SNETP REPORT

SNETP FORUM 2024 - Proceedings

SNETP Association

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This SNETP FORUM 2024 – Proceedings report was prepared by the SNETP Association.

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Executive Summary

The SNETP FORUM 2024 was held from 17th April to 19th April 2024 in Rome, Italy with the support of Italian Nuclear Association (AIN). Almost 300 participants from more than 20 countries were actively involved in this 2024 edition.

The SNETP Forum 2024 was opened by the president of the Italian Nuclear Association (AIN), Stefano Monti and the president of SNETP, Bernard Salha.

This opening session discussed prospects for nuclear energy in Europe and more particularly in Italy towards net zero emissions by 2025. Discussed topics were from existing power plants, building SMRs, enhancing safety to public engagement.

Stefano Monti highlighted Italy's shift towards nuclear energy, focusing on R&D, regulatory functions, public awareness, and international cooperation. Italy aims to bolster Europe's nuclear renaissance through active participation at home and abroad.

Bernard Salha mentioned the European Industrial Alliance on SMRs which represents a significant step in advancing nuclear technologies across Europe. Over 300 applicants from several countries seek to accelerate SMR projects by the early 2030s. Collaboration, best practices sharing, innovation, and skills development are prominent within this alliance, aligning with clean energy objectives. European partnerships play a crucial role in bolstering nuclear research and industry capabilities collectively.

International collaborations for nuclear research, talent acquisition, and shared interest and commitment were emphasized for propelling innovations in the European nuclear sector. European partnerships are key for achieving common environmental goals across borders. Commitment from diverse members and active engagement in governance bodies lay a strong foundation for advancing nuclear technologies towards a more sustainable future.

Both highlighted that the key role of technology and innovation, research, and development are essential for strengthening nuclear energy in Europe and in Italy. The technology scope ranges from existing units to new builds, including various reactor types and applications like hydrogen and heat generation.

Skills and motivation among the youth are decisive for the success of nuclear energy in the current energy transition.

1. Introduction

The SNETP FORUM 2024 took place from April 17th to April 19th, 2024, in the historic city of Rome, Italy, with the enthusiastic support of the Italian Nuclear Association (AIN). This year's event drew nearly 300 participants representing over 20 countries, highlighting the global interest and collaborative spirit within the nuclear energy community.

The forum was officially inaugurated by Stefano Monti, the president of the Italian Nuclear Association (AIN), and Bernard Salha, the president of SNETP.

The programme was designed with the help of the Scientific and Industrial Innovation Committee (SIIC) including moderators of the SNETP FORUM:

- ✓ Jozef Sobolewski (NCBJ)
- ✓ Sasha Szabolcs (Bay Zoltan),
- ✓ Petri Kinnunen (VTT)
- ✓ Pavel Kral (UJV),
- ✓ Baptiste Pothet (Framatome)
- ✓ Christophe Schneidesch (Tractebel – ENGIE)
- ✓ Michele Frignani (Ansaldo)
- ✓ Sanjeev Gupta (BT),
- ✓ Elisabeth Guillaut (Orano)
- ✓ Michael Futterer (JRC),
- ✓ Dominique Hittner (USNC),
- ✓ Christophe Varé (EDF)
- ✓ Robert Krivanek (NRG)
- ✓ Stéphane Sarrade (CEA),
- ✓ Nadia Cherubini (ENEA)
- ✓ Anthony Banford (NNL),
- ✓ Marjorie Bertolus (CEA),
- ✓ Marco Cherubini (NINE),
- ✓ Roger Garbil (EC – DG RTD)
- ✓ Marc Schyns (SCK CEN)

And the organisation committee:

- ✓ Abderrahim Al Mazouzi (EDF)
- ✓ Candice Boudet (LGI)
- ✓ Clara Demange (LGI)
- ✓ Gilles Quénéhervé (LGI)

2. Presentation of the Italian Nuclear Landscape

The first session of the forum was dedicated to the Italian nuclear landscape. As of 2023, Italy is one of the only three countries, along with Lithuania and Germany, that completely phased out nuclear power for electricity generation. This decision was the result of a 1987 referendum, organised after the Chernobyl disaster, the country closed its last reactors in 1990. With the election of the new government, the situation may change in the coming year, as the Prime Minister wants to restart nuclear plants as part of the country's decarbonization plan.

This round table was moderated by Bernard Salha, president of SNETP and Stefano Monti, president of AIN.

- As an introduction to the session, a video made by **Minister Pichetto-Fratin**, Minister of the Environment and Energy Security was presented.
- **Mrs Daniela Gentile**, CEO of Ansaldo Nucleare, presented their journey from pioneering efforts to collaborations on advanced reactor technologies like SMRs. For her, a political consensus to start within a year after a political decision is made, is mandatory to restart nuclear in Italy. As of today, Italy is able to construct 8 SMR-like plants per year starting from 2030s.
- **Mr Nicola Monti** , Edison's CEO, emphasized nuclear power's importance for a carbon-neutral future due to its reliability and decarbonization benefits.
- **Mr Gilberto Dialuce**, ENEA's president, focused on Italy's research advancements and collaborations within Europe for developing next-gen nuclear systems.
- **Professor Marco Ricotti** from Politecnico di Milano discussed the role of Italian universities in training nuclear experts and tackling challenges like insufficient research funding. According to him, the community must proactively engage young generations and leverage their enthusiasm for decarbonization to accelerate nuclear deployment.
- **Professor Franco Cotana**, CEO of RSE spa, shared insights into clean energy technology research initiatives supporting renewable energy deployment and potential contributions to nuclear technology advancement. He advocates for enlarging favourable opinions and politicians to gain support for initiating nuclear power plant projects in Italy.

Summary of the session:

The session addressed the history, challenges, and future of nuclear energy in Italy.

The Italian landscape was approached with different angles:

- The first one was in regards to **research and developments.** All panellists emphasized the importance of research and development in nuclear technology education and they mentioned the collaboration with European institutions for technical assistance and knowledge sharing.
- The second aspect was the **international collaboration**. Extensive international cooperation network involving collaboration in technology programs and representing Italy in green energy initiatives is performed.

- The third aspect consists of **infrastructure development and skills**. The session highlighted the importance of a well-trained setup of companies and sourcing competencies from outside of Italy for infrastructure development. Italy must encourage engagement of young generations and improve the education system to attract talent and address needed skills. Nuclear is an opportunity for the **young generation** to be part of the future.
- The panellists focused on analysing impacts of different **energy scenarios** from **decarbonization** and energy security perspectives. It was mentioned the need for a new European strategy on energy and collaboration with European institutions.
- **Cooperation and readiness** of Italy to cooperate with European projects and institutions towards advancing nuclear technology was discussed and explored, putting the emphasis on the need for organizational alignment around European rules among member states.
- Finaly, challenged by the audience: the **timeline** for nuclear power plant construction in Italy. For today, predicting the timeline for the first kwh produced by an Italian nuclear power plant is challenging. But the question was enlarged to Europe: when a new nuclear power plant will produce its first kwh in Europe?

The discussions with the audience encompassed regulatory aspects, skill development needs, public perception, amelioration, and projected timelines for operational nuclear plants in Italy. The audience raised questions about accelerating European efforts towards sustainable energy production through collaborative partnerships and timely strategies in member states. This session displayed diverse perspectives aligning with technological innovation goals and societal responsibilities in transitioning to greener energy solutions.

To conclude, opportunities and challenges for nuclear development in Italy can be summarized as following:

- **Challenges**: Stable and convincing political actions, rebuilding regulations, communication, and modification in authorization processes were highlighted as key challenges. The new approach in Italy must come from a bottom-up instead of a top-down approach.
- **Opportunities**: New approach by young generations (open and not idealistic) and converging interests (supply chain, utilities, energy producer) from stakeholders in the nuclear industry.

3. Boosting Nuclear Innovation and Development

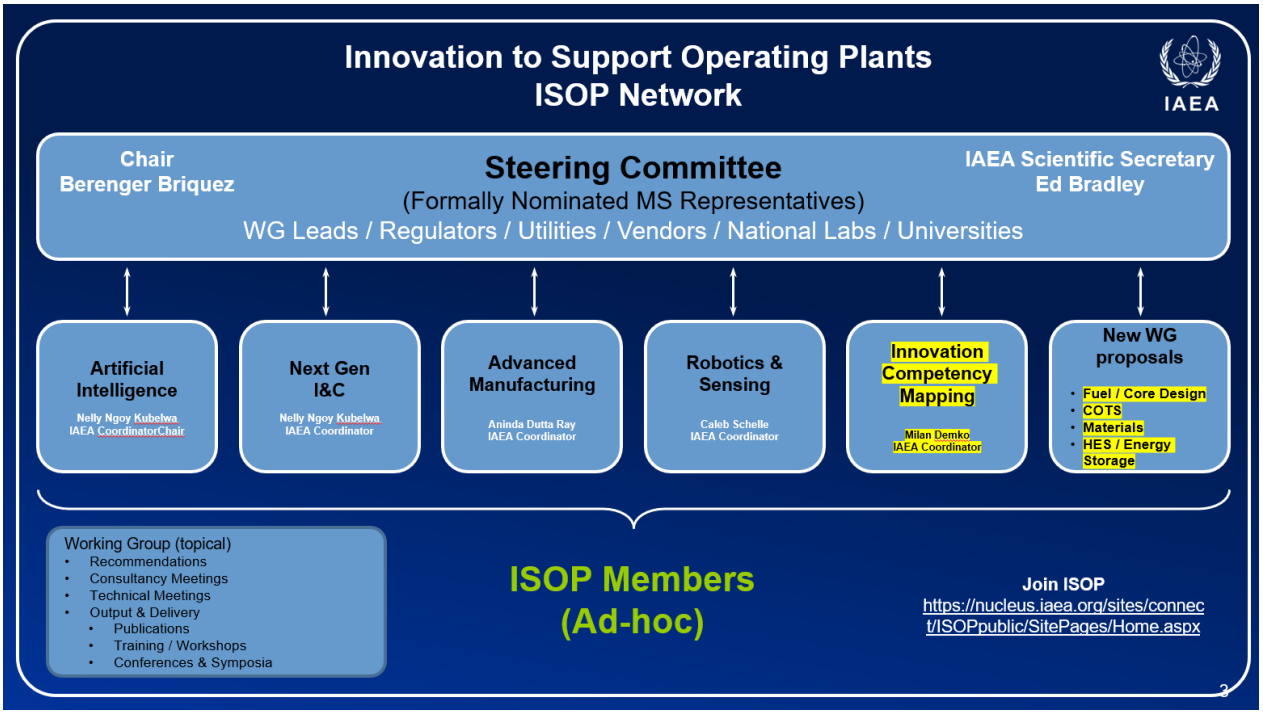
The second plenary session focused on the way to boost nuclear innovation and its development in the European and world landscape from the institutional point of view.

This round table was moderated by Marc Schyns, SCK CEN, and Roberto Adinolfi, Ansaldo Nucleare.

- As an introduction to the session, a video made by **Rosalinde Van Der Vlies**, Directorate-General for Research and Innovation was presented.

- **Aline des Cloizeaux,** Director**,** Division of Nuclear Power, Department of Nuclear Energy of the IAEA, provided an overview of the Innovation to Support Operating Nuclear Power Plants (ISOP).

She underlined the need to prioritize innovation in construction techniques to reduce build risk and increase certainty. ISOP network fosters industry-wide collaboration to accelerate the adoption of Innovation in the nuclear industry, in terms of technologies, processes, frameworks including regulatory aspects, culture & leadership. The vision of ISOP is to ensure the sustainable operation of existing NPPs or plants expected to enter service in the next ~5years as well as a secure adoption of new technologies.



Four working groups (WG) are active and running:

- AI working group
- Advanced manufacturing WG
- Robotics WG
- Next Gen I&C WG

- **Willem Janssens**, Head of Department Nuclear Science, Safeguards and Security, Directorate Nuclear Safety and Security, EC-JRC, encouraged innovation in research reactors before commercial deployment to test innovations effectively.

- **Gianfranco Brunetti**, DG ENER, focused his presentation on business models, particularly those involving new end users, as an area for innovation. He put the emphasis on closing the fuel cycle for responsible use of nuclear energy.

From the European Industrial Alliance on SMR the Commission received 300 applications and selection must be known by the end of April 2024. He highlighted the lack of workforces (talents and skills) what will be tackled by the Alliance on SMR. From him, innovation can boost the time and be the booster at the same time;

- **Neil M. Wilmshurst**, Senior Vice President, Energy System Resources, Chief Nuclear Officer at EPRI, recalled that innovation is not easy. In industry failure is not acceptable whereas in innovation failure is a way to construct the path to success. The industry needs to change its mindset.

He mentioned the Global Forum 2022 for nuclear innovation sharing the spirit and the energy of the forum. From Global Forum four grand challenges emerged:

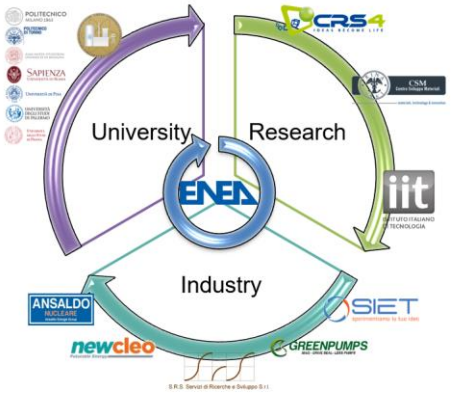
- Operating a lean machine,
- Safe doesn't have to be slow
- No talent, no sector
- Beyond electricity

The next Global forum for nuclear innovation will take place from 24th to 27th June 2024 in Miami, US.

Lessons learned:

- Be intentional
- Culture is important – culture of innovation
- Fear of failure is real within nuclear
- Hire for behaviours, train for skills
- Diversity

- **Alessandro Dodaro,** Director of the ENEA Nuclear department, presented ENEA as a catalyst for all LFR R1D projects in the Italian landscape.



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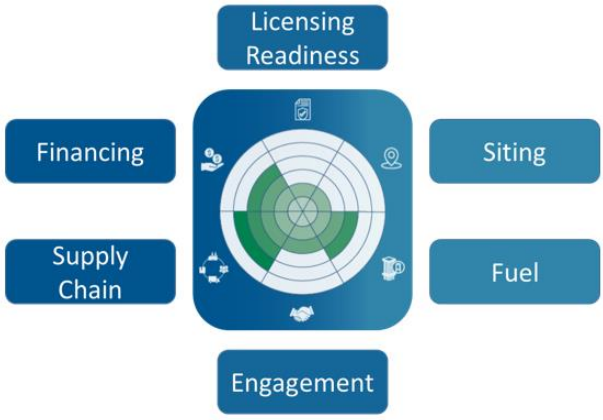
In November 2023, Italian Ministry of the Environment (MASE) approved an allocation of resources amounting to 502 million euros to promote, in the three-year period 2024-2026, research and development of innovative energy technologies with zero carbon emissions. Out of this budget, 135 million euros are dedicated to the nuclear sector for the implementation of research activities on SMR and fourth generation in the short-medium term and on fusion technologies for the long term.

A large amount of the resources will be used specifically for training activities, with the aim of strengthening professional, technical and specialist skills in this sector.

- **Michel Barthelemy**, Nuclear Strategic Policy Advisor, Nuclear Technology Development and Economics Division, OECD/NEA, presented the NEA SMR Dashboard identifying 25 nations committed to tripling nuclear energy by 2050.

NEA identified 6 indicators to track SMR progress:



The NEA Small Modular Reactor Dashboard: second edition

The SMRs under development are in a wide range of sizes – some as small as 5 MWth, others exceeding even 900 MWth – and providing a wide range of outlet temperatures – from 280 to 800 degrees Celsius.

The analysis performed by NEA covers 21 different SMRs. A few designs are already operating and there is a robust pipeline of SMRs making progress towards first-of-a-kind deployment.

High licensing number in the USA with almost 20 SMRs, where the second one is Canada with 9 reactors.

Summary of the session:

The session highlighted the importance of innovation in advancing nuclear energy, particularly Small Modular Reactors (SMRs) and Advanced Modular Reactors (AMRs). Innovation in construction techniques and business models is crucial to drive progress. A culture of innovation, where failure is viewed as a learning opportunity, is essential. Balancing technological advancements with safety considerations is critical, recognizing the significant consequences of failures in the nuclear sector. Leveraging research reactors for testing innovations before commercial deployment was suggested.

The panellists discussed the different approaches among countries regarding regulations, research reactors utilization, and fostering innovative solutions for SMRs and AMRs. The question of how many technologies should emerge as winners to achieve economies of scale within SMR development was raised. Implementing lessons learned from failures across regions with varying regulatory environments, such as Japan's post-Fukushima efforts versus Italy's cautious approach, was considered. Understanding safety culture and its implications on reactor types, from micro to 300-megawatt reactors, was emphasized.

Challenges with SMRs were underlined, including high qualification costs and the need for standardization for an effective series strategies. Addressing financial aspects is crucial for efficient deployment and operation of SMRs, with over ten units needed to amortize qualification costs exceeding 1 billion euros for each design. There are plans to continue discussions, focusing on active contribution to the forth-going efforts while acknowledging the ongoing need for innovation to overcome construction risks and uncertainties in the nuclear energy sector.

4. How can nuclear contribute to achieve decarbonization in an efficient way?

- **Sandro Baldi,** commercial director International Nuclear Development, EDF, presented EDF's vision and activities on nuclear new build.

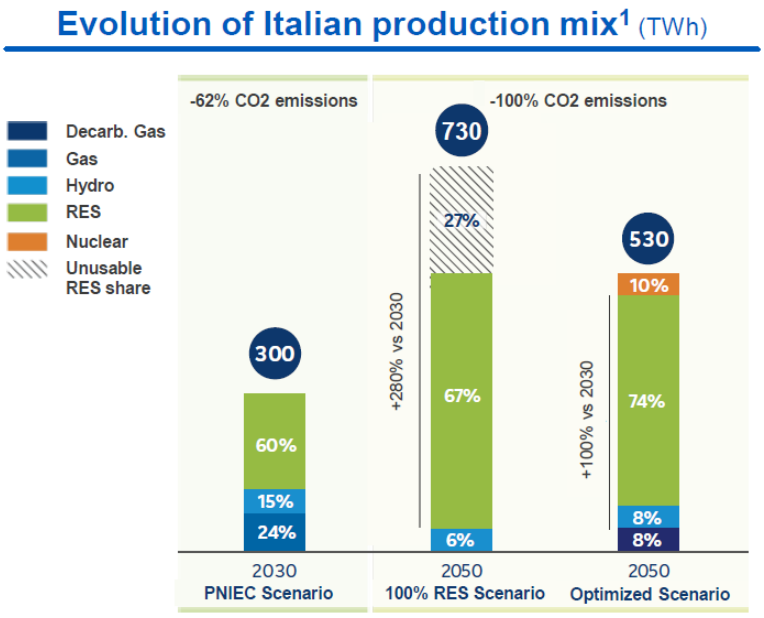
Combining innovation and efficiency, EDF's reactor portfolio (from the large size reactors to SMRs) offers tailored solutions meeting diverse energy needs for a sustainable energy future. He presented the concrete perspectives for EPR and Nuward SMR projects in Europe:

- In operation or in construction:
  - Finland: 1 EPR in commercial operation and at least 2 EPR and a Nuward SMR program
  - UK: 2 EPR under construction, 2 EPR under development, potential Nuward SMR Program
  - France: 1 EPR under construction, 6 EPR under development, and first of a kind SMR program with NUWARD SMR under development
- Bids in progress:
  - Poland: preliminary offer for up to 6 EPR and a potential NUWARD SMR program
  - Czech Republic: Bid for 1 EPR1200, potential of 3 EPR1200 and a NUWARD SMR program
- Advanced commercial discussion:
  - Sweden: Potential NUWARD SMR program. Fleet of large power units under consideration
  - The Netherlands: Potential of 2 EPR in first phase. Potential NUWARD SMR program to be considered in a second phase
  - Slovakia: Potential of 1 EPR1200 and a NUWARD SMR program
  - Slovenia: Potential for 1 EPR / 2 EPR1200

Conclusions:

- The renewed global interest in nuclear energy offers a significant opportunity for European countries and their nuclear industry.
- There is a tangible market in the next 10 years for large reactors and a growing interest in SMRs.
- EDF aims to contribute to the success of a European nuclear programme by developing a strategy around European technologies and industry. Building nuclear projects around the same technology also helps to consolidate industrial performance over time.
- EDF has significant advantages, notably being a sovereign European operator and the only one building 3rd generation reactors in Europe.
- Europe, with EDF, has the high potential to deliver its own sovereign low carbon energy solution.

- **Lorenzo Mottura,** EVP Strategy, Corporate Development & Innovation at Edison**,** presented Edison as a key energy player in Italy. In regards with low carbon and RES power generation, Edison is the 3rd national player for installed capacities (2.2 GW RES), the 2nd player for natural gas import and the 2nd player for electricity volumes sold. He presented the new nuclear in the Italian scenario:



1) PNIEC Scenario June 2023 in 2030, Edison simulated Scenario Edison in 2050

The new nuclear may contribute to the development of the Italian nuclear supply chain, both for the possible new Italian fleet and for growing EU project pipeline.

Lorenzo Mottura put the emphasis on the benefits of new nuclear for Italy:

- Electric mix decarbonation
  - Programmability and modulation: complementarity with RES
  - System costs reduction: less energy storages, less transmission lines
- Heat supply decarbonization
  - Direct heat supply to industrial clients/districts and district heating
  - High efficiency H2 production for hard-to-abate sectors
- Energy security and competitiveness
  - Contribute to reduce dependency from gas imports
  - Reduce electricity price volatility
- Growth of the Italian industry
  - Enhance the industrial value of the existing Italian supply chain, both for Italy and potentially export
  - Contribute to GDP growth and employment level growth

- **Francesca Ferrazza,** Head of ENI, Head of the Magnetic Fusion Initiatives unit at Eni S.p.A., Italy's Energy company, in charge of supporting the development of fusion technology and projects.

- **Waclaw Gudowski**, Orlen Synthos Green Energy (OSGE), Professor in Reactor Physics at the National Center of Nuclear Research (NCBJ), Swierk, Poland, and Professor in Neutron and Reactor Physics at Kungliga Tekniska Högskolan (KTH) - The Royal Institute of Technology in

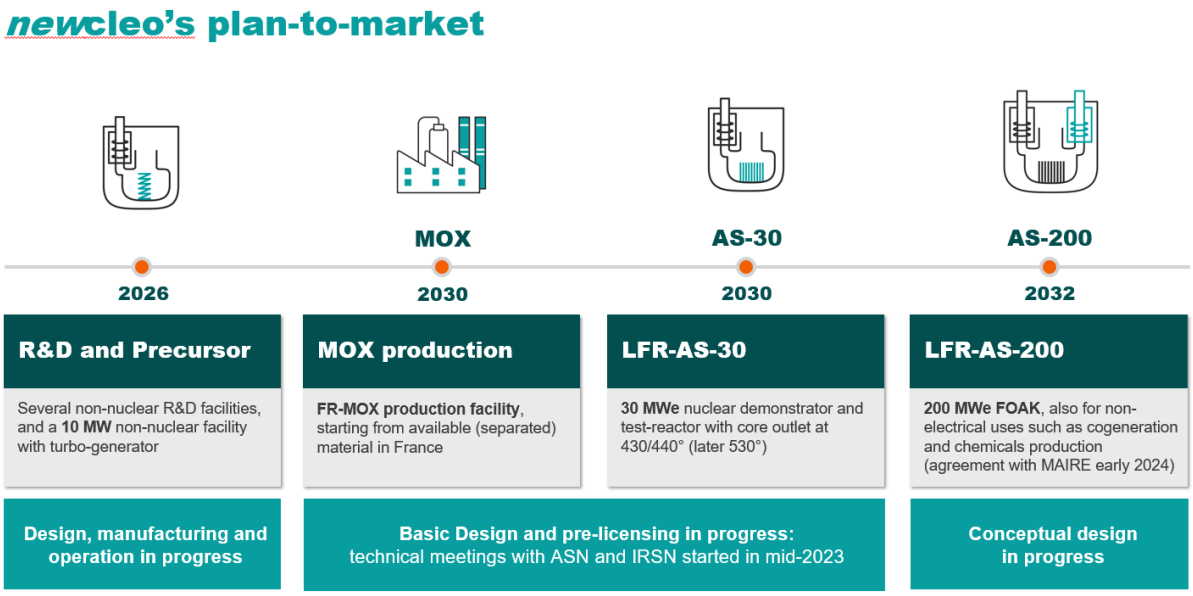
Stockholm, Sweden. He also works as an advisor to the Board of Orlen Synthos Green Energy (OSGE).

- **Anders Wik**, Vattenfall R&D, presented Vattenfall one of Europe's largest producers and retailers of electricity and heat.

The interest for nuclear in Sweden increased in the past years:

- Interest from customers,
- New technology solutions,
- Strong public support,
- Increased demand
- Security of supply

- **Luciano Cinotti**, CSO, Newcleo. Newcleo is a new innovative player in nuclear energy, launched in September 2021, it hires more than 600 persons and is currently raising up to 1 billion euros.



The **recognition of nuclear as a key solution for future energy** implies several actions highlighted by the panel:

- Market response:
  - Utilizing three main technologies to respond to the market
  - Clear view on potential projects in Europe
- Capacity Planning
  - Objective to build equivalent of two EPR

- Assessment of capacity needs for the next 20 years in Europe
- International Cooperation
  - Emphasis on serious cooperation and partnership with European utilities
  - Importance of collaboration with nuclear safety authorities
- Decarbonization Strategies
  - Focus on energy mix, technology, and markets
  - Emphasis on public acceptance, technology development, and maintaining competitive advantage
- Future Energy Scenarios
  - Simulation of different scenarios for optimization
  - Focus on contributing to decarbonization and system cost reduction
- Technological Development
  - Urgency in developing new systems and technologies
  - Importance of ongoing experimental programs and partnership growth
- Sustainability Goals
  - Urgency in reaching 2050 decarbonization goals
  - Emphasis on attracting young talent and fostering international projects
- Innovation and Collaboration
  - Ongoing activities for new European systems
  - Recommendations for cooperation and qualification in technological advancements

Summary of the session:

The session primarily focused on discussing various aspects of nuclear energy, including plans to foster European exchange, to adapt existing plants to climate change, to ensure energy security, and to address financing challenges in Europe compared to other countries like the US and the UK. Discussions also touched on responding to market demands with different technologies, emphasizing the pipeline of projects and the need for efficient processes.

Subsequently, job creation needs in Europe's nuclear energy sector were addressed. Plans outlined expanding analysis beyond France, considering Small Modular Reactors (SMR) for future development and international cooperation. The ambition was highlighted towards making nuclear a vital part of achieving carbon targets in Europe, focusing on France and the broader European perspective. Insights were shared on utilizing fission technology, hydrogen production through electrolysis, and innovative solutions like SMRs tailored for specific applications based on demand.

Furthermore, a shift towards decarbonized power sources such as fusion technology alongside advancements in hydrogen production was highlighted. The importance of developing innovative solutions including SMRs tailored for specific applications while ensuring competitiveness through technological advancements was emphasized. Recommendations were made regarding validation processes for computational chains, thermos-hydraulic knowledge, mechanics,

qualification steps, and collaborations with RES operators for the future integration of renewables into the energy mix.

In conclusion, the session underlined the significance of rigorous validation processes. The discussions emphasized uncertainties surrounding project timelines and the importance of incorporating renewable energy sources into the energy mix, focusing on future integration and ensuring optimal performance levels within varying contexts.

5. SNETP Stakeholders session

This panel gathered relevant and new SNETP stakeholders having signed a Memorandum of Understanding (MoU) with the SNETP association. Their diverse interests and perspectives bring opportunities to cooperate internationally on nuclear applications (e.g. ESA Space propulsion) or to learn from each other on how to stimulate broader social communication, and how to engage with civil society, other corporate associations, the young generation and workforce of the future. They can contribute to identifying priorities in the development and deployment of cross-cutting sustainable nuclear research and innovative technologies. They can enable broader understanding of the area by engaging with civil society, by supporting soft skills, knowledge sharing and understanding of responsible uses of civil nuclear applications, energy and non-energy applications, for the health, wealth and benefits of every European citizen to tackle today's societal challenges.

- **Yves Desbazeille**, Director-General of Nucleareurope

Nucleareurope is the Brussels-based nuclear industry trade association in Europe. Nucleareurope acts as the voice of the European nuclear industry in energy policy discussions with EU Institutions and other key stakeholders. The membership of Nucleareurope is made up of 15 national nuclear associations representing nearly 3,000 companies.

The industry point of view focuses on accelerating the deployment of nuclear technologies for reaching the net-zero CO2 emission targets, either for current reactor designs but also SMRs which can fulfil specific electric and co-generation needs e.g. on clean heat for energy-intensive industries, hydrogen generation, contributing to the decarbonisation of the EU energy mix.

The Commission recognizes the potential contribution of Small Modular Reactors to achieving the energy and climate objectives of the EU Green Deal, as reflected in its recommendation for the 2040 emission reduction targets.

The nuclear industry should therefore engage on the following:

- To deliver on time and within budget all projects, be it large or small, and support the development of complementary advanced nuclear technologies to achieve sustainability of nuclear fission in the longer term e.g. through innovation, using common standards, demonstration, industrialisation, and advanced SMRs

- A strong supply chain, benefitting from state-of-the-art infrastructures, a skilled and well-trained workforce, and various training career opportunities
- With public/private financial support for large investments, enhancing competitiveness, and enabling an economic optimisation and advantages of constructions in series
- And working towards converging Licensing processes, safety and reliability, but also security and non-proliferation of the technologies selected

- **Valérie Faudon**, General Delegate of SFEN

The SFEN (French Nuclear Energy Society) is the French crossroads for knowledge on nuclear energy. Created in 1973, the mission of the SFEN is to develop the knowledge of all those interested in nuclear energy. The SFEN brings together 3,600 professionals, engineers, technicians, chemists, doctors, professors, and students, from French industrial sites and nuclear research organizations.

SFEN is a nuclear society and advocate playing a crucial role to promote transparency, accountability, production and dissemination of knowledge, and public trust in nuclear sciences and technologies.

We have seen in the two recent years a shift in favour for Nuclear within Europe at various political and local levels as a result of the invasion of Ukraine by the Russian Federation and the energy crisis.

- There is a political support of 15 European Member States, taking into account economic considerations, radioactive waste management and geological repositories progress other the last 3 decades, promotion of a real circular economy of the industry, high levels of safety, non-proliferation and security (3S) in the new technological designs, and security of energy supply for Europe
- There is a combination of long term and secure vision of the needs to decarbonise the economy, net-zero by 2050, innovation investments and technology developments, international cooperation and promotion of science diplomacy
- European Member states need to ensure the ''Sustainability triangle's equilibrium between Economy, Environment and Social pillars'' is achieved, having comprehensive environmental, economical and social impact assessments, and where decisions benefit from unbiased evidence-based policy making that anyone can fully trust
- Today's citizens' engagement is growing, dialogue on ethical and societal issues is promoted more extensively between all actors being researchers, industry, regulators, policy makers and local communities, for the public health and wealth benefits of every European citizen to tackle today's societal challenges.

- **Jamila Mansouri,** Head of Propulsion, Aerothermodynamics and Flight Vehicles Engineering Division- ESA

The European Space Agency (ESA) was established in 1975 and has now 22 Member States, with more than 500 million European citizens. Its mission is the peaceful exploration and use of space for the benefit of everyone.

In a more general framework, ESA is member of the International Space Exploration Coordination Group (ISECG) that is a forum set up by 14 space agencies to advance the Global Exploration Strategy through coordination of their mutual efforts in space exploration.

ISECG has performed a technology gap assessment on nuclear power & propulsion to identify nuclear technology needs to be filled in order to achieve the objectives of its Global Exploration Roadmap (GER). Four categories are considered for nuclear technologies to provide solutions covering thermal and electrical power needs:

- radioisotope systems offer thermal and electrical solutions from a few watts up to one kilowatt
- small reactors can generate electricity from a few kilowatts up to 100 kilowatts
- large reactors from 100 kilowatts up to one megawatt and beyond
- special reactors which can provide large quantities of heat for nuclear thermal rockets or electricity for nuclear electric thrusters

European led capabilities in the 2030-2040 time-span will cover radio-isotopes, nuclear power and nuclear propulsion. In ESA, the Innovative Propulsion Cross Cutting Initiative (IP-CCI) follows previous and ongoing cross-cutting initiatives by focusing on particular topics of interest in breakthrough technologies to harness significant benefits in terms of mass, performance, cost and flexibility.

All those three topics can be source of partnerships with SNETP as the ESA and its members can deploy limited expertise in such fields. Cross-cutting topics may include:

- Advances in nuclear technologies both for land and spatial applications in heat and power productions
- Experience in tackling extreme if not adverse deployment and operational conditions
- Regulatory aspects related to nuclear technologies' deployment.

- **Amparo Soler**, WiN Global, President of WiN Spain

Women in Nuclear (WiN) Global is a non-profit organisation of women working professionally in various areas of nuclear energy and radiation applications, open to individuals from all genders, and legally registered in Vienna, Austria. Since the WiN foundation on 27 November 1992, they have been strong advocates for environmental sustainability, diversity and gender equality. WiN Global plays a relevant role on all continents and keeps a balanced geographical representation.

With around 35.000 members and over 20 partners, WiN Global is a solid network with a strong presence in more than 145 countries, regions and international organisations. WiN Global is an influential player of the nuclear sector at the international, regional, and national levels, and actively contributes resources to define nuclear policies and gender equality strategies in the nuclear field.

WiN Global and the SNETP have officialised their partnership by the signature of a MoU by WiN Global President, Dominique Mouillot, and Bernard Salha, SNETP President, at the World Nuclear Exhibition in Paris (30th November 2023).

Joint efforts within this partnership cover:

- Education, training and mentorship to promote gender balance and diversity in the nuclear sector
- Networks of expertise, promoting the expertise and vast experience of WiN G membership in various strategic areas of the nuclear sector, with the support of key partners, which could cover vital areas such as decommissioning and innovation
- Joint communication.

- **Jadwiga Najder,** ENS Science and Outreach Manager

European Nuclear Society (ENS) is a Learned Society that brings nuclear societies and professionals in Europe together with more than 12,000 professionals from the academic world, research centres, industry and authorities, allowing them to exchange knowledge and experience about nuclear science and technology. ENS promotes the development of nuclear science and technology and the understanding of peaceful nuclear applications. Founded in 1975, ENS is the largest society for nuclear science, research and industry in Europe.

The contribution of the nuclear sector to the decarbonisation strongly requires the engagement of the talented and motivated workforce, in particular the young generations, to match the short- and long- term challenges underlying the nuclear technologies' deployment.

Summary of the session:

Several key points to help attract and retain people:

- There is a need to work on improving the public opinion on the nuclear technologies for power generation by adequate communication on ethical and societal issues to restore the reputation of the sector
- Nuclear as solution for reaching the net-zero objectives must be recognized by official institutions and must receive the full support on the long term by governmental bodies of any level in EU and its member states
- Talented and motivated young generations require high quality education and training, which goes through adequality supporting and funding E&T organisations and infrastructures to ensure diversity in skills and mobility
- Help young people to develop a deeper understanding of nuclear fission implications for our energy future, giving a view on and offering opportunities to dive into nuclear sector from school age on and projects for early careers promoting their professional development.

The success in reaching those goals requires the commitment of all nuclear stakeholders.

During the panel, the importance of European partnerships in strengthening nuclear research and industry capabilities was marked by the agreement between SNETP and the European Nuclear Society (ENS), signed by their presidents, Bernard Salha and Stefano Monti.

6. Technical session – Business strategies for SMRs: Coordinated approach to accelerate the deployment of SMRs - Increasing the bankability of Small Modular Reactors

This technical session was moderated by Józef Sobolewski (NCBJ).

6.1. Scope

There are two technical panels related to SMR strategies. This first one was dedicated to the increase of bankability of SMRs, second one to the most important initiative in this area within the EU: the SMR Industrial Alliance. But both panels investigated the same topic; how to accelerate the deployment of SMRs in the EU.
How to increase the bankability is not easy to answer. Bankability of SMR projects depends on multiple factors: financial health, environmental impact, social acceptance, and investor return. Investors need confidence in stable political, economic, and regulatory environments. SMRs are a new technology requiring successful demonstration plants to prove their economic viability. There are three different approaches presented, the Czechia implementation roadmap, the rule of startups and the French program with the vision of Nuward deployment.

6.2. Summary of technical sessions

6.2.1. **Jan Prasil,** Director of New Energy Technologies Department, Ministry of Trade and Industry, Czech Republic : Experience of the Czech SMR Roadmap implementation

Jan Prasil explained the steps taken and planned by relevant Czech Ministries, the regulatory body and potential investors on the way to deploy SMRs in Czechia. The construction of small and medium-sized reactors is envisaged in National Energy and Climate plan, with a view to operationalizing the first SMR in the mid30s. The potential is estimated up to 3 GWe in SMRs. Three utilities have declared their interest in SMRs, one of them envisages to select the technology by the end of 2024. The viable financing model for SMRs in Czechia needs to involve different financial institutions and tools. There is an initial phase of discussions about the state aid measures and export financing with no specific milestones yet.

6.2.2. **Guerric de Crombrugghe**, Partner at Nuketech, Belgium: Deep dive in the nuclear energy startup ecosystem

Guerric de Crombrugghe presented the venture capital company Nuketech's perspective on innovation within the nuclear startup ecosystem. What issues can startups help to solve? Answer was; do faster, better, with less. Startups can bring technology in four main segments: digitalization, robotization, hardware cost reduction and innovation across different aspects of

nuclear activities. There are over 170 nuclear startups over the world. Nearly half of them in EU. Nuketech will investigate the thematic focuses, geographical distribution, synergistic relationships with other sectors, and potential strategies to foster the emergence of nuclear startups.

6.2.3. **Fabrice Legendre**, Innovative Nuclear Program Agency (APNI), France : Background and current status of France 2030 support for innovative nuclear reactors" of SMRs

Fabrice Legendre explained the objectives of the nuclear part of France 2030, which aims to support research and development projects on nuclear reactors, the French government has launched a program of calls for projects (AAP) designed to support new innovative nuclear reactor concepts, in the fields of nuclear fission and fusion, and to create a new ecosystem of nuclear start-ups. The presentation focused on the context and terms of the call for innovative reactor projects, and indicated the projects which are laureates from the first stage of the program.

6.2.4. **Sandro Baldi**, Commercial Director NUWARD SMR – EDF, France, Unlocking the potentials of the European SMR market

Sandro Baldi compared large and small nuclear solutions. While large scale reactors require large upfront investment with long construction duration impacting the payback period, they are largely proven and deliver an excellent and competitive low-carbon service to the electricity grid. On the other hand, SMR are supposed to have shorter construction duration and smaller upfront individual capital investment but they suffer from the scale-down effect which works adversely on cost per installed kilowatt. In order to unlock SMR full potential a number of market conditions need to be met: simplification and standardisation of design, exportability and licensing of design, planning for a fleet, developing the supply chain, and financing. EDF is working on all of these dimensions to make SMR market real.

6.3. Take-aways

We do not have real data about economic viability of SMR and therefore their bankability is still to be proven. We have more questions than answers. There are three main topics we should consider:

- Financing of the deployment:
  - First phase - Development, financing mechanisms exist mainly supported by state, but also possible one supported by private investors.
  - Second phase - FOAK is at the bottom of the valley of death. State aid is still expected. It was not mentioned by the panellists explicitly but private-public- partnership could be envisaged.
  - Third phase - NOAK, contracts of energy supply with users (Contract for Difference, Regulated Asset Base, Power Purchase Agreement, etc.) will be the base to ensure the bankability. Not to forget the Mankala model.

- SMR - Economy of series instead economy of scale:
  - There are real challenges to develop the economy of series (simplification, standardisation, harmonization) but it can be possible.
  - The future needs are huge, and it will be dozens or hundreds reactors. The question is in which time.
  - Questions during discussion from audience: Should large NPP be completely discarded? Clear answer from panellists was that they should not be discarded.
- Role of the start-ups:
  - Start-ups can bring deployment perspective (attract investors) and also innovation to the sector to speed-up deployment (AI, robotics, etc).

7. Technical session – Business strategies for SMRs: Coordinated approach to accelerate the deployment of SMRs - The SMR industrial alliance

This technical session was moderated by Stéphane Sarrade (CEA).

7.1. Scope

Two technical panels related to SMR strategies were scheduled during the forum. This first one was dedicated the increase of bankability of SMRs, and the second one on the important initiative in this area in EU, the SMR Industrial Alliance.
This second session aimed at discussing how European cooperation can help accelerate the deployment of SMRs in Europe. Four presentations were given during this session: a general presentation on the newly launched European SMR industrial alliance whose aim is to help develop SMR projects in Europe; the partnership between two start-ups and how they can develop common facilities to create the best conditions to accelerate the development of the technology, a presentation on the SMR business model and finally a presentation on the EASI-SMR EU project to be started in 2024.

7.2. Summary of technical sessions

7.2.1. **A. Al Mazouzi**, EDF, SNETP, European industrial alliance on small modular reactors: general presentation

Abdou Al Mazouzi gave a general presentation on the newly launched European Industrial Alliance on SMR, resulting from the work carried out with the European SMR pre-partnership over the last couple of years. The alliance was launched in early 2024 with the objective to accelerate the development, demonstration and deployment of SMRs projects in Europe in the early 2030s, by assisting emerging SMRs projects to reach the demonstration and deployment phase. The Alliance will provide a framework for coordinating activities, preparing analytical studies, sharing best practices, developing, and conducting joint actions aimed at fostering the deployment of SMRs in Europe. The structure will be divided between technical working groups and project

based working groups. A strategic action plan will be established by early 2025 to deliver on specific tasks such as:

- facilitate interactions between different stakeholders,
- develop a technology roadmap,
- promote connections with potential end-users,
- map and regularly assess the performance and completeness of the European supply chain,
- map the availability of financial support, attract private investment,
- identify and prioritise future needs for research, innovation, qualification, demonstration, and skills development
- explore the skills and training needs,
- strengthen exchanges and contacts of project promoters with the European Nuclear Safety Regulators Group and national safety authorities,
- engage stakeholders in a dialogue .

7.2.2. **Kiki Lauwers** –Thorizon and **Jean Luc Alexandre**-Naarea Coordinated approach to accelerate the deployment of molten salt technology

Kiki Lauwers and Jean-Luc Alexandre jointly presented the approach to develop molten salt technology. Thorizon and Naarea are two start-up companies based on molten salts technologies. Since February. 2024, both start-ups have signed a collaboration agreement to create the best conditions to accelerate the development of the technology. Their partnership will contribute to pool common resources for demonstrations and build knowledge in MSR technology, developed shared laboratories and test facilities, secure access to reprocessed fuel materials needed, provide the market with complementary energy solutions with common basis and increase support basis for MSR technology.

7.2.3. **Roberto Adinolfi,** Ansaldo Nucleare, the SMR business model: what is going to change in the industry?

Roberto Adinolfi focused on the new SMR business model and explained what should change in the industry. Over the last few years, we have observed in Europe a growing nuclear market driven by energy polices and energy security concerns. This was characterised by the announcement of new build programmes in some European countries and support for the development of innovative reactors such as SMRs. The emergence of the SMRs markets bring a change in business model and new investments are needed to ensure sustainability. In addition, it was mentioned that supply chain will be a critical feature of the upcoming European market and will play a fundamental role for their success.

7.2.4. Nicolas Sobecki, EDF, EU project EASI-SMR

Nicolas Sobecki summarized the objectives of the newly accepted European project EASI-SMR starting in 2024 and that will focus on two reference LWR designs: NUWARD (170 MWe) and LDR-50 (50 MWe). This project gathers 35 partners from 16 countries. The main objectives of the project are to address safety issues related to LWR to ensure the highest level of safety, assess the impact of different designs on safety and address regulatory and societal challenges towards the deployment of SMRs in Europe.

7.3. Summary of panel discussion

Two main topics were addressed during the panel discussion: the need for a sustainable supply chain and the acceleration of deployment of SMRs. Concerning the supply chain, it becomes clear that a unique integrated supply chain is needed and that vendors should promote and secure this supply chain within Europe. Accelerating the deployment of SMRs would benefit from lessons learned from other industries. In addition, public and private investments are needed. It appears important to develop and maintain long-term partnerships and collaborations through EU programs and in particular, to develop common facilities and laboratories and to share existing or new platforms and validation codes.

8. Technical session – New NPPs (Lessons learned and how to improve)

This technical session was moderated by Pavel Kral (UJV), Petri Kinnunen (VTT) and Szavai Szabolcs (Bay Zoltan).

8.1. Scope

Licensing, building and commissioning of big NPP units is an extremely important task, presently not so much in focus as are the SMRs. Therefore, the organization team of the SNETP Forum included this type of session in its program. The six presentations covered a wide range of topics related to “new build”: overview of nuclear new build with 2050 perspective, public acceptance of nuclear, preparation of licensing analyses, construction works, and experience from the first campaign of a new reactor unit. The presentations and discussions confirmed that Europe is restarting and strengthening its capabilities for building of new big nuclear power plants.

8.2. Summary of technical session

8.2.1. Andrea Goicea, Nuclear Europe, Overview of nuclear new build in EU with 2050 perspective

The first presentation was given by Andrea Goicea who gave an overview of nuclear new build with a 2050 perspective. Nucleareurope's role is to make policy and discuss it with the EU. The EU needs to decarbonise massively in all sectors. It is not only electricity, but also hydrogen, industrial heat and district heat. However, in many scenarios, installed nuclear capacity appears to be declining. The new Nuclear Alliance on SMRs is a step towards a more ambitious European nuclear future. In total, all planned new builds should reach 150 GW capacity. In the past, 127 GW were built in 20 years, so the current target should be achievable. The challenges for nuclear new

builds are well known, the most important being the supply chain. Component availability, large component manufacturing, etc. are the main supply chain issues. The available workforce also remains one of the big challenges. The positive thing is that there are several companies in Europe with world-class expertise.

8.2.2. **Attila Hugyecz**, Paks2, Current status of the Paks II project

Attila Hugyecz explained the status of the Paks II project. The plans are to construct two new VVER-1200 type of units of at least 1000 MW. EU has given green light on the project. Actually, the project is not Russian but international as the requirements are based on EUR, IAEA and WENRA. Also, relevant parts of the reactor systems come from western Europe. Also, the EU procurement obligations apply (55% of EPC value to be offered for tenders publicly available). The Paks II project will result in units 5 and 6 in Paks NPP. The construction license was obtained in 2022. The site excavation works are on-going currently. One specificity in the new build site is the cut-off wall that surrounds the new reactors and enables the control of the ground water flows on the site. The soil improvement is a noticeable effort on the site. The core catcher has been manufactured and the RPV manufacturing is about to start soon. The state aid has been a difficult topic in the process and politically impacted.

8.2.3. **Pavel Kral**, UJV, Building expertise for safety assessment of the new build PWR in the Czech Republic. Comparison of VVER and PWR safety characteristics

Pavel Kral gave a presentation on building expertise for safety assessment of PWR design in Czech Republic. The presentation handled e.g., comparison of safety characteristics of VVERs and PWRs concerning the basic reactor coolant system, the secondary system and the ECCS characteristics. The comparison outcome has increased knowledge on PWRs in Czechia. UJV has also validated several computer codes on the PWR type tests indicating the differences in the code outcome. After the validation several PWR and LW-SMR models have been prepared or modified at UJV. Pavel also indicated the importance of international co-operation in the development work.

8.2.4. **Merja Airola**, VTT, Public acceptance of nuclear. Fostering social acceptability & engagement: Insights from Finnish nuclear sector

Merja Airola’s topic was public acceptance of nuclear in Finland. Public acceptance as a term is quite differently understood in different occasions. There are several levels in “social license to operate”. The stakeholder engagement is a wide area to cover. Learnings can be taken e.g., from Canada, where the SMR acceptability has been widely studied. Example from the US is related to the spent nuclear fuel. In Finland the interest in SMRs has increased remarkably. Different studies are currently on-going. In Finland the trust in institutions is high. Now the SMRs in Finland are planned to be located in cities, and that changes the view quite much in comparison to earlier projects. The studies indicate that men are supporting nuclear more than women, but the reason for this difference is not well known. The surveys indicate that openness and transparency are

extremely important. The processes of social acceptability and participation underscore the dynamic nature and the complexity involved.

8.2.5. Anne Kontula, TVO, Experiences in OL3

Anne Kontula gave a lesson on learnings from OL3 project in Finland. OL3 started its regular production in April 2023 and it is currently in its first maintenance outage. The plant's design basis lifetime is 60 years. In the first year two unexpected shutdowns happened. One was due to valves and the other one was caused by external factors. The lessons learned include e.g., design readiness, regulator readiness, communication, data management, safety culture, co-operation, etc. Understanding of the root causes of problems is a key factor. The importance of the schedule cannot be overemphasized. And the collaboration needs to be close and effective. The first annual outage is currently on-going and its original schedule was 40 days. However, it needs to be extended for more than 20 days due to longer-than-expected time for maintenance and inspection processes. After the first three outages the period between maintenances will be increased to two years eventually.

8.2.6. **Marisa van der Walt**, NRG,PALLAS, Experiences from licensing – The Pallas Reactor

Marisa van der Walt explained experiences from licensing and construction in progress for the PALLAS reactor in Netherlands. The radioisotope market is a difficult market in overall and predictions are difficult to make. The contracts have been changed in the middle of the project due to the need to minimize risks. Public financing has been secured. Key success factors need to be defined (like "we will not start constructing until we are ready"). A very structured way of working is needed. Also, the value engineering is a must and it contains not only the costs of the reactors but also other values related to the project (like the safety for the workers). The major learning has been that you need to take your time in the beginning of the project and it will save time later.

9. Technical session– Supply Chain Session

This technical session was moderated by Michele Frignani (Ansaldo Nucleare), Christophe Schneidesch (Engie), Baptiste Pothet (Framatome).

9.1. Scope

Considering the current ramp-up of nuclear programs in Europe, the progresses made by the SMR and AMR startups and the projections to fit the decarbonations expectations, the supply chain session intends to investigate the state of the European supply chain, its vision of the challenges ahead and provide elements regarding the programs that have been engaged by the European actors to bridge the potential gaps.

The session gathered the following contributors and the direction of their speech:

- Aline Des Cloizeaux, IAEA - commercial grade dedication & harmonization
- Leena Aarnio-Wihuri, Fortum, Finland - SMR pre-partnership WS4 (Supply Chain)
- Mohamed Zouari, Framatome, France - state of the French supply chain to support New Builds
- Michele Frignani, Ansaldo Nucleare, Italy - Italian supply chain capabilities and capacity
- Charles Carpenter, NAMRC, UK – supporting the UK Nuclear supply chain
- Massimiliano Tacconelli, Walter Tosto, Italy - Enhancing Nuclear Manufacturing through Technological Innovation
- 1.2.7. Teemu Kelavirta, Fortum, Finland – KELPO: Use of serially produced commercial grade equipment

9.2. Summary of technical sessions

9.2.1. **Aline Des Cloizeaux**, IAEA - commercial grade dedication & harmonization

A specific program has been setup, considering a shift in the nuclear landscape, including startups. IAEA considered several points of views, such as: nuclear suppliers require stability to invest; regulatory bodies expect a local supply. Hence, the NHSI initiative has been built to make nuclear simpler, with the following axes:

- More harmonization - notably to make series savings possible.
- Common approach for codes & standards from the existing ones; with a graded approach

IAEA entered the second phase of the process this year, with strong dissemination objectives through several forums / meetings. TSO are involved through a dedicated TSO forum.

9.2.2. **Leena Aarnio-Wihuri**, Fortum, Finland - SMR pre-partnership WS4 (Supply Chain)

The SMR pre-partnership highlighted several specificities:

- SMR seek competitiveness through the series approach.
- Modular erection approach is advised.

In order to gather insights from the SMR ecosystem, 91 suppliers have been identified in the EU and have been asked to answer a survey. Those suppliers have been characterized as such:

- 60% are familiar with nuclear tech.
- 60% are confident to increase capacity if provided business perspectives.
- They need raw material and workforce.

The main take-away of the survey are:

- An expectation to push and promote cooperation, as a lever to accelerate market penetration.
- The ecosystem expects mutual recognition from TSO.
- Cross border deployment will be necessary.

The question session highlighted that IP-related challenges have not been discussed within the pre-partnership construction phase.

9.2.3. **Mohamed Zouari**, Framatome, France - state of the French supply chain to support New Builds

Equipment manufacturing is a key element to answer to the ambitious roadmaps of reduction of emissions. As of France, heavy investments are ongoing to be able to deliver 1,5 EPR/year.

Advanced and additive manufacturing is being used to leverage our capacities, with the objective to produce quicker, cheaper, and with an enhanced quality. Several processes and materials have been qualified and parts have been delivered for irradiation. Gains have been measured for those new methods on a case by case basis:

- Impellers production time is reduced by the factor of 2.
- The technologies may help reducing CO2 releases, up to 70% reduction.
- New designs are possible for new builds.

9.2.4. **Michele Frignani**, Ansaldo Nucleare, Italy - Italian supply chain capabilities and capacity

In 1960s, Italy was a leading country in nuclear but the Chernobyl accident annihilated the public acceptance in the Italian nuclear program. Considering this initial statement, Michele highlighted the reasons of the resilience of the Italian supply chain:

- programs continued, notably on passive systems.
- Italy contributed to the French SFR program and the erection of SuperPhenix.
- Italy maintained work on fusion, notably on JET, ITER.

Consequently:

- About 8 B€ in decommissioning contracts have been won.
- 1,6 B€ on ITER contracts.
- Plus support in new built programs abroad.
- As well as participations on the maintenance of the French fleet.

The capacity of the Italian supply is evaluated at 8 SMR RPV/year, reinforced by a notable tradition with large forgings.

9.2.5. **Charles Carpenter**, NAMRC, UK – supporting the UK Nuclear supply chain

Charles Carpenter emphasized that Net zero targets for clean, secure, and low-carbon energy will require significant activities across the supply to deliver this ambition. There will be a significant opportunity for companies across the supply but there are large challenges in areas such as supply

chain capacity and required workforce. The Nuclear AMRC is supporting the UK nuclear sector through manufacturing innovation and supply chain development.

In the UK, there is a conjunction of requests between civil and defence nuclear applications, that challenges UK's supply chain. The gap between the forecasted demand and the capacity has been analysed; NAMRC built up programs as a response. fit4nuclear is part of it, implementing a cohort approach. The impact for the companies has been monitored: it brought more than 2 B£ of contracts.

NAMRC otherwise carries out several programs regarding innovative technologies to improve the manufacturing flow, such as Electron Beam weld, allowing drastic reduction of welding time, or HIP for vessel head.

9.2.6. **Massimiliano Tacconelli** , Walter Tosto, Italy - Enhancing Nuclear Manufacturing through Technological Innovation

Walter Tosto identified several pillars in the perspective of SMR cost reduction: productivity, repeatability, modularity, quality, traceability, logistics; and implemented technologies to serve these pillars:

- EB weld, with very large machines; capable of 100 mm thickness; efficient for circular welds,
- Monoweld, with a narrow chamfer,
- Large machining solutions,
- Large cutting machines for precise assembly,
- Capability to project a 3D model on parts,
- Real time tracking of the production (industry 4.0),
- A handling tank for large components has been developed.

9.2.7. **Teemu Kelavirta**, Fortum, Finland – KELPO: Use of serially produced commercial grade equipment

Fortum uses the KELPO procedure for commercial graded dedication, that has been a solution to overcome the challenges of Finland nuclear industry and it is opportunity to reduce exploitation costs. The KELPO Procedure, in a nutshell, applies to systems except the primary loops. KELPO expects a good collaboration between the licensee and the suppliers.

KELPO is based on:

- The supplier's own quality procedure and supplier´s existing product series,
- A recurrent audit of the supplier that testifies the sound quality procedure,
- The pressure equipment directive (PED),
- Full transparency towards the regulator and towards the supplier,
- Verified information transfer between licensee and manufacturer.

The implementation of KELPO in Finland required 2 years, via a pilot project. The time can be shorter in other countries. KELPO appears now to be a gate to leverage suppliers to nuclear and allows reducing equipment supply prices.

KELPO is in pilot phase in Sweden. The supplier for pilot has just been approved.

10. Technical session Digitalisation (including cybersecurity)

This technical session was moderated by Sanjeev Gupta (BT) and Elisabeth Guillaut (Orano), with the support of Ferry Roelofs (NRG) and Eero Vesaoja (Fortum).

10.1. Scope

Digitalisation in nuclear is crucial for enhancing efficiency, safety and monitoring of nuclear facilities. It enables real-time data analysis and predictive maintenance. In addition, robust cybersecurity measures must be considered to safeguard against potential cyber threats and ensure the integrity and security of nuclear systems and data.

The session covered the following topics:

- How nuclear support the innovation in digitalization, and vice-versa how innovations from other sectors can benefit to the nuclear industry, including topics such as AI and robotics.
- How to create the right framework conditions to accompany the transformation of our processes to benefit from this digital trend, while ensuring appropriate cybersecurity for operators.
- Examples of projects supported by the Euratom training and research programme.

10.2. Summary of technical session

As an introduction of the session, the moderator presented the recently launched initiative on a European Thermal Hydraulics Community (ETHC), developed in the frame of SNETP. Its mission is to establish, stimulate, share and maintain high-level knowledge and expertise in all areas of Nuclear Thermal Hydraulics. Please contact SNETP Secretariat for being added to the mailing list.

10.2.1. **Hervé Bury**, FRAMATOME, The cybersecurity journey of critical nuclear assets:

Cybersecurity approaches comprise several steps, from design to continuous computer security maintenance. It includes architecture and design, identification and classification, vulnerability and remediation intelligence, risk mitigation and remediation implementation. This graded approach allowed the development of a global strategy promoted by nuclear codes and standards, for nuclear systems during their full life cycle. FRAMATOME developed a system to identify and check potential vulnerabilities (vulnerability scans and automatic routines, OEM and supply chain collaboration, documentation parsing) combined with industrial context. The defence is built accordingly. As a conclusion, it was reminded that new designs bring new challenges in terms of

cybersecurity: for example, simulation and twins are giving productivity advantages in both design and operation phase but continuous connections to simulated environments is opening attack surface.

10.2.2. **Szavai Szabolcs**, BZ, Application of AI and machine learning for evaluation of X-Ray inspection of welds:

Non-destructive testing (NDT) ensures the quality of welded structures without damaging them. Regulations define what NDT tests are needed. Current X-ray testing is manual and slow, so BZ proposes an AI-based system to automate analysis and improve efficiency. This system would meet industry standards and integrate with other data analysis tools.

10.2.3. **Niklas Hurmerinta**, Fortum, Application of Large Language Models in the Nuclear Field:

An on-premises AI assistant was established at the company. It is a natural language model that understands questions, retrieves relevant sections from relevant literature and facilitates operators work. It requires its own hardware and support, and focuses on a selected use case and limited scope. Main risks and challenges are safety and regulation (including cybersecurity) and usability (it provides training for employees and facilitates data democratization).

10.2.4. **Sofiane Benhamadouche**, EDF, Challenges and added value of High-Performance Computing:

CFD simulates fluid flow and temperature at a small scale, predicting forces on objects, temperature changes and more. CFD uses equations and numerical methods to solve problems. There are commercial and open-source solvers available. Because fluid flow can be chaotic, simplified approaches are often used, but for more detailed simulations, high-resolution approaches are required. The nuclear industry uses both approaches depending on the specific needs. Powerful computers are essential for complex CFD simulations. HPC uses many CPUs to perform these calculations. Two industrial examples are given: predicting temperature variations in a nuclear reactor and simulating flow through a control rod guide assembly.

10.2.5. **Jean-Reynald Macé**, ORANO, Factory of Tomorrow:

A project aiming to accelerate I4.0 cutting edge technologies deployment within Orano's plants, today and tomorrow, was presented. It covers 5 business pillars: smart plant, augmented operator, proactive management of waste and dismantling, connected logistics and transports, digital engineering. These innovations are used in different phases (design phase, operation, maintenance…). The I4.O technologies are an operational efficiency enhancement and safety accelerator for existing plants and for assisting operators in complex situations. For future plants, an essential enabler in order to address more dosing, high temperature and corrosive

environments, and for new activities, an enabler to better understanding complex process and facilitate effective scaling-up.

10.2.6. **Cristina Corrales**, EPRI, Digital innovation study proposal overview and intent and current research on digital innovation:

SNETP has recently launched a study to be performed by EPRI on Digital Innovation. The application areas for the study, the process for collecting information, the analysis methodology and the schedule were presented. The study's objective is to identify the opportunities that digital transformation technologies offer to improve safety, reduce costs and increase efficiency withing the European nuclear industry.

11. Technical session – Market demand for non-electric energy products

This technical session was moderated by Michael Fütterer (JRC) and Dominique Hittner (HTR).

11.1. Scope

In SNETP Forum sessions since 2022, many non-electric applications with a large potential for decarbonization, securing strategic industry in Europe and improvement of energy security had been presented and ways were discussed to facilitate their implementation. This time, the objective was to highlight concrete industrial market demands for non-electric energy products across Europe, to show the diversity of required energy products, and to understand the size, dynamics and geographic distribution of the market.
With this in mind, a second session then addressed possible nuclear solutions to satisfy this market demand.

11.2. Summary of technical session

In this session, four large markets from the very North to the very South of Europe were described.

11.2.1. **Grzegorz Józwiak**, ORLEN SA, Poland: Role of Low Carbon Hydrogen and Synthetic fuels in energy transformation of fuels production

Grzegorz Józwiak presented the current business and the market vision of ORLEN, as a Poland-based petrochemical company, for decarbonization, and specifically the targets for hydrogen production, infrastructure development (incl. storage) and applications, in chemistry and as synthetic fuels for road, rail and air transport. Achieving ORLEN's 2030 targets would lead to a CO_2 abatement of 1.6 million tons per year. Poland is one of the biggest beneficiaries of the IPCEI Hy2Use. Current regulations indicate the need to develop the use of green hydrogen in three segments, namely for industry, transport and for production of synthetic fuels with specific emphasis on aviation. It is critical how nuclear sources will be regulated under the low-carbon fuels delegated acts in the New Gas Directive (Art. 83). In the current definitions, nuclear as an

energy source is indeed compatible with the New Gas Directive (Art. 2). Grzegorz Józwiak pointed out three areas of possible utilization of nuclear energy in this context:

- utilization of high temperature heat for H2 production in thermo-chemical water splitting processes (>850°C) or in SOE electrolysers (>720°C)
- synthetic low-carbon fuels production based on HTGR as the source of energy with usage of co-electrolysis process for syngas production
- energy from HTGR for refinery decarbonization by direct steam production or replacement fossil fuels with process heat from HTGR

In conclusion, it should be ensured that European and national legislation allow for use of nuclear reactors as a low-carbon energy source. A large and stable energy provision is paramount to decarbonization of industry.

11.2.2. **Mariusz Ilnicki**, Synthos Green Energy, Poland, H_2 and H_2 derivatives for the chemical industry, ammonia and synfuel

Mariusz Ilnicki presented Synthos Green Energy's (SGE) plans to deploy a fleet of Small Modular Reactors in Poland and beyond. A joint venture with ORLEN envisages construction of GEH's BWRX-300 and will invest USD 400 million. SGE is also working on H_2 production from high-temperature steam. The company considers nuclear H_2 production as beneficial compared to other methods.

SGE was responsible for applying for participation in the IPCEI Hydrogen where the project „Development and demonstration of hydrogen generation technology based on high-temperature steam decomposition using zero-emission energy resources" has been approved by the European Commission to receive €22 million. Part of the project involves the use of a nuclear power plant as an energy source. SGE is also participating in the Euratom project GEMINI 4.0 using an HTGR for poly-generation purposes. Mariusz Ilnicki referred to analyses from the US DOE about H_2 production capability and cost estimates from the OECD-NEA. He pointed at the importance of cost-effective nuclear H_2 as an enabler of a whole ecosystem of H_2 and its derivatives for energy storage, food security, and synthetic fuels.

11.2.3. **Juhani Hyvärinen**, LUT, Finland, District heating, cooling, and other heat applications

Juhani Hyvärinen first explained that nuclear district heating makes engineering sense as it can achieve very high efficiencies. However, consumption varies strongly during seasons, which is an economic challenge. He provided numbers for the district heating market in Europe (total of 300 TWh per year) distributed over various energy sources.
He presented numbers for 38 cities in Finland with a district heating demand of 37 TWh per year. As both fossil and biomass-based district heating are under pressure in Finland, nuclear heat could economically cover 50% of the total district heat demand. As heat cannot travel economically over long distances, this would require a number of new sites for nuclear plants. Very positively

in this context, the Finnish nuclear regulator STUK has abolished a fixed kilometre rule for the EPZ of nuclear plants, which could facilitate deployment. One of the candidate reactors is USNC's MMR, a 30-45 MWth HTGR, currently under a pre-feasibility study, not only for heating, but also industrial purposes, to be built in Lappeenranta. Juhani Hyvärinen clearly demonstrated the very large potential of such reactors in different Finnish industry sectors, which is responsible for more than 1/3 of the total Finnish energy consumption. He also pointed at different processes requiring heat and compared the suitability of LWR and HTGR.

11.2.4. **Maria Teresa Dominguez**, EAG, Spain: Seawater desalination

Maria Teresa Dominguez first provided an overview of large desalination projects worldwide and the market outlook. She explained the various technologies for desalination and highlighted that future large H_2 production facilities will also require large desalination capacity (in practice approx. 20 litters water per 1 kg H_2). She also pointed at the additional water demand for various electricity generation technologies. In Europe, climate change around the Mediterranean is expected to drive desalination needs including for agriculture. Maria Teresa Dominguez then shared operational experience from different large desalination projects in which her company is involved. EAG was a partner in the former EU project EURODESAL, which analysed different coupling methods between nuclear reactors and desalination plants. EAG currently participates in the Euratom project TANDEM, which investigates the integration of LW-SMR in future Hybrid Energy Systems, including for desalination.

She concluded her presentation by emphasizing the large market, the maturity of technologies, the high added value of HTGR for this purpose due to their poly-generation capability, and the need to demonstrate this technology in the near future.

11.3. Take-aways

Addressed in all presentations was the need to identify and develop new nuclear sites, and often close to industrial installations or agglomerations. Therefore, a very small Emergency Planning Zone (EPZ) is an asset or even a necessity for collocation of nuclear power sources. As of today, only a few safety authorities accept reduced EPZ. District cooling, although a significant potential market for energy-intensive high-rise buildings, is currently all electrified, so there is no urgent need to replace the existing installations, although this would enhance efficiency.

12. Technical session – Nuclear solutions to non-electric energy demand

This technical session was moderated by Dominique Hittner (HTR) and Michael Fütterer (JRC).

12.1. Scope

In the session dedicated to the market demand for non-electric energy products, the width of this market, its diversity and its strong growth has been evidenced. The objective of this second

session was to show concrete nuclear solutions that can respond the specifics of this market. The residual challenges for succeeding in the emergence of these solution were also addressed.

12.2. Summary of technical session

This session started with a presentation from EPRI, which allowed seeing how the challenge of decarbonisation of non-electric energy uses is addressed outside of Europe, followed by two presentations from countries, which are presently the most advanced in Europe in the development of technologies for nuclear non-electric energy applications, Poland and UK, followed by a presentation of three projects of Horizon Europe all dedicated to nuclear hydrogen production, showcasing the effort performed at Euratom level.

12.2.1. **Steve Chengelis**, EPRI, US: The Clean Energy Transition - Nuclear energy's important role as part of a low carbon future

All tools for decarbonization will need to contribute to the US energy mix, renewables, carbon capture, usage and storage, hydrogen and energy storage and will have to be combined to form together virtual power plants that can manage intermittency. In the US, the role of nuclear energy will not be devoted only to new plants including advanced systems: life extension of existing LWRs up to 80 years will be quite critical. Nevertheless, 90% of industrial heat demand will require advanced reactors that can deliver higher temperature heat than feasible from LWRs. Currently, electricity represents only 17.7% of energy end-uses, and a growth in electricity consumption (coming from nuclear and renewables) of a factor 2 to 3 is expected by 2050, but renewables will not be sufficient to fill the gap. The remainder will have to be filled mainly by nuclear. The decade starting now will be critical in terms of challenges, but will generate numerous opportunities.

12.2.2. **Mariusz Dabrowski**, NCBJ, Poland, HTGR-POLA (POLish Atomic) Research Reactor for Polygeneration

There is industrial heat demand of 6500 MWth between 400 and 550°C in Poland, presently provided by natural gas and coal. For replacing fossil fuel by low-carbon heat, NCBJ is developing HTGR technology. But taking into account the limited development of nuclear in Poland, and the absence of a demonstrated commercial offer of HTGR worldwide (except in China), a first step that is considered necessary is the construction of a research reactor of 30 MWth, HTGR-POLA, which will have the capacity to demonstrate the feasibility of industrial process heat supply at small scale. It will be constructed on the Swierk campus of NCBJ. The development of this reactor is performed in cooperation with JAEA, but it will be quite different from the Japanese research reactor HTTR, as it will integrate as many features of a commercial reactor as possible, including a steam generator. The reactor will also be a test bench for materials, equipment and fuel. Furthermore, it will be used for tests to support the safety demonstration of the future commercial reactor. HTGR-POLA will have a block type core, but with a block design close to the MHTGR (as opposed to the HTTR) design.

The basic design phase of HTGR-POLA has started in 2023 and will be completed by the end of 2024. Construction is expected to begin in 2028.

12.2.3. **Paul Nevitt**, NNL, UK: UK Nuclear – What does the future hold?

The UK government has defined a roadmap for the development of nuclear energy combining large PWRs, light water SMRs and advanced reactors. Two competitions were organised: in the first one, 6 LWR-SMR models were down selected. For advanced reactors, first HTGR technology has been assessed to be the best to meet the needs for the UK. Among HTGR designs, two have been selected, the UK-Japan HTR from a team led by NNL and the MMR from USNC.

A site has been selected for the demonstration plant and the first 2 commercial plants in the vicinity of the Hartlepool Power Station.

Moreover, a new funding scheme of £300 million has been launched to establish HALEU enrichment capacity and routes to deconversion capabilities in the UK by the end of this decade.

12.2.4. **Canet Serin**, Framatome-Covalion : Euratom projects GEMINI 4.0, TANDEM and NPHyCo

Three Euratom projects of Horizon Europe are currently addressing nuclear hydrogen production. NPHyCo is assuming an existing LWR, the two others employ different SMR technologies coupled to different hydrogen production processes: in the TANDEM project, the nuclear heat source is a LW-SMR, in GEMINI 4.0 it is an HTGR. The 3 projects share coordinated approaches to safety, communication and public acceptance, economic and impact assessment, and the development of hydrogen production flow sheets in order to deliver comparable results.

For producing hydrogen production from existing LWRs the key questions concerns profitability, which depends on the price of electricity and of CO_2, as well as on the transport possibilities to end-users. Contrary to large LWR, SMRs are expected to be built in the vicinity of end-user applications, such that transport becomes a minor issue. Both TANDEM and GEMINI 4.0 consider poly-generation of electricity, heat and hydrogen with a particular effort in TANDEM dedicated to the flexible integration of such a poly-generation supply facility into a Hybrid Energy System (HES), integrating multiple sources of energy (not only nuclear, but also renewables and energy storage). GEMINI 4.0, starting from a standard HTGR design developed in the predecessor project GEMINI+. The purpose was to deliver high temperature steam (550°C) for flexible cogeneration of process steam and electricity. Now GEMINI 4.0 aims at showing that in addition this system is able to produce hydrogen at the same time. Such a high temperature nuclear system would thus be able to cover most needs of industry for decarbonization of its processes.

In addition, the three projects address specific safety and regulatory aspects arising from poly-generation and specifically from the co-location of a nuclear plant with hydrogen production facilities.

12.3. Take-aways

It appears that for non-electricity applications a fundamental requirement for a nuclear system is to have a very small Emergency Planning Zone, such that it can be located close to applications. In addition, most industrial applications require heat at a significantly higher temperature than what LWRs produce. To avoid efficiency penalties, other types of reactors operating at higher temperature are required. Given that short term-solutions are needed to fulfil the European net-zero 2050 objective, the use of already proven technologies is preferred, which is why in several countries HTGR were selected for this purpose.

Although HTGR technology has been proven by past and present realisations, there are still some challenges on the way to industrial deployment:

- To manufacture the very specific HTGR fuel, the TRISO fuel in Europe;
- To obtain and maintain the test facilities required for component (e.g. helium loops) and fuel qualification;
- To have regulators accept the very specific safety approach of modular HTGRs for licensing the FOAK industrial system;
- To have authorities, regulators and public opinion support an increase of the number of nuclear sites and their location close to industrial applications;
- To involve end-users in the development of applications in their domains.

A large part of the growth of nuclear energy in Europe will be related to non-electric applications. Increasing efforts are visible in several European countries and overseas to face this growth. Most SMR designers now include non-electric applications in their specifications. This effort needs to be amplified to ensure that nuclear energy can contribute its part to displacing fossil fuels.

13. Technical session – LTO (innovative approaches)

This technical session was moderated by Robert Krivanek (NRG) and Christophe Vare (EDF).

13.1. Scope

The scope of the session “LTO (innovative approaches)” was to discuss latest developments and challenges connected with preparation of nuclear power plants for long term operation (LTO). Particular attention was provided to increasing considerations of LTO beyond 60 years of operation. Presentations were mostly focused on R&D activities to support safe LTO.

From all participants, it appears that there is no deadlock to operate NPPs beyond 60 years. Nevertheless, there is a need for R&D to complement gaps in knowledge. As a result, LTO is a very

active field for both industrial and R&D activities. Many initiatives are being launched. Next suitable step could be ensuring coordination and exchange of results among all of them.

13.2. Summary of technical sessions

13.2.1. **Robert Krivanek**, NRG OECD/NEA 'LTO Beyond 60 Years' project

Increasing energy prices and energy security concerns in the last years triggered growing interest of operators to consider an option of LTO beyond 60 years. 30% of operating NPPs are in operation for more than 40 years and many exceeding 50 years (source: https://www.iaea.org/PRIS).

In September 2022, NRG launched, in cooperation with OECD/NEA Working Group on Integrity and Ageing (WGIAGE), a research project 'LTO beyond 60 Years' with the objective to collect and analyse available information regarding preparation of NPPs for safe LTO beyond 60 years of operation. It will create a knowledge basis for projects to support NPPs` LTO beyond 60 years.

This research activity is divided into three phases. The project was initiated and defined in Q4 2022 and Q1 2023. Work on the research task is being performed in 2023 and 2024. Gaps in knowledge and technology will be identified and suitable solutions proposed. Dissemination activities like national and international workshops are foreseen to share projects results in 2025.

Irrespective of the approach considered for LTO, the current regulatory framework is considered to be sufficient for LTO beyond 60 years relicensing purposes and adequate demonstration of safe operation beyond 60 years. The IAEA Safety Standards comprehensively support LTO beyond 60 years.

Several countries operating NPPs have initiated technical and administrative steps to provide for evaluation and possibly allow operation beyond 60 years. First licenses for 80 years of operation were awarded in the USA in 2020.

From a technical and safety perspective, LTO beyond 60 years will require many activities including evaluation of design against latest codes and standards, dispositioning new, long-term, physical and non-physical (obsolescence) ageing related issues, environmental impact assessment, addressing human resources and knowledge transfer issues, etc. Besides economic, political and safety reasons, environmental and technical reasons may play more important role for operation up to 80 years comparing to operation up to 60 years.

The knowledge collected, analysed and disseminated within research project 'LTO beyond 60' will improve the understanding and knowledge of activities which will be needed to extend the operating time of NPPs as well as identify gaps in knowledge and technology.

13.2.2. **Michael Guillodo**, Framatome, R&D challenges for long term operations beyond 60 years

Framatome R&D for long term operations beyond sixty years (LTO60+) of light water reactors (LWR) is organized according to four guidelines linked with our core business: design,

manufacturing, and services. First guideline is about prediction degradation modes for main systems, structures, and components (SSCs) to get a better understanding of aging effects such as irradiation, fatigue, thermal, wear …, based on thermomechanical (THM) calculations to optimize operation margins. Second guideline deals with SSCs monitoring with reliable instrumentations to perform relevant measurements and data processing. Third guideline is about mitigation of aging effects by design improvement or by modifying component/material manufacturing process and in considering regular operating feedback. Last guideline aims to secure supply chain and propose innovative repair technologies.

From the guidelines, six technological bricks are currently investigated in LTO60+ R&D roadmap with medium- and long-term objectives and milestones. Non-destructive examinations (NDE) brick studies the optimization of ultrasonic testing (UT) and the coupling of UT and acoustic emission technique to better monitor aging induced by vibration phenomenon. Instrumentation brick works on temperature drift in the reactor coolant circuit (RCS) and life extension of in-core instrumentation. Fracture mechanics and fatigue modelling brick aims to ensure reactor pressure vessel (RPV) structure integrity with the risk of cracking failure, with a medium-term objective to have a validated codification in the RCC-M pressure vessel code, and with a long-term objective to get more about phenomenon understanding about mechanical damages. Water chemistry management brick is dedicated to the mastery of contamination in the RCS and corrosion product transportation from Steam Generator (SG) material manufacturing process and the effect of metallurgical properties on SG cation release phenomenon. Corrosion brick is related either to primary water stress corrosion cracking (PWSCC) of nickel base alloys and austenitic stainless steels in presence of welds, or outer diameter stress corrosion cracking (ODSCC) in secondary side environment, and particularly the investigation of the effect of chemical impurities with chemistry/electrochemistry approaches. Finally, a thermo-hydraulic (T-H) brick provides expertise in T-H studies allowing the determination of parameters of interest such as fluid temperature, pressure, and fluid-to-wall transfer coefficient in the RPV, allowing for example to improve pressurized thermal shock (PTS) transient by using a dedicated T-H system code.

First applicative case of R&D challenges for LTO60+ is involving fracture mechanics and fatigue modelling in the frame of a 4-year R&D collaboration contract between EDF and Framatome, started end-of-2023. The main objective is the establishment of a common EDF – Framatome codification on advanced fracture mechanics criteria for analysis of the risk of fast fracture and fatigue for LWRs. Investigated damages covers brittle fracture, ductile fracture, and fatigue cracks with residual stresses. R&D program aims to prepare/provide (i) test databases consolidation, (ii) theoretical and experimental validation for each criterion/justification approach and, (iii) pre-codification for introduction in the AFCEN dedicated to methods and tools for justification in fracture mechanics.

Second applicative case is to investigate the chain between THM and Computational fluid dynamics (CFD) numerical analysis to improve quantification of safety margin gains by reducing uncertainties of transient files. Main objectives consist in having a relevant coordination between T-H and THM analyses, to develop standardized CFD numerical analysis with documented and approved methods and to improve representativeness of calculations based on a better understanding of physical phenomena. The final industrial objective is to provide reliable and robust chains for safety reviews.

Finally, the main technological bricks of Framatome R&D for LTO60+ are related to NDE, instrumentation, fracture mechanics & fatigue modelling, water chemistry and corrosion management and T-H calculations. Collaborative R&D work with EDF is underway on fracture mechanics and fatigue to improve mechanical engineering methods. CFD numerical analyses is another example of LTO60+ R&D to develop new approved mechanical engineering methods.

13.2.3. **Marc Scibetta**, SCK CEN, RPV ageing and embrittlement in a LTO perspective – enhanced surveillance strategy

SCK CEN is worldwide known for the quality of surveillance programs, including mechanical tests, reactor dosimetry measurements and irradiation damage assessment. Proper and detailed analysis of all test results are delivered according to high quality standards, not only according to accreditation standards, regulations and codes but more importantly by our property-to-property correlation tools developed at SCK CEN in the framework of the enhanced surveillance strategy. The latter relies on scientifically-based physical models where rational assessment of the data is performed and compared with a large database of results and materials. This gives additional guarantees to the validity and full understanding of the data which plays a central role from the safety perspective. SCK CEN is unique in this enhanced surveillance and plays a central (and neutral) role in interactions with the safety authorities and regulatory bodies.

In the context of Reactor Vessel Surveillance Programs, SCK CEN has a multi-decennial experience in testing, analysis and interpretation of the standard surveillance capsules of all Belgian nuclear power plants, first of a kind research reactors at SCK CEN (BR1, BR2 and BR3) and several foreign reactors.

This has led to a large database of available materials and understanding of embrittlement and hardening that goes well beyond 40 years of operation allowing to support the National energy policy [Magnette]. Additional research on materials irradiated in the BR2 reactor has led to further basic understanding of embrittlement and hardening of RPV materials with respect to neutron flux and fluence, irradiation temperature, chemical composition and metallurgy of the RPV materials. As a result, SCK CEN has been at the forefront to provoke and implement adjustments to existing regulations and standards (such as ASTM, ISO, IAEA, CRPs).

Current RPV surveillance practices rely heavily on Charpy impact testing, to which fracture toughness bounds are indexed empirically. Therefore, this methodology entails significant uncertainties susceptible to penalize operation flexibility and adversely affect plant life management decisions of ageing reactors. In addition, irradiation effects on strain rate sensitivity are not taken into account and complex damage mechanisms are lumped into generic trend curves. Therefore, the enhanced surveillance methodology [Fabry94, Fabry95] was developed at SCK CEN. It incorporates property-to-property correlation, statistical fracture mechanics and damage modelling, while also taking maximum advantage of the data that is generated by conventional surveillance practices. Complementary reconstitution and miniaturizing techniques allows to implement such strategy with a minimum material inventory. The gained results can be rationalized in a physically based way to increase the reliability of the integrity assessment of the RPV.

This mechanistic property-to-property approach which combines tensile, Charpy impact, fracture toughness and Pellini drop weight tests also allows to verify the overall consistency of results and analysis.

An advanced method to correlate and convert engineering material test data (i.e. Charpy, …) towards more science based material properties (i.e. fracture toughness, …) was developed. This approach is based on advanced characterization methods such as: reconstitution and miniaturization techniques, physics based analysis methods as well as the use of advanced tools to interpret the data (FEM, neural networks, AI, ML, …). It furthermore also leads towards integrity assessments based on fracture toughness (RTT0) rather than Charpy and Pelini (RTNDT) testing [Uytdenhouwen]. Tools for safety margins can be improved, going from deterministic towards probabilistic and also towards using of real material values and reducing the strong over-conservatism. While only systematically applied in Belgium this method has been (successfully) applied in support of LTO operations in other countries.

13.2.4. **Christophe Vare**, EDF, Beyond 60 years, EDF R&D stakes

The oldest French nuclear power plants have now exceeded 40 years of operation. EDF is therefore actively preparing for the 5th ten-yearly outage programs and has initiated discussions on the operation of its nuclear reactors beyond 60 years. To reach this goal, EDF can draw on the experience of a certain number of other operators whose oldest plants have been in operation for over 50 years.

First studies on the continued operation of the reactors beyond 60 years were initiated at EDF in 2020. An initial opportunity phase (2020-2022) confirmed that reactor operation beyond 60 years was possible. The current strategic phase (2023-2024) has led to the establishment of the roadmap to be implemented to achieve this ambition. This roadmap identifies the technical deliverables to be produced in 2024. They will be examined by the French regulator over the period 2025-2026, with a view to issuing a notice on the long-term operation of nuclear reactors in France.

To date, EDF's work has led to the following conclusions:

- No player in the international nuclear industry has identified a generic technical barrier that would prevent reactors from being operated beyond 60 years,
- New R&D needs are emerging without leading to a disruptive evolution of the means to be mobilized.

R&D is a major contributor to providing the technical elements justifying the continued operation of reactors beyond 60 years. Five main R&D stakes are defined:

- Long term aging of materials which covers materials studies for operating lifetime greater than 60 years,
- Advanced methodologies for the justification of components, including licensing of new methods determining available margins more realistically,
- Climate Change with studies on the adaptation of power plants over the period 2040-2070,

- International, with the organization of experience-sharing with leading utilities worldwide and the establishment of strategic partnerships,
- Innovation to benefit from the best technologies to ensure the continued operation of reactors beyond 60 years.

Finally, some examples of innovative work carried out by EDF are presented. These include different areas: data analytics, additive manufacturing, and adaptation to climate change. Each of them contributes in its own way to EDF's new ambition for its nuclear fleet.

13.2.5. **Emma Wong**, OECD/NEA, Overview from NEA/EPRI workshop on the holistic and risk informed approaches to Long Term Operation (LTO)

The existing nuclear fleet remains the largest low-carbon source of electricity generation in OECD countries. In 2021 the average nuclear power plant had already been operating for 31 years and some 30% of reactors worldwide were already operating under long-term operation conditions. The long-term operation of this existing nuclear capacity will be essential over the next decade to keep decarbonisation targets within reach. At the same time, by keeping the long-term-operation option open, countries could also reap a wide-range of socio-economic benefits including more affordable and secure electricity supply. Nevertheless, an increasing number of reactors are being shut down earlier than expected due to policy decisions and increasing market pressures in some regions.

Currently, there are several research projects related to long term operations (LTO) of NPPs going on in various countries and organisations. It is essential for the LTO to maintain its safety and to better address effective ageing management programs (AMPs) it is time to investigate new technologies and /methods. Therefore, the OECD/NEA and EPRI have hosted a workshop to discuss an innovative approach to using holistic and risk informed approaches to asset management and LTO.

The outcomes of the workshop were multifaceted. The first was to establish a baseline from the international participants to provide an overview of the status on utilizing non-deterministic approach (including risk insight) for the ageing/asset management program. Then a common understanding of asset management, holistic and probabilistic approaches for safe, reliable and sustainable operation of NPPs amongst the participants was established. The participants had opportunities to share experiences, brainstorm innovative ideas, establish best practices and identify gaps for management of NPP assets that could leverage non-deterministic and probabilistic methodologies when practicable. Specific IAEA effort on the same topic was also presented and it was agreed that EPRI, NEA, and IAEA should coordinate these efforts to be organised around key pillars. Finally, future tasks have been identified to further the discussion and establish action items.

13.2.6. **Maksym Zarazovskii**, IPP Centre, Open Issues in Justification of WWER-1000 Long-Term Operation

Work dedicated to the short description of the most serious practical problems which are limiting the lifetime of Ukrainian WWER-1000 Nuclear Power Plants.

Firstly, the brief description of the Ukrainian nuclear fleet is given, including current status of all the Units in terms of their lifetime and lifetime extension. As for now 80% of Units are operating after design life.

Rector Pressure Vessel (RPV) is the most important part of Unit, since its replacement is practically almost impossible and has never been performed. The procedure and criteria for deterministic RPV integrity assessment are presented. Based on the RPV safety assessment experience in Ukraine the open issues in justification of WWER-1000 LTO are described, which include crack resistance of RPV cladding and Transition Temperature incorporation to RPV justification for 80 years and beyond.

Regarding RPV internals (RVI) the most severe problem is the irradiation induced void swelling. The calculations show that degradation of RVI material along with geometric distortion, called swelling, is quite severe. In fact, currently this effect is the most limiting factor for Unit lifetime.

And last open issue is the degradation of the Heat Exchanger Tubes (HET) of Steam Generator which can lead to unacceptable primary-to-secondary leaks resulting to shut down of the Unit. To improve the decision-making procedure for HET plugging the analytical risk assessment method is presented, which in particular is based on distribution law for defect depth and defect aspect ratio, taking into account laws for defect growth.

14. Technical session – Decommissioning, Dismantling and Waste Management

This technical session was organised and moderated by Anthony Banford (NNL), Nadia Cherubini (ENEA) and Erika Holt (VTT).

14.1. Scope

The Decommissioning and Dismantling (including waste management) technical session focussed on:

- Updates on the European Nuclear landscape form the European Commission
- Waste management best practices and challenges including a focus on waste minimisation and extracting value from ‘waste’
- Challenges related to decommissioning and dismantling, of existing NPP, and
- Waste management from “energetic” and “non energetic” activities.

14.2. Summary of technical sessions

14.2.1. **Gianfranco Brunetti** and **Roger Garbil**, European Commission.: Landscape Introduction –

The European Commission estimates that approximately one third of the 145 power reactors currently operating in the European Union will need to be shut down within a few decades.
This will result in the need to dismantle, decontaminate and demolish these nuclear facilities as well as to undertake processing, conditioning and disposal of nuclear waste and spent fuel. The presentation illustrated the status of the Nuclear Reactors in Europe and the projections of the decommissioning expenditures.

In particular, in the framework of their EU accession negotiations, Bulgaria, Lithuania and Slovakia took a formal commitment to close eight reactors located on their territories. Since the early 1990s, the European Commission has been working closely with those Member States to meet the closure commitments and to support the decommissioning process.
The benefits of sharing best practice in decommissioning was highlighted with ongoing exchanges of knowledge between activities on the Kozolduy and Bohunice decommissioning projects.
The European Parliament and the Council promoted actions to ensure the collection and dissemination of knowledge and expertise from current decommissioning programmes in Europe, and to support future decommissioning projects. (Council regulation 2021/100 and 2021/101).

The presentations also highlighted the role of the collaborative R&D programmes initiated by the Commission through recent calls, that have contributed to the generation of knowledge in the area of waste management and decommissioning, including projects such as THERAMIN SHARE, HARPERS, INNO4GRAPH, PLEIADES and PREDIS alongside the EURAD joint programme.

14.2.2. **Francesca Onofrio**, SOGIN, Garigliano NPP Vessel & Internals Dismantling

SOGIN, the state-owned Company in charge of the decommissioning of the Italian nuclear installations, is currently working on the dismantling of the vessel and of the internals of Garigliano Nuclear Power Plant. The vessel and the internals are the most contaminated and activated components of a nuclear power plant as they were in direct contact with the neutron flux.

The project that has been developed can be divided into three phases:

- Phase 1: dismantling of the upper internals – on going: all the material will be cut and packaged into shielded containers under water in the reactor channel. From these operations 2 ILW containers will be produced.
- Phase 2: dismantling of the upper internals – completed design phase: all the material will be mechanically and remotely cut and packaged into shielded containers under water in the reactor channel. From these operations 35 ILW containers will be produced.
- Phase 3: dismantling of the vessel - completed design phase: the vessel will be mechanically and remotely cut partially in situ and partially in the reactor channel, both

under water and in dry condition. From these operations 38 LLW containers will be produced.

All the containers will be stored in the temporary storage building on site before their shipment to the National Repository.

14.2.3. **Istvan Szoke**, IFE, Innovation Opportunities at the Intersection of AI, Data, and Robotics in the Nuclear Back-End .

The goal of this topic is to offer a comprehensive overview of the pioneering work conducted by the team at the HADRON laboratory, situated within the Institute for Energy Technology (IFE). As a non-profit research organization, IFE spearheads advancements in nuclear technology, particularly focusing on innovations for the safe operation and decommissioning of nuclear installations. At the forefront of this endeavour is the HADRON laboratory, dedicated to hazard-aware digitalization and robotics in nuclear and other sectors. With a primary emphasis on AI, data, and robotics innovations, the lab strives to ensure sustainable decommissioning and life cycle management within nuclear and allied industries. IFE's global prominence in this domain is underscored by its recognition as an International Collaborating Centre by the IAEA and its role as the host of the annual DigiDECOM conference, which serves as a focal point for digitalization and robotics innovation in the nuclear sector.

The presentation has illuminated key trends in international innovation for nuclear decommissioning and waste management, focusing on the integration of digitalization and robotics with nuclear technologies. It traced the evolution of HADRON's vision, from its inception to its realization, highlighting milestones achieved through both completed and ongoing national and international projects such as PLEIADES, PREDIS, and HARPERS.

Furthermore, the presentation has introduced three recently proposed Euratom projects—DORADO, XS-Ability, and EURAD 2 – WP DITOCO—that align with HADRON's overarching vision. These projects, developed in collaboration with international partners, symbolize a collective commitment to advancing the frontiers of nuclear back-end technology through digitalization and robotics.

14.2.4. **Christophe Bruggeman**, SCK CEN, Radium-226 – from medical miracle to annoying legacy waste to life-saving raw material.

Radium-226, discovered by Marie Curie in December 1898, was hailed as a miracle material which would cure all ailments and invigorate people and products. Its name was used to market luxury products, much like silver-gold-platinum-diamond today are used as prefixes for prestigious products. The danger of the radiation emitted by radium, particularly when ingested, was only realised much later and the story of the Radium Girls is a particular demonstration of the risks of working with radium. Soon after, the use of radium was abandoned completely and thousands of sources were collected as waste throughout the world, each country owning a few grams of the 1600-year half-life isotope in the form of needles or curie therapies sources. For decades, countries have struggled with this legacy and although smaller inventories have been disposed of

or removed to improve global nuclear security. Today, radium is once again becoming a highly precious and rare resource, particularly as the raw material from which actinium-225, one of the most promising medical alpha emitting isotopes currently under clinical development, can be produced.

The presentation illustrated the legacy and promise of radium-226 and the approach PanTera is taking to safely and responsibly use it in its Ac-225 production facility. This is an interesting example of the value in material once considered as waste.

14.2.5. **Nathalène Christ**, Cyclife , Cyclife Best practices from 30 years in the clearance and recycling of contaminated metals .

The presentation offered a comprehensive overview of Cyclife activities, focusing on contaminated metal treatment.

The presentation was structured in three sections:

1. Metal treatment facility: an overview of EDF Group and Cyclife activities, with key figures. It presents how Cyclife benefits from more than 30 years of experience in decommissioning and waste management activities. Cyclife assets are presented with a focus on Cyclife Sweden facility located in Nyköping, where more than 50,000 tonnes have successfully been processed.

2. Metal treatment process and metal recycling concept: this part of the presentation described how Cyclife studies each specific request to find the best sustainable waste route, in line with the waste hierarchy:

- Decontamination
- Volume reduction of a factors of 10 to 15
- Recycling possibilities

3. Benefits with metal melting aiming for clearance: based on the Kesselheim Steam Generator treatment example, the section demonstrated how Cyclife metal treatment lead to a recycling rate of 90%.

This was another interesting illustration of the value of applying the principles of the waste hierarchy.

14.2.6. **Alessandro Dodaro**, ENEA, Management of radioactive waste resulting from non-nuclear energy related applications .

ENEA plays a major role in the management of low and medium-level radioactive waste and high-activity sealed radioactive sources originating from medical, industrial, and research activities.

The Integrated Service is the system, including a group of authorized operators, which ensures the management of all the phases of radioactive waste cycle produced in the medical, industrial and research activities in Italy.

ENEA is the public manager of the Integrated Service by Law, performing the function of direction and control of the whole management cycle, including transport, characterization, storage, treatment and conditioning of such wastes. ENEA assumes the ownership of the collected waste and takes charge of their final disposal, releasing the waste producer from any legal responsibility.

The service offered to producers and operators in the frame of Integrated Service refers to radioactive waste and/or radioactive sources, consisting of materials with the presence of radionuclides, of which the original manufacturer does not considers re-use technically possible or economically convenient and whose only destination is the final disposal in suitable facilities.

The service is schematically divided into the following phases:

a) "collection" phase, relating to the verification of the chemical and physical characteristics at the keeper/producer of the wastes and/or radioactive sources for the purposes of acceptability at the infrastructures of the C.R. Casaccia;

b) phase of "acceptance, treatment e conditioning ", relating to the acceptance, taking charge, treatment and conditioning of collected radioactive sources and wastes;

c) phase of "temporary medium-term storage of the treated or conditioned radioactive sources and wastes ", relating to safe storage for the time necessary for their transfer to final disposal site or to another authorized operator.

The presentation illustrated the management of radioactive waste resulting from non-nuclear energy related applications by ENEA.

14.3. Highlights

The presentations in this session and the discussions in the 2024 Forum highlighted and reinforced the importance of the following topics as a focus for the future of this area;

- Sustainability – the importance of an integrated approach to waste minimisation, through application of the waste hierarchy to achieve value through the circular economy
- Advanced Technologies – development in advanced technologies including digital, artificial intelligence is accelerating, and we need to act now.
- Collaboration – the sharing of best practices in this technical area through collaboration and Learning from Experience can make a real difference to the efficiency of implementation of waste management and decommissioning.
- Industry guidance and involvement in focussing R&D is critical to achieving impact – SNETP and Nugenia can support this through position papers to inform the R&D stakeholders.

15. Technical session – Fuel cycle

This session was moderated by Marjorie Bertolus (chair NUGENIA TA7) and Marco Cherubini (NINE). It was organized by Baptiste Pothet (Framatome) and Elisabeth Guillaut (Orano).

15.1. Scope

The scope of the session “Fuel Cycle Issues” was the following:

- Efforts launched by the EU industry to reinforce security of supply (in particular to reduce dependency towards Russia);
- Needs for the new technologies of reactors (SMRs);
- Research and development efforts necessary to enhance sustainability in fuel supply;
- Perspectives for the closing of the fuel cycle

15.2. Summary of the plenary session

The session was introduced by M. Bertolus who made a short presentation on the work carried out by the TA7 under Nugenia.

15.2.1. **Alain Frichet**, VP of Fuel Products and Technologies, Framatome:

The war in Eastern Europe has clearly accelerated the effort of entry and re-entry of the two main PWR Fuel suppliers under the pressure and with the support of the VVER European Operators (19 reactors in EU) and with the support of the European Commission, to ensure as soon as possible a diversity and security of supply in EU for this reactor segment. This represents a very significant effort for the industry and multiple Europeans partners which will allow to ensure security of supply on the VVER European reactors.

Framatome is currently developing one design for VVER 1000 and one design for VVER 440 (two types of fuel assemblies in VVER 440) in parallel.

To address the stake of European sovereignty, Framatome will rely on its European technologies for designs and materials and its fully European supply chain in particular for the Zirconium cladding.

15.2.2. **Jean-Michel Marin**, Fuel Cycle Technical Director, Newcleo:

- New nuclear power is a reality and numerous SMR/AMR projects around the world demonstrate its dynamism
- The most interesting AMRs (GEN IV) are those which exploit a fast neutron spectrum
- These reactors allow a symbiotic approach to nuclear parks in complementarity with PWR reactors
- They allow multi-recycling allowing effective long-term management of Major Actinides (U and Pu) and Minor Actinides.
- By making the best use of nuclear materials present at national level, it is possible to resolve energy sovereignty issues.
- The company is planning to choose a symbiotic approach, using used fuel from big PWR-LWR. It will also support the reduction of Pu stockpile that needs to be managed.

15.2.3. **Paul Nevitt**, VP Science & Technology, NNL (UK):

The current context provides a lot of opportunities, but at the same time, it requires a lot of investments. NNL takes part in the global effort to remove all dependency from Russian fuel by 2030. This week marked the one-year anniversary of the creation of the Sapporo 5 — a strategic partnership between the United States, Canada, France, Japan, and the United Kingdom. This group is laser-focused on increasing the depth and resilience of the global civil nuclear fuel supply chain free from Russian influence. The UK has committed to remove any remaining Russian fuel and uranium supply to the UK by 2030 and will deliver UK HALEU enrichment and deconversion capability by investing £300m.

For research and development efforts necessary to enhance our sustainability and our autonomy in fuel supply across short, medium, and long-term horizons; a UK NNL perspective:

- Short term – a focus on coated cladding advanced technology fuels (ATF) for LWR markets, plus applying fuel cycle separations chemistry to the recovery of valuable isotopes for medical and space applications
- Medium – revolutionary ATF concepts, deliver a UK Coated Particle Fuel (CPF) product for domestic and international commercial HTR markets, plus developing advanced recycle technology for advanced reprocessing of LWR (and MOX) used fuels.
- Long term – fuel fabrication and supply to a fast reactor demonstrator, advanced recycle of ATF to produce future fuels, supply of molten salt fuels for to reactor demonstrator(s).
- Closing the fuel cycle is recognised as a shared objective to advance nuclear sustainability. Most policy makers focus on energy security and decarbonisation. These are the main drivers. Moving towards advanced fuel cycles will also need significant global collaboration. We need to restart and get building nuclear again, recognising also that a once through cycle can be sustainable and we shouldn't lose sight of this. But we should continue to optimise the move to ensure that we maximise the value from the resources we have and that we drive to minimise to impact on future generations – no different to other energy generating technologies. NNL sees two key bottlenecks in achieving this goal:
    - Policy
    - Investment in maturing the demonstration of the technologies to move towards advanced fuel cycles and ultimately towards closing the fuel cycle. This includes across separation technologies, fuel fabrication, transmutation systems, fuel reprocessing and fuel technological aspects (transportation, cooling and handling).

15.2.4. **Philippe Valbuena**, Strategic Marketing Manager, Orano:

Orano is willing to provide support to all types of new reactors.

- The material needed to manufacture fuel assemblies for SMR-LWR reactors, low enriched uranium is not different from the one required for PWR or BWR large reactors currently in operation: the GBII plant (Tricastin), which production will be increased by 30% in 2028, will provide front-end services for SMR-LWR reactors.
- For HGR, Orano holds the competences and the technologies (production of HALEU materials and deconversion of UF6 into oxide or metal forms).
- For FNR, Orano can help producing FNR MOX fuel.

- For MSR, Orano is investigating R&D to develop liquid fuel aiming to support a demonstrator in the early 2030's.

In terms of circularity, Orano is doing efforts on the long-term continuity of the existing La Hague reprocessing plant and Melox plant to extend their operations beyond 2040. The company is also involved in studies towards multi recycling of LWR fuel to enable to reprocess all types of spent fuel (ENU, ERU and MOX). It will allow to stabilize the French spent fuel inventory and further decrease extraction of natural resources (up to 40% compared to open cycle).

15.3. Conclusions:

Considering the answers provided by the panellists, key elements of this discussion around fuel technology are:

1. The Fuel supply industry is working hard to face the challenges posed by the situation on current fuel especially in Central/eastern Europe.
2. Important R&D programs are being developed to anticipate future challenges, to support EU sovereignty and new designs.
3. The EU support is expected and needed at political and financial level in relation to R&D but also for infrastructures.
4. The European industrial alliance for SMR will be an important actor for startups and other industrials to reach their objectives.

16. SNETP Forum programme

SNETP Forum 2024

PROGRAMME (*version: 15th April 2024*)

Day 1 - 17th April – SNETP Forum

13.30	**Welcome and Opening of the SNETP FORUM 2024 :** **B.Salha** (President of SNETP), **S. Monti** (President of the Italian Nuclear Association)
14.00	**Italian Nuclear Landscape - AUDITORIUM** **Moderators: B.Salha, S. Monti** - **Minister Pichetto-Fratin**, MASE secretariat - **Mr Gilberto Dialuce,** President ENEA, - **Ms Daniela Gentile,** CEO Ansaldo Nucleare, - **Prof. Franco Cotana**, CEO of RSE spa, - **Mr Nicola Monti,** CEO Edison, - **Prof. Marco Ricotti,** President at Polimi/Cirten,
15.30	Coffee break

16.00	**Technical parallels sessions:** • **Business strategies for SMRs: coordinated approach to accelerate the deployment of SMRs - Increasing the bankability of Small Modular Reactors** - AUDITORIUM *moderators: J. Sobolewski (NCBJ)* ○ **Jan Prasil**, Ministry of Industry and Trade of the Czech Republic, Experience of the Czech SMR Roadmap implementation ○ **Fabrice Legendre**, CEA, France, Overview of France 2030 ○ **Guerric de Crombrugghe**, Nuketech ○ **Sandro Baldi**, EDF, Unlocking the potentials of the European SMR market • • **New NPPs (Lesson learned and how to improve)** – SAN FRANCESCO - *moderators: S. Szabolcs (BZ), P. Kinnunen (VTT), P. Kral (UJV)* ○ **Andrei Goicea**, NuclearEurope, Overview of nuclear new build with 2050 perspective ○ **Attila Hugyecz**, Paks II, Current status of the Paks II project. ○ **Pavel Kral**, UJV, Building expertise for safety assessment of new build of PWR design in the Czech Republic. Comparison of VVER and PWR safety characteristics. ○ **Merja Airola**, VTT, Public acceptance of nuclear ○ **Anne Kontula**, TVO, Experiences in OL3 ○ **Marisa van der Walt,** NRG|PALLAS, Experiences from licensing and construction in progress for the PALLAS reactor in the Netherlands. • • **Supply Chain (cross EU fertilization) –** SAN BERNARDINO DA SIENA - *moderators: B.Pothet (Framatome), C.Schneidesch (Tractebel) , M. Frignani (Ansaldo)* ○ **Aline Des Cloizeaux**, AIEA - commercial grade dedication & harmonization ○ **Aarnio-Wihuri Leena**, Fortum, Finland - SMR pre-partnership WS4 (Supply Chain) ○ **Mohamed Zouari**, Framatome, France - state of the French supply chain to support New Builds ○ **Michele Frignani**, Ansaldo Nucleare, Italy - Italian supply chain capabilities and capacity ○ **Charles Carpenter,** NAMRC, UK – supporting the UK Nuclear supply chain ○ **Massimiliano Tacconelli** , Walter Tosto, Italy - Enhancing Nuclear Manufacturing through Technological Innovation ○ **Teemu Kelavirta**, Fortum, Finland – KELPO: Use of serially produced commercial grade equipment
18.00	End of the day

Day 2 - 18th April – SNETP Forum

9.00	**Boosting Nuclear Innovation and Development** **Moderators: M. Schyns, R. Adinolfi** - **Rosalinde Van Der Vlies,** DG RTD - **Willem Janssens**, DG JRC

	- **Gianfranco Brunetti,** DG ENER, - **Aline des Cloizeaux,** IAEA**,** - **Neil M. Wilmshurst,** Director EPRI - **Alessandro Dodaro**, Director at ENEA - **Michel Barthelemy** (OECD/NEA)
10.30	Coffee break
11.00	**Technical parallels sessions:** • **Digitalisation (including Cybersecurity) –** SAN BERNARDINO DA SIENA - *moderators: S. Gupta (Becker Technologies), E. Guillaut (ORANO)* ○ **Hervé Bury**, Framatome , The cybersecurity journey of critical nuclear assets ○ **Szavai Szabolcs**, BZ , Application of AI and machine learning for evaluation of X-Ray inspection of welds ○ **Niklas Hurmerinta**, Fortum, Application of Large Language Models in the Nuclear Field ○ **Sofiane Benhamadouche, EDF,** Challenges and added value of High Performance Computing ○ **Jean-Reynald Macé**, ORANO, Factory of Tomorrow ○ **Cristina Corrales**, EPRI , Digital innovation study proposal overview and intent and current research on digital innovations • • **Market demand for non-electric energy products, -** AUDITORIUM - *moderators: M. Fütterer (JRC) , D. Hittner, J. Sobolewski (NCBJ)* ○ **Grzegorz Jóźwiak**, Process Heat (steam and other forms) ○ **Mariusz Ilnicki**, Synthos Green Energy, Hydrogen and hydrogen derivatives for the chemical industry, ammonia and synfuel, ○ **Juhani Hyvärinen,** LUT, District heating and cooling, and other applications, ○ **Maria Teresa Dominguez**, EAG, Seawater desalination, • **LTO (innovative approaches)** – SAN FRANCESCO - *moderators: C. Varé (EDF), R. Krivanek (NRG),* ○ **Robert Krivanek** (Manager for Ageing Management and LTO Projects), NRG, – OECD/NEA project 'LTO Beyond 60 Years' ○ **Michael Guillodo** (LTO Project manager), Framatome- "R&D challenges for LTO beyond 60 years" ○ **Marc Scibetta** (Deputy Institute Director Nuclear Energy and Technology (NET)) SCK-CEN, "RPV ageing and embrittlement in an LTO perspective – Enhanced Surveillance strategy" ○ **Christophe Varé** (LTO Program Manager), EDF R&D – "Beyond 60 years, EDF R&D stakes" ○ **Emma Wong**, OECD/NEA/EPRI, "Overview from NEA/EPRI workshop on the holistic and risk informed approaches to LTO" ○ **Maksym Zarazovskii** (Chief Engineer), IPP-Centre (Ukraine) – "Open Issues in Justification of WWER-1000 Long-Term Operation"
13.00	LUNCH
14.00	**How can nuclear contribute to achieve decarbonization in an efficient way?**

	Moderators: John Stairmand (Jacobs), Marco Ricotti (CIRTEN) - **Sandro Baldi**, EDF - **Lorenzo Mottura**, Director EDISON, - **Francesca Ferrazza**, Head of ENI, - **Waclaw Gudowski,** Orlen Synthos Green Energy (OSGE) - **Anders Wik**, Vattenfall - **Luciano Cinotti**, CSO, Newcleo
15.30	Coffee break
16.00	**Technical parallels sessions:** • **Business strategies for SMRs: coordinated approach to accelerate the deployment of SMRs – The SMR industrial alliance** - - AUDITORIUM - *moderator: S. Sarrade (CEA)* ○ **A. Al Mazouzi**, the SMR Industrial Alliance ○ **K. Lauwers** and **J.L. Alexandre**, Joint presentation Thorizon and Naarea ○ **R. Adinolfi**, The SMR Business Model, what is it going to change in the industry ○ **N. Sobecki**, EU project EASI-SMR: Ensuring Assessment of Safety Innovation for SMR • **Nuclear solutions to non-electric energy demand,** SAN BERNARDINO DA SIENA - *moderators: M. Fütterer (JRC), D. Hittner, J. Sobolewski (NCBJ)* ○ **Steve Chengelis**, EPRI, Status of development in the US including fuel availability ○ **Mariusz Dąbrowski**, NCBJ, HTGR Pola and industrial projects in Poland, ○ **Paul Nevitt**, NNL, UK perspectives, ○ **Michel Pasquet, Canet Serin**, Euratom projects on nuclear cogeneration and H2 production, • **Decommissioning and Dismantling (including waste management) moderators,** – SAN FRANCESCO - *N. Cherubini (ENEA), E. Holt (VTT), A. Banford (NNL)* O LANDSCAPE INTRODUCTION (Chairperson Anthony Banford and Euratom perspectives from **Seif Ben Hadj Hassine**) O DECOMMISSIONING & BACK END ▪ Garigliano NPP: Dismantling of Reactor Vessel Internals & Management of ILW and LLW – SOGIN (Italy, **Francesco Pisciotta & Francesca Onofrio**) ▪ Innovation Opportunities at the Intersection of AI, Data, and Robotics Technologies in the Nuclear Back-End. – IFE (Norway, **Istvan Szoke**) ○ WASTE HANDLING ▪ Radium-226 – from medical miracle to annoying legacy waste to life-saving raw material – SCK CEN (Belgium, Deputy Director General, SCK CEN **Christophe Bruggeman**) ▪ Best practices from 30 years in the clearance and recycling of contaminated metals - Cyclife (France, **Nathalène Christ**) ▪ Management of radioactive waste resulting from non-nuclear energy related applications– ENEA (Italy – **Alessandro Dodaro**, Director of ENEA Nuclear Department) O DISCUSSION/Q&A Panel (**C. Bruggeman** (SCK-CEN), A. Banford (NNL)))

	End of the day

Gala Diner – 19h30

Palazzo Rospigliosi, Via Ventiquattro Maggio, 43.

SNETP Innovation Award and I4N Italy competition

Day 3 - 19th April – SNETP Forum

9.00	**Fuel Cycle -** AUDITORIUM **Moderators: Marjorie Bertolus (chair NUGENIA TA7)+ Marco Cherubini (NINE)** - **Paul Nevitt,** VP Science & Technology, NNL (UK) - **Alain Frichet**, VP of Fuel Products and Technologies, Framatome - **Philippe Valbuena**, Strategic Marketing Manager, Orano - **Jean-Michel Marin**, Fuel Cycle Technical Director, Newcleo
10.00	**SNETP Stakeholders -** AUDITORIUM **Moderators: Ch. Schneidesch (Tractebel – ENGIE) and R.Garbil (EC – DG RTD)** - **Yves Desbazeille,** nucleareurope - **Valérie Faudon**, President SFEN - **Jamila Mansouri,** European Space Agency (ESA), head of propulsion and aerothermodynamic section - **Amparo Soler, WiN Global**, President of WiN Spain - **Jadwiga Najder,** ENS, Engaging and waking passion in nuclear professionals for progress of nuclear sector
11.00	Coffee break
11.30	**Wrap up of the Parallels sessions (10min each) -** AUDITORIUM **Moderator: A. Al Mazouzi**
13.00	End of the SNETP Forum 2024

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17. Appendix 1: Photos


SNETP FORUM 2024


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See more pictures on the SNETP webite: https://snetp.eu/events/snetp-forum/#

ABOUT SNETP

The Sustainable Nuclear Energy Technology Platform (SNETP) was established in September 2007 as a R&D&I platform **to support technological development for enhancing safe and competitive nuclear fission in a climate-neutral and sustainable energy mix.** Since May 2019, SNETP has been operating as an international non-profit association (INPA) under the Belgian law pursuing a networking and scientific goals. It is recognised as a European Technology and Innovation Platform (ETIP) by the European Commission.

The international membership base of the platform includes industrial actors, research and development organisations, academia, technical and safety organisations, SMEs as well as non-governmental bodies.

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