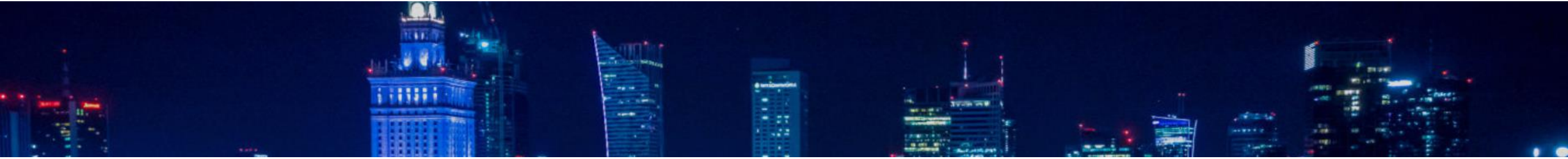


Parallel II.3 "Solutions to non-electric energy demand including hybrid energy systems“

Wednesday 14 May 2025, 10:30 – 12:30

Panelists:

Józef Sobolewski, Director for HTR Development, NCBJ, PL
Michele Frignani, Nuclear Technology and Safety, Ansaldo, IT
Nicola Rega, Executive Director, Climate Change and Energy, CEFIC, BE
Slavica Ivanović, SMR Innovation Project Lead, Tractebel, BE
Paul Nevitt, VP Science and Technology, NNL, UK
Stéphane Sarrade, Direction des Programmes Énergies, CEA, FR

Moderators: Alexis Amachree, Women in Nuclear YG and Michael Fütterer, EC JRC
Rapporteur: Stéphanie Cornet, CEA, FR

Solutions to non-electric energy demand including hybrid energy systems
Polish example

FISA-EURADWASTE 2025 & SNETP Forum, WARSAW 12-16 May 2025

Dr Józef Sobolewski

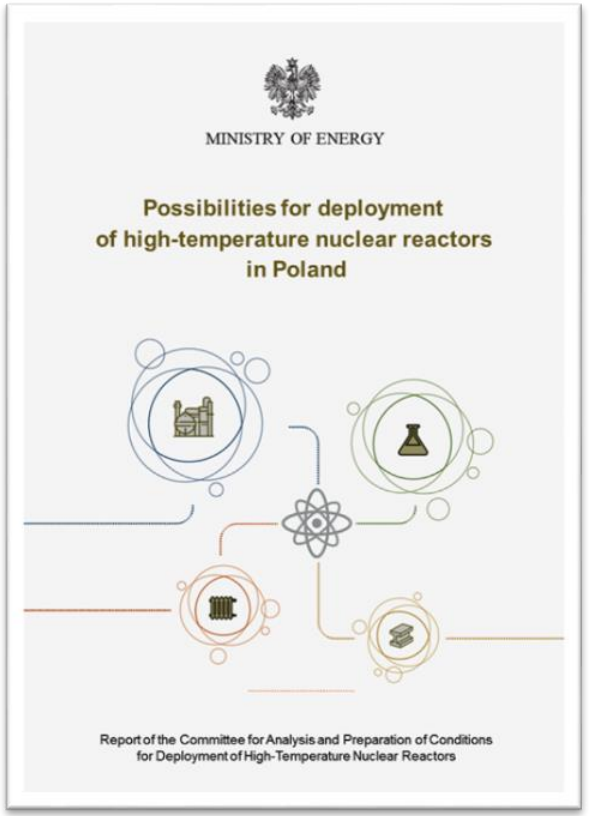
National Centre for Nuclear Research

NATIONAL CENTRE FOR NUCLEAR RESEARCH ŚWIERK

Advanced nuclear technologies in Poland

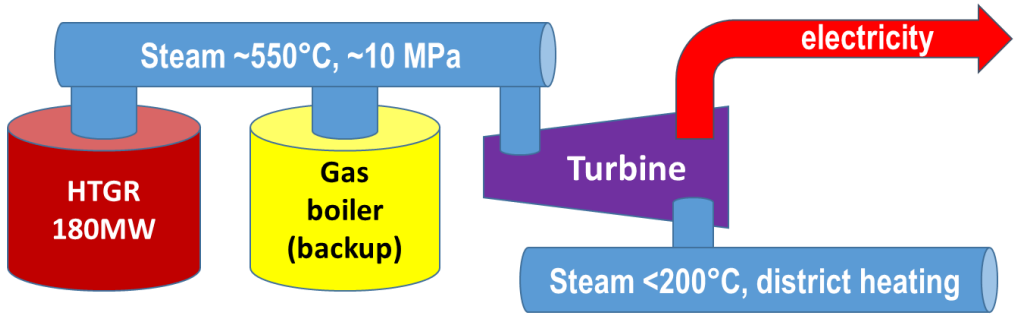
Minister of Energy appointed the Committee for Analysis and Preparation of Conditions for Deployment of High-Temperature Nuclear Reactors (HTR Committee) in Poland in July 2016. Report with results of the Committee's works published in January 2018.

Industrial heat market in Poland:
13 largest chemical plants need 6500 MW of heat at T=400-550°C.



Available reactor technologies were reviewed recognizing High Temperature Gas-cooled Reactors (HTGR) as the best option. As a result, we initiated the R&D projects on HTGR's (especially for industrial cogeneration) with the following objectives:

- Decreasing dependence on fossil fuel import.
- Decreasing sensitivity of economy to environmental regulations.
- Synergy with multi-GW LWR programme.



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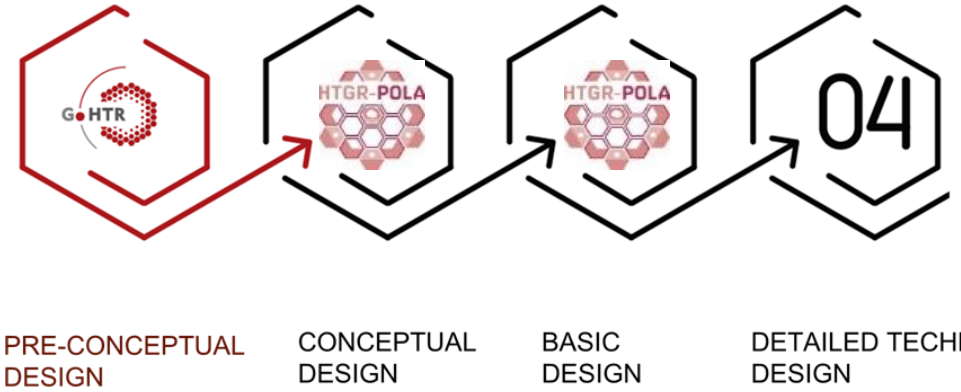
Way to High Temperature Gas-cooled Reactor - POLish Atom (HTGR-POLA)



National Centre of Nuclear Research is gaining knowledge on HTGR technology by strengthening collaboration with Japan Atomic Energy Agency (JAEA).

GoHTR (2019-2022). In the frame of national strategy program GOSPOSTRATEG project for preparation of law, organization and technical instruments to deploy the HTR reactors in Poland.

Contract between the NCBJ and the Ministry of Education and Science (MEiN) entitled “Technical description of the HTGR gas-cooled high-temperature research nuclear reactor” signed on May 2021 until December 2024. It is intended for the implementation of another batch of design work for the experimental HTGR, being also the technology demonstrator.

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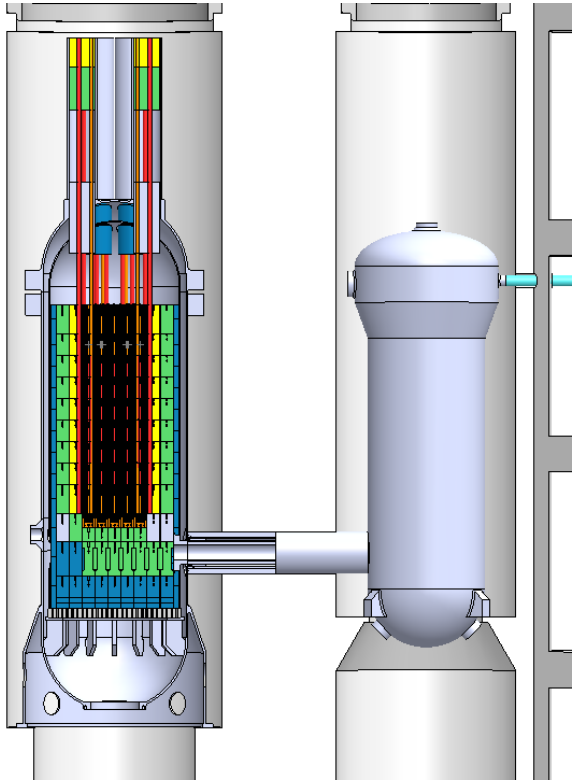
JAEA

- Reactor thermal power 30 MW
- Prismatic core (composed of hexagonal graphite blocks)
- Graphite moderator - Helium coolant
- TRISO fuel (HALEU, 9.9% enrichment UO2)
- Reactor outlet temperature 750 ^{o}C
- Cogeneration operation, electrical power max. 10 MW gross, high-temperature heat in steam max. 25 t/h, low-temperature thermal power in water max. 16.5 MW.



The High Temperature Industrial Heat (HTIH) project

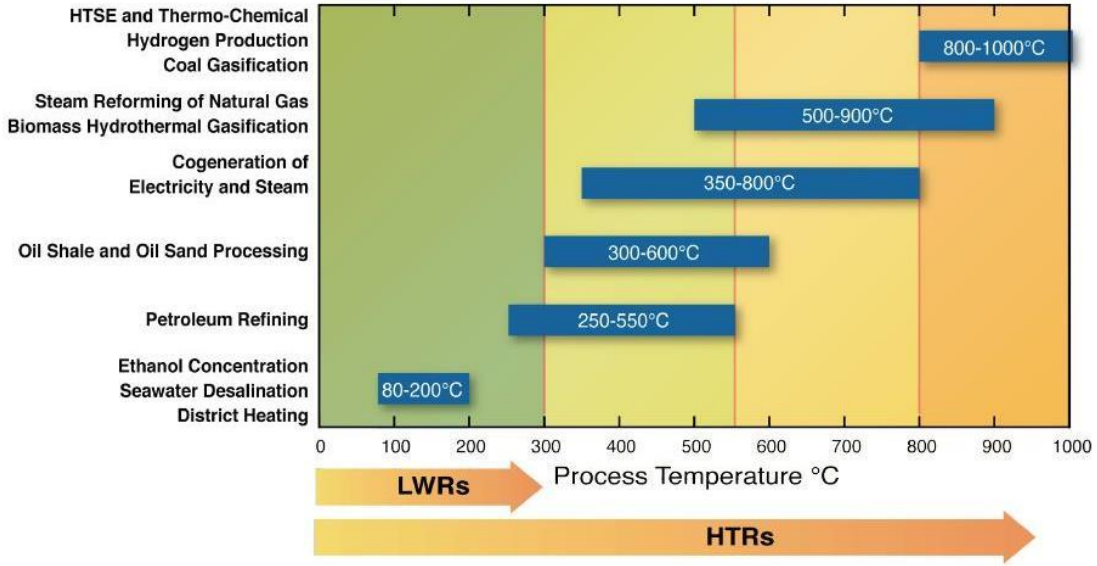
J. Buongiorno, J. Parsons, D. Petti et al., "The future of nuclear energy in a carbon-constrained world" MIT, Cambridge, MA, 2019

Euratom project GEMINI+ (2017 – 2021). Developed main design options for HTGR to meet the requirements for cogeneration use in Europe. Project led by NCBJ.

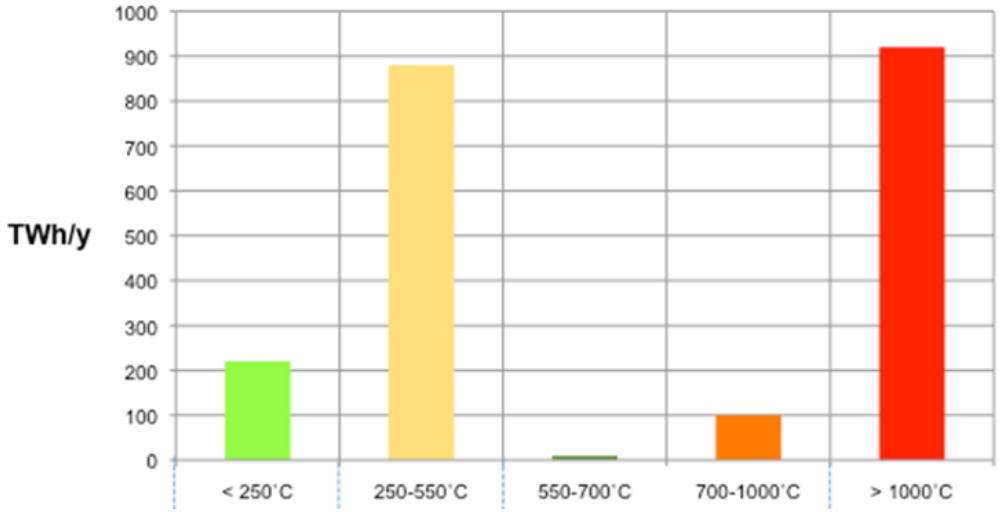
GEMINI+

GEMINI 4.0 (2022 – *2025*). Euratom project as a continuation of GEMINI+ led by Framatome with participation of NCBJ.

GEMINI 4.0



The objective of the HTIH Project is to enable a commercial deployment of high temperature nuclear cogeneration in Europe as early as possible, by developing a commercial system on the basis of the existing European know-how, of the GEMINI design recently defined in two Euratom funded projects, and of the Polish demonstration experience with HTGR-POLA.



Distribution of the industrial heat market by domain of temperature in Europe

NC2I Nuclear Cogeneration Industrial Initiative

framatome

Hit Tech Relay

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Thanks

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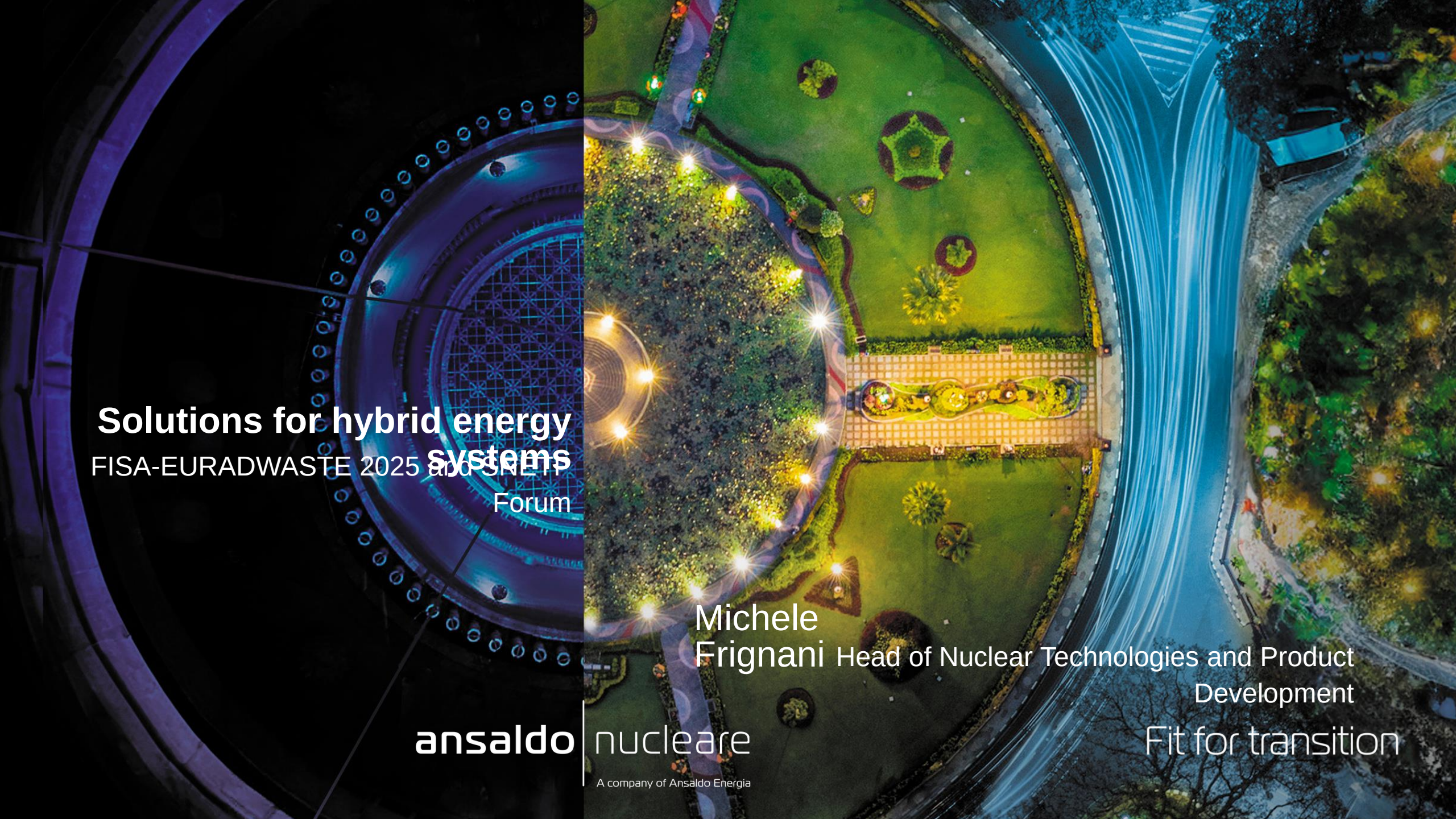


Solutions for hybrid energy systems

FISA-EURADWASTE 2025 and SNETP Forum

Michele Frignani Head of Nuclear Technologies and Product Development

ansaldo nucleare

A company of Ansaldo Energia

Fit for transition

Ansaldo Nucleare and Italy

ansaldo nucleare

Ansaldo Energia Group, owned by Cassa Depositi e Prestiti, is an international leader in the field of power generation (gas turbines, steam turbines, generators, turnkey plants, service solutions).

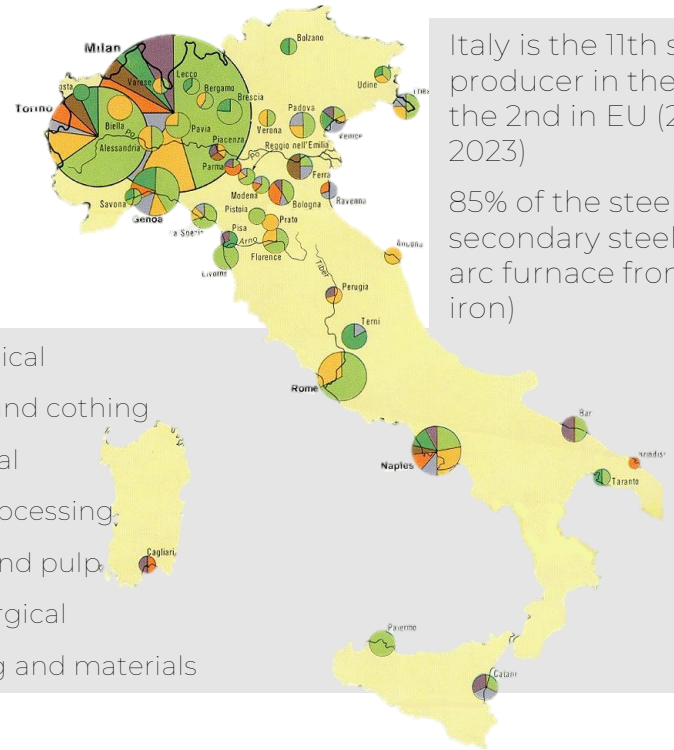
Ansaldo Nuclear is fully devoted to
- Exploiting engineering and manufacturing capabilities
- Exploring new technologies and developing products

400 Resources

90 € million Revenues

Renewed interest in nuclear in Italy

- Sept. 2023: «National Platform for Sustainable Nuclear» by IT Govt.
- Feb. 2024: MoU ENEL-Ansaldo on SMR and AMR
- Apr. 2024: IT Govt joins European Industrial Alliance on SMRs
- Jun. 2024: IT National Energy and Climate Plan includes a scenario with 8 GWe installed capacity by 2050 (11% of electricity demand)
- Multiple LoI and MoU signed by Ansaldo Nucleare with utilities, operators, vendors and intensive energy users
- Nov. 2024: Announcement of a newco among Enel, Ansaldo and Leonardo



Italy is the 11th steel producer in the world and the 2nd in EU (21 Mt in 2023)

85% of the steel is secondary steel (electric arc furnace from scrap iron)

TEHA

Key strategic benefits of nuclear energy for the Italian industries

- Reduced system costs
- Security of supply
- Competitive industrial production
- Industrial applications

- Mechanical
- Textile and cothing
- Chemical
- Food processing
- Wood and pulp
- Metallurgical
- Building and materials

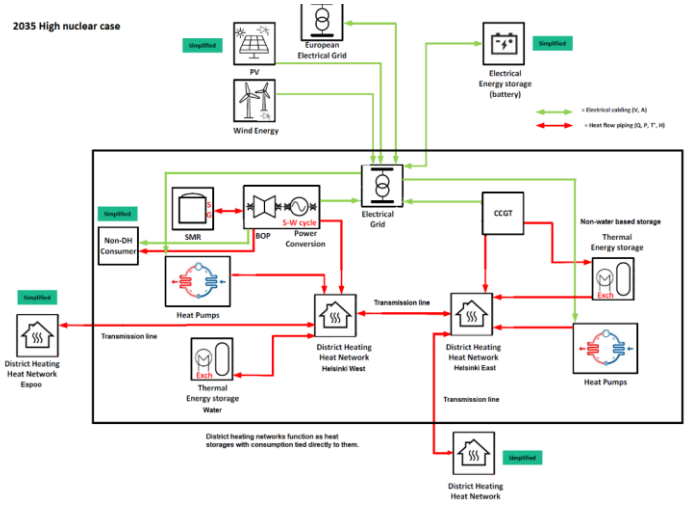
ansaldo nucleare

Involvement in EURATOM funded projects on co-generation

ID:101059479
Sept. 2022 - Aug. 2025
Total budget: 3.8 m€
Coordinator: CEA

Small Modular ReacTor for a European sAfe aNd Decarbonized Energy Mix

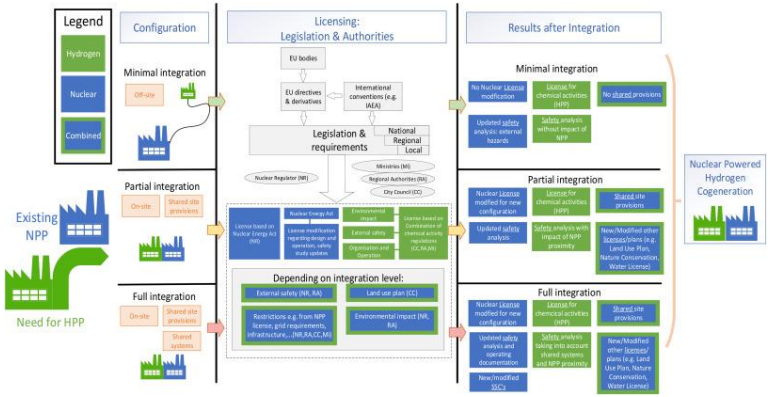
Assessing safety of small modular reactors integrated into hybrid energy systems



ID:101061007
Sept. 2022 - Feb. 2025
Total budget: 2.7 m€
Coordinator: Framatome Gmbh

Nuclear Powered Hydrogen Cogeneration

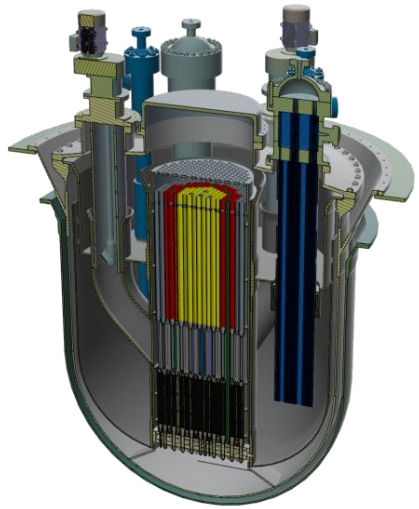
Using nuclear energy to produce hydrogen



ID:101061185
Sept. 2022 - Aug. 2026
Total budget: 4.5 m€
Coordinator: SCK CEN

Advanced Nuclear Safety Evaluation of Liquid Metal Using Systems

Boosting the safety of advanced Generation IV liquid metal-cooled nuclear reactors



ansaldo nucleare

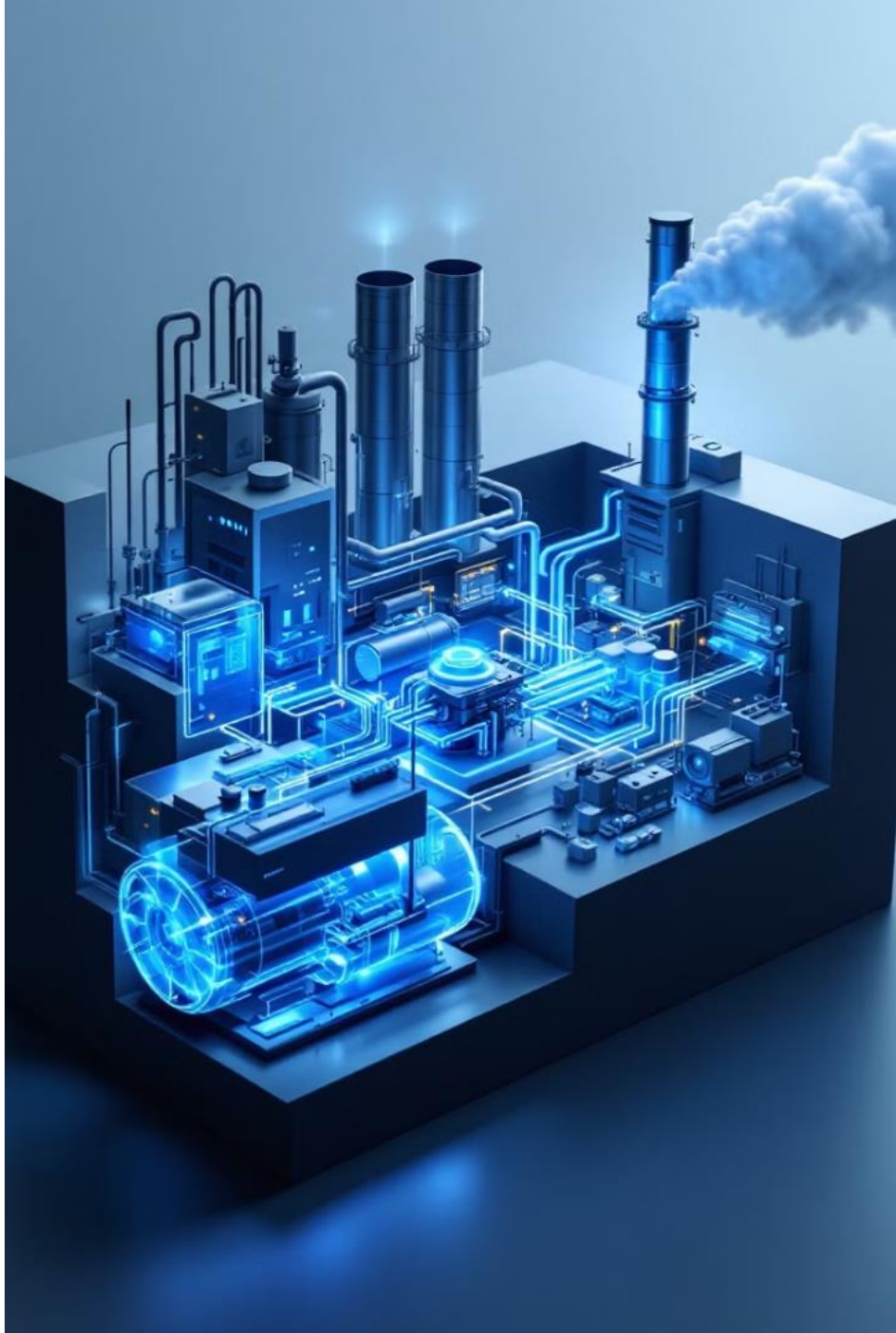
Case study: SMR4steel

H_2-DRI conversion could reduce carbon emissions by approximately 90% compared to traditional blast furnace methods while maintaining high product quality

SOEC Electrolysis	Reverse Osmosis	EAF Process
3,204	3.26	570
GWh/Mton CS	GWh/Mton CS	GWh/Mton CS
Hydrogen production	Water desalination	Electric arc furnace operation

System uses 100% hydrogen for reduction and pre-heating.
Energy demands based on Best Available Technology reference values.

Further studies related to the Italian industrial sectors are on-going, both through supply of medium-enthalpy steam and through hydrogen as energy vector



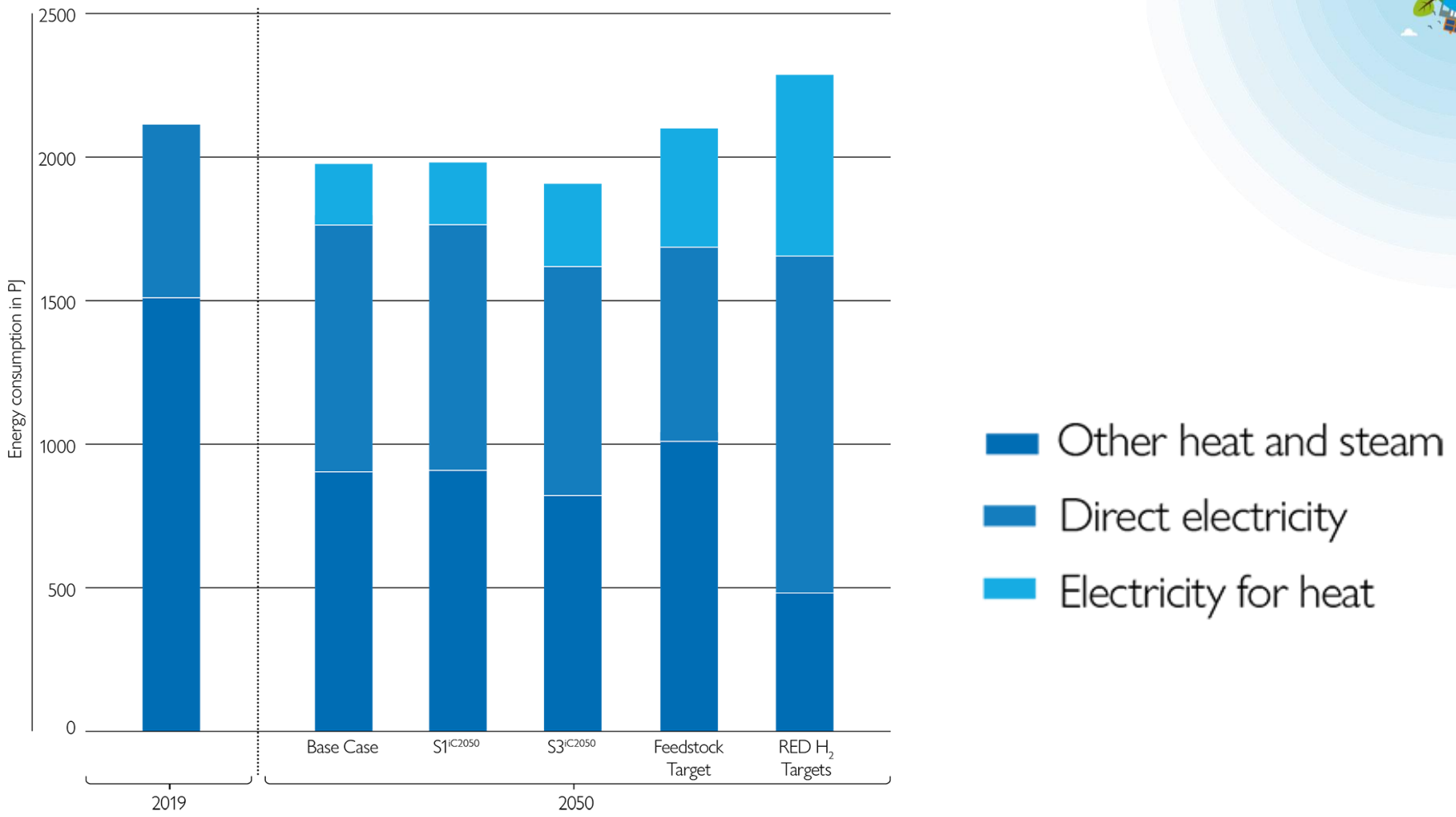
Chemical industry perspectives on SMRs

Nicola Rega
Executive Director
Climate Change and Energy
Cefic

FISA-EURADWASTE 2025 & SNETP Forum
Warsaw, 14 May 2025

The European Chemical Industry Council, AISBL – Rue Belliard, 40 - 1040 Brussels – Belgium
Transparency Register n°64879142323-90

Prospectives for electricity use in the chemical industry



Final energy consumption across policy scenario in 2050

Source: The Carbon Managers (Cefic, December 2024)

The Possible role of SMRs for the Chemical Sector

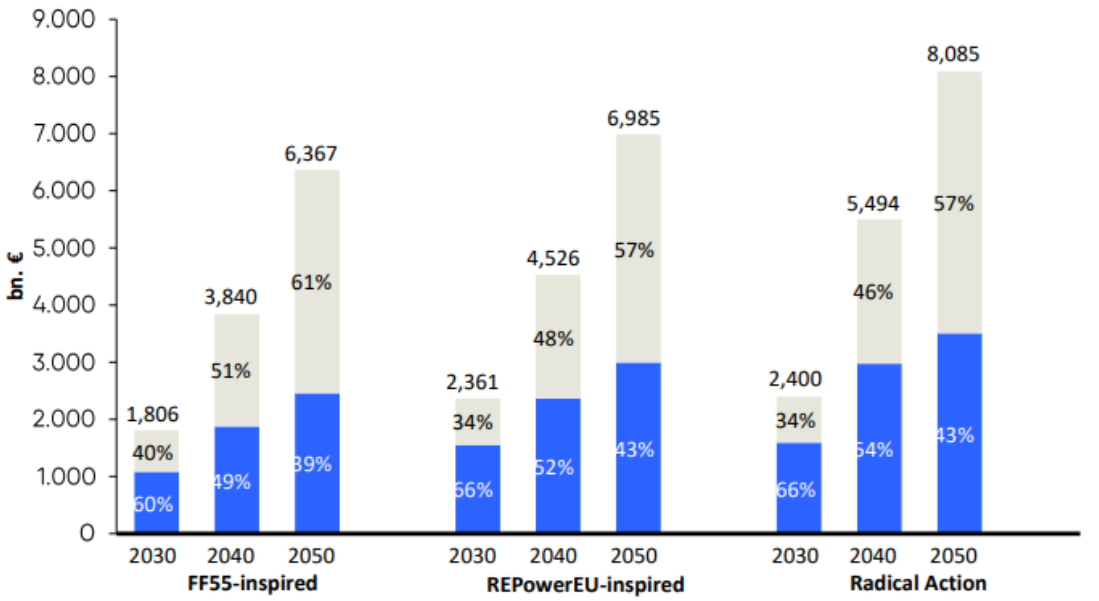
Starting position

- **High electricity costs are prohibitive to investments in electrification**.
- **These costs are not expected to reduce** and will not be off-set by efficiency gains.
- **The largest part of these costs will come from accessing the grid**, in the form of network charges, renewable taxes and other taxes, fees, levies and charges
- Against this background, **on-site energy production** is an attractive option for industrial consumers to mitigate high grid-electricity costs and preserve international competitiveness.

Both CAPEX and OPEX for electricity generation grow over time and over the scenarios *

Cumulative CAPEX and OPEX of the power sector for clean generation in EU27+UK for 2020-2050*

Comprising CAPEX for the installment of new RES or clean generation technologies as well as the Investments into utility-scale batteries and electrolysers. OPEX comprises the fixed and variable OPEX (e.g. Fuel costs) for 2020-2050*

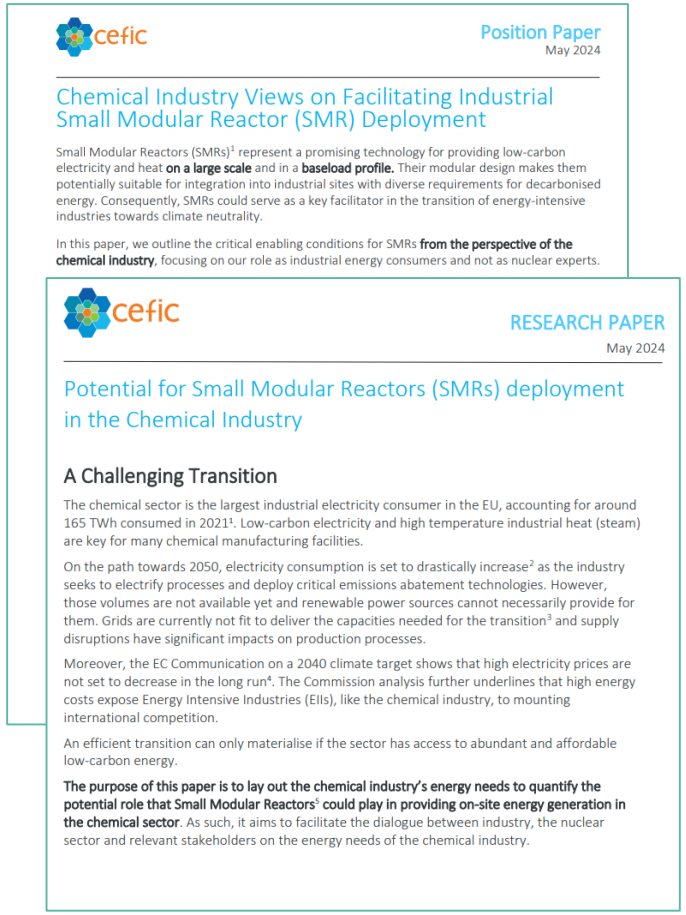


Sources: 1. EMBER (2022), TYNDP 2022 scenarios: Global Ambition, Distributed Energies, National Trends. 2020 only EMBER, 2030, 2040 and 2050 average of 3 TYNDP scenarios and EMBER

*Eurelectric report

The Possible role of SMRs for the Chemical Sector

- On-site Small-modular reactors (SMRs) may represent one possible pathway to accommodate the electricity needs of energy-intensive industries during the transition.
  - The modular nature of the technology makes it potentially attractive
    - To standardize a product tailored to different industry needs
    - To be deployed in industry clusters.
  - Possible new partnerships between energy producers and energy-intensive consumers
- A number of barriers still need to be addressed:
  - **Clarity needed on technology perspectives**
    - Multiple SMR technologies are currently being developed in parallel – which ones will meet industrial needs?
    - A timely development of different technology solutions to the transition to climate neutrality is crucial.
  - **Technology readiness** needs to go hand-in-hand with **regulatory readiness**.
    - Challenges may arise from their size, their electricity output, or safety requirements.
    - Early discussions between SMR developers and industry are necessary to anticipate these needs and challenges.



cefic

Position Paper
May 2024

Chemical Industry Views on Facilitating Industrial Small Modular Reactor (SMR) Deployment

Small Modular Reactors (SMRs)[1] represent a promising technology for providing low-carbon electricity and heat **on a large scale** and in a **baseload profile.** Their modular design makes them potentially suitable for integration into industrial sites with diverse requirements for decarbonised energy. Consequently, SMRs could serve as a key facilitator in the transition of energy-intensive industries towards climate neutrality.

In this paper, we outline the critical enabling conditions for SMRs **from the perspective of the chemical industry**, focusing on our role as industrial energy consumers and not as nuclear experts.

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RESEARCH PAPER
May 2024

Potential for Small Modular Reactors (SMRs) deployment in the Chemical Industry

A Challenging Transition

The chemical sector is the largest industrial electricity consumer in the EU, accounting for around 165 TWh consumed in 2021[1]. Low-carbon electricity and high temperature industrial heat (steam) are key for many chemical manufacturing facilities.

On the path towards 2050, electricity consumption is set to drastically increase[2] as the industry seeks to electrify processes and deploy critical emissions abatement technologies. However, those volumes are not available yet and renewable power sources cannot necessarily provide for them. Grids are currently not fit to deliver the capacities needed for the transition[3] and supply disruptions have significant impacts on production processes.

Moreover, the EC Communication on a 2040 climate target shows that high electricity prices are not set to decrease in the long run[4]. The Commission analysis further underlines that high energy costs expose Energy Intensive Industries (EIIs), like the chemical industry, to mounting international competition.

An efficient transition can only materialise if the sector has access to abundant and affordable low-carbon energy.

The purpose of this paper is to lay out the chemical industry's energy needs to quantify the potential role that Small Modular Reactors[5] could play in providing on-site energy generation in the chemical sector. As such, it aims to facilitate the dialogue between industry, the nuclear sector and relevant stakeholders on the energy needs of the chemical industry.

Cefic views on SMRs available at this link

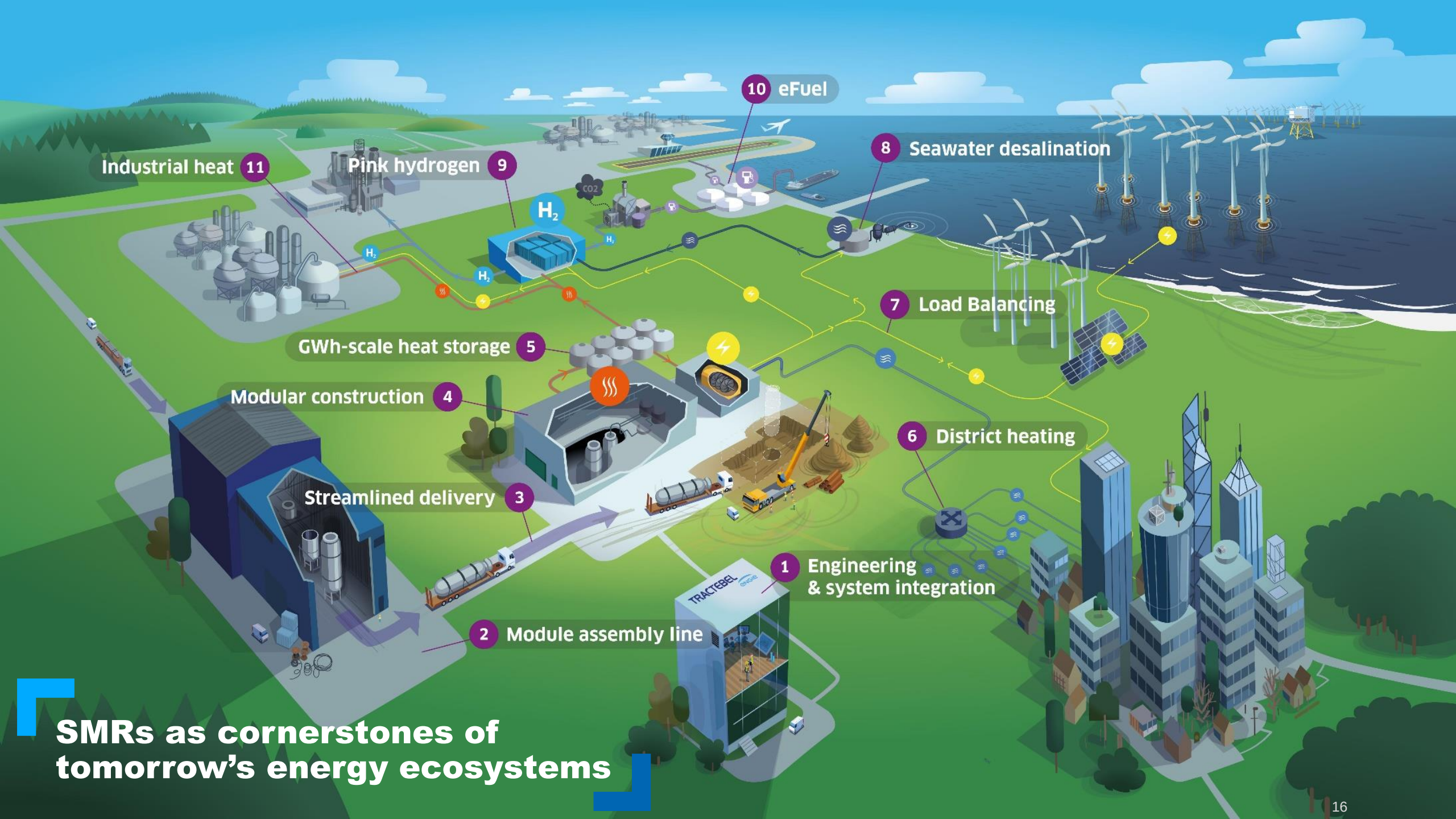
Thank you.

Contact:
Nicola Rega
Executive Director
Energy and Climate Change
nre@cefic.be

About Cefic

Cefic, the European Chemical Industry Council, founded in 1972, is the voice of large, medium and small chemical companies across Europe, which provide 1.1 million jobs and account for 15% of world chemicals production. Cefic members form one of the most active networks of the business community, complemented by partnerships with industry associations representing various sectors in the value chain. A full list of our members is available on the Cefic website.
Cefic is an active member of the International Council of Chemical Associations (ICCA), which represents
chemical manufacturers and producers all over the world and seeks to strengthen existing cooperation with global organisations such as UNEP and the OECD to improve chemicals management worldwide

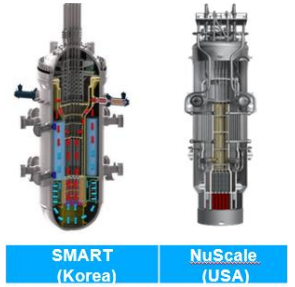
The European Chemical Industry Council, AISBL – Rue Belliard, 40 - 1040 Brussels – Belgium
Transparency Register n°64879142323-90



SMRs as cornerstones of tomorrow's energy ecosystems

Tractebel SMR capacity building
International EURATOM R&D Projects

- Relevant participation to consortium of EURATOM projects
  - TANDEM : SMR for a European safe and decarbonized energy mix, SMR integration in hybrid energy systems
  - GEMINI : Conceptual design for high temperature nuclear cogeneration
  - EASI-SMR: Ensuring assessment of safety innovations for SMR
  - MCSafer : High Performance Advanced Methods and Experimental Investigations for the Safety Evaluation of Generic Small Modular Reactors
  - R2CA : Reduction of radiological consequences of design basis and design extension accidents
  - SASPAM-SA : Safety Analysis of SMR with Passive Mitigation Strategy (SASPAM) - Severe Accident (SA)



Key Takeaways from Tractebel's Studies on Industrial/Cogeneration

- Common Trends Across Projects:
  - Industrial off-takers demand fast deployment and low-cost energy — the former directly impacts the latter.
- Major Uncertainties:
  - WACC and project schedule are the most significant risk factors.
- De-risking Through Business Models:
  - Early off-taker participation in financing/ownership reduces delays.
  - Integrated energy storage enables grid-balancing and boosts revenues.
- Role of Policymakers:
  - Taxation and subsidies shape market viability.
  - Early engagement with policymakers is essential for FOAK bankability.

click on slide and present as pdf (Ctrl L)

United Kingdom National Nuclear Laboratory

Solutions to non-electric energy demand including hybrid energy systems

Dr Paul Nevitt

VP Science and Technology, UKNNL

SNETP Governing Board Member

Vice Chair Generation IV International Forum

The Challenge of Non-Electric Energy Demand in Europe

Dr Stephane Sarrade

Director Energy Programmes Division (CEA)

Chairman of Generation IV International Forum (GIF)

FISA-EURADWASTE & SNETP Forum- Parellel session II.3

Context and challenges

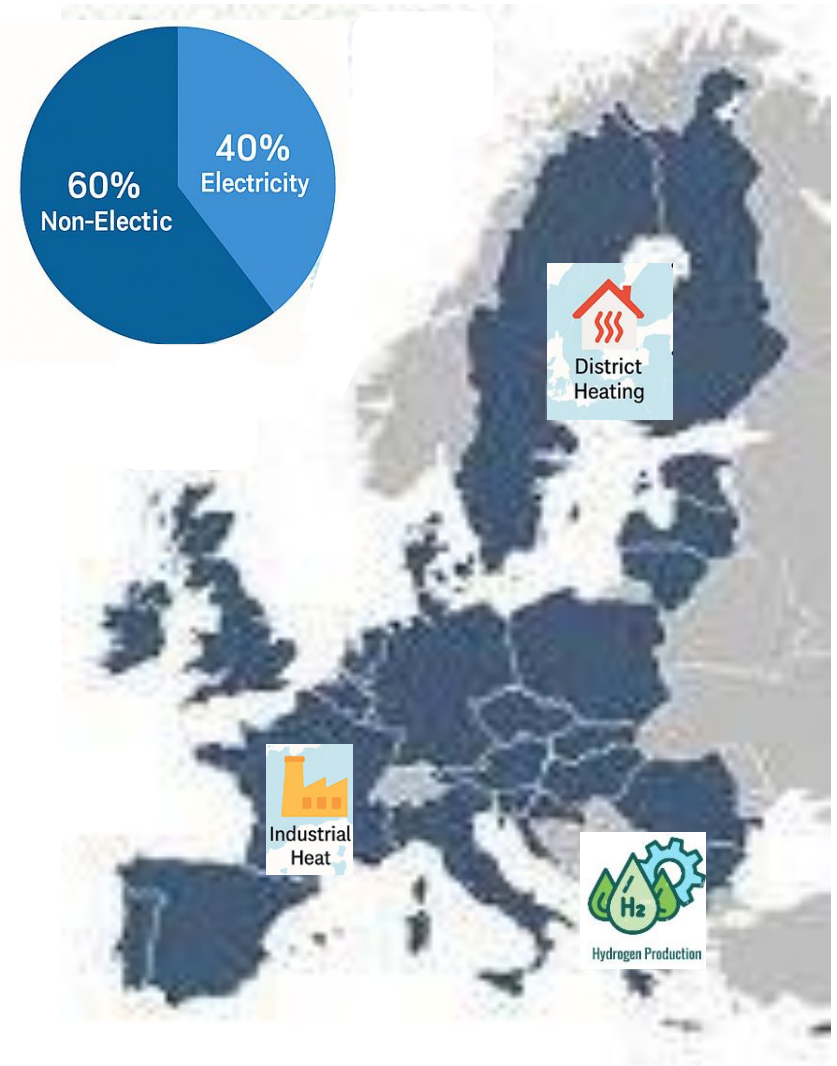
Decarbonising Non-Electric Energy Demand: A Key Pillar for Europe's Energy Transition

- **Non-electric energy demand** accounts for nearly **two-thirds** of Europe's final energy use — including **industrial heat**, **residential and district heating**, and **transport fuels. This sector are still relying heavily on fossil fuels**

- These sectors are **harder to decarbonise** due to:
  - **Heat** being **difficult to transport** over long distances
  - **High-temperature heat requirements** in industry (e.g. chemicals, steel, cement),
  - **Energy density and storage needs** for mobility and transport.

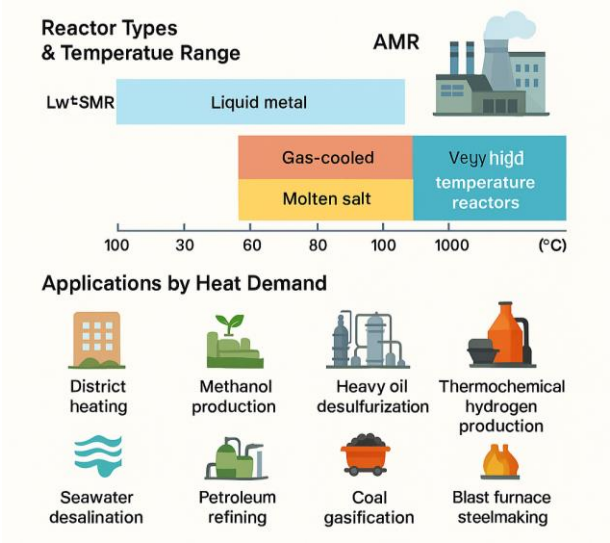
- **Hybrid energy systems**, where nuclear supports both electric and non-electric needs (e.g. process heat, hydrogen, desalination), are emerging as a **strategic solution**.

- In Europe, Euratom is supporting R&D in this area, aligning with climate goals and the Green Deal

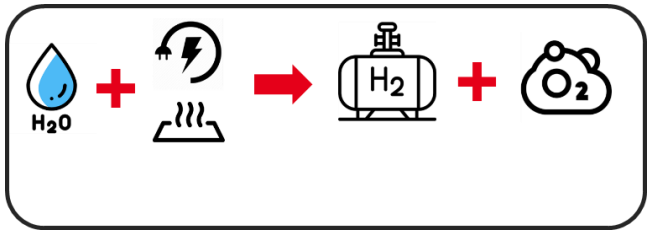


Hybrid Energy Systems: Integrating Nuclear with Other Energy Sources

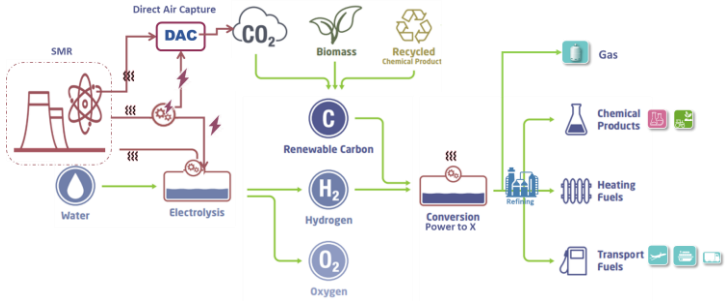
- **Small and advanced modular reactors- unlocking new heat markets**
  - diverse applications, from **district heating and desalination** to **steelmaking and hydrogen production**, based on their thermal output.



- **Coupling SMR and HTSE for H2 production:**
  - Both SMR and AMR can supply heat for HTSE
  - High Temperature Steam Electrolysis (HTSE)



- **Nuclear to X concept integrates nuclear energy to synthetic fuel production - bridging the gap from neutrons to chemicals:**
  - Synthetic aviation fuels (SAF) production pathways with a focus on technical and economic feasibility, scaling for CO_2 sourcing and energy efficiency optimization.



- **CEA: Active role in Euratom demonstration projects and joint initiatives on nuclear-based hybrid systems.**
- **Collaboration with EU research platforms (e.g., SNETP, NC2I) to design integrated systems.**

Enabling the Future of Hybrid Energy for Decarbonization

- **Policy** and **funding** are critical to scaling up hybrid systems demonstrators
- Collaboration ‘cross sector ‘ is essential: nuclear, renewables, industry, etc

- **Recommendations:**
  - Accelerate techno-economic assessments of hybrid systems
  - Raise awareness across branches of the industry of the potential of hybrid systems.
  - Support pilot projects and industrial demonstrators.
  - Integrate hybrid energy strategies into national and EU energy roadmaps.

- **Euratom Involvement:**
  - Expand R&D focus beyond electricity: industrial heat application, cogeneration, high temperature heat production and storage
  - Foster cross sector collaboration via joint programmes with other EU bodies
  - Integrate hybrid systems in strategic roadmap

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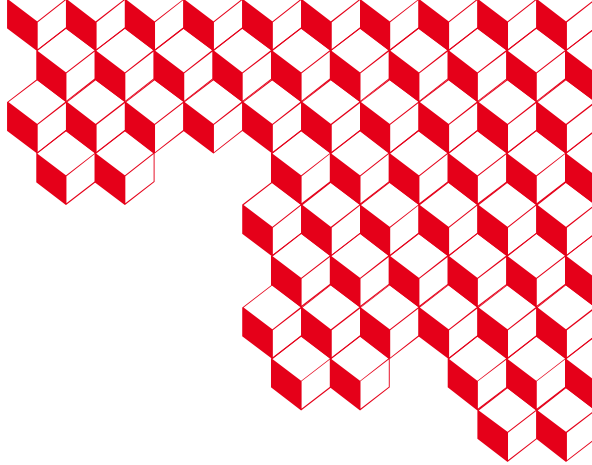

Thank you for your attention