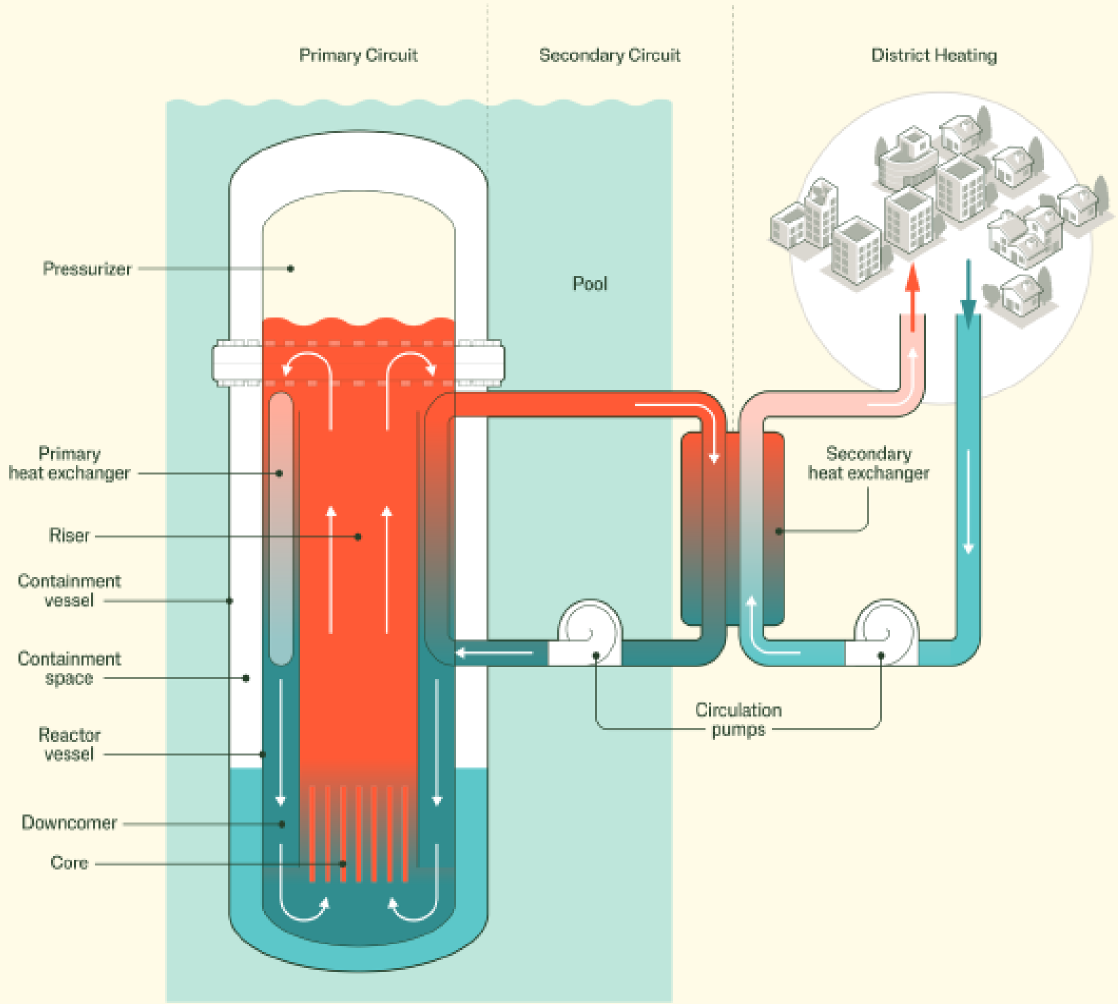
Source: Eurostat, Heat and cooling demand and market perspective

Calogena's module is specially designed for 3rd and 4th generation district heating networks

Power	30 MWth
Temperature adaptable to network requirements	70-110°C
Module lifetime	> 60 years
Ability for load-following	20-100% P_{nom}
Refuelling frequency	2 years
Land requirement	3000 m²
Electricity requirement	Standard for SMEs[1]
Water requirement	No cooling source[1]
Fuel	UO_2 3.4%
Installation	Suburban

LDR-50 – Technological simplicity

- Use Light Water Reactor technology, commercially mature for business without technology risk (TRL 9)
- Thermal power 50 MW per reactor
- Refueling every 2-3 years
- “Tried and tested” light water technology
- Only few moving parts
- Very low operating temperatures and pressures
- The reactor is the size of a shipping container
- Passive heat removal system
- Physically separated water circuits, lowest pressure inside reactor — therefore possible leak retained inside plant
- Reactor hall as strong as civil defense shelter



Why?: EU market needs

Electricity

1600 TWh/y
EU Low carbon electricity production to be deployed by 2040

80GW
European Nuclear capacity to be replaced by 2050 (end of life)

Hydrogen

>20 Mt H_2/y
REPowerEU Market Estimate for 2030

1000 TWh/y
Equivalent additional clean electricity demand

>125 GW
Equivalent nuclear capacity

Industrial heat

~1250 TWh_{th}/y
Iron – Steel, Non-metallic minerals and chemicals heat demand in EU26

> 45% market
Heat < 400°C

District heat

~500 TWh_{th}/y
Current district heat demand in EU26

> 2/3 fossil- fueled
Assets to be retired and replaced in the coming two decades

QUESTIONS ?

European Industrial Alliance on SMALL MODULAR REACTORS

Find out more

SCAN ME

Contact us: grow-EU-SMRS-ALLIANCE@ec.europa.eu

Photos and Icons, source::stock.adobe.com, sources: Ansaldo nucleare: https://www.ansaldoenergia.com/companies/ansaldo-nucleare; Enea: https://www.enea.it/it; RATEN: https://www.raten.ro/;SCK-CEN: https://www.sckcen.be/en;Calogena: https://www.calogena.com/; Steady Energy: https://www.steadyenergy.com/; Last Energy: https://www.lastenergy.com/; newcleo: https://www.newcleo.com;Nuward: https://www.nuward.com/en; OSGE: https://osge.com/; Rolls-Royce: https://www.rolls-royce.com/innovation/small-modular-reactors.aspx#/; RoPower: https://www.nuclearelectrica.ro/; Thorizon: https://thorizon.com/

nucleareurope

SNETP Sustainable Nuclear Energy Technology Platform