NNWI
New Nuclear Watch Institute

19–20 JUNE 2023

BUDAPEST CONFERENCE

FUELING THE ENERGY TRANSITION WITH NUCLEAR

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BUDAPEST CONFERENCE

Fueling the Energy Transition with Nuclear

Budapest Marriott Hotel

19 June 2023

Evening Reception

17:30 - 20:00

17:30	Registration
18:00	Opening Welcome
18:30	Drinks Reception
20:00	End

20 June 2023
Conference
08:30 – 16:30

08:30 **Registration**

09:00 **Opening Address**
Tim Yeo, Chairman, **New Nuclear Watch Institute**
Costis Stambolis, Executive Director, **Institute of Energy for South East Europe**

09:15 **Panel 1: Harnessing Advanced Nuclear Technologies to Accelerate the Energy Transition**

- Chirayu Batra, Chief Technology Officer, **TerraPraxis**
- Henri Paillere, Head, Planning and Economic Studies Section, **IAEA**
- Aliki van Heek, Sustainable Energy Business Research, **Nuclear-21**
- Alexis Honner, Business Development Manager, **Rolls Royce SMR**

10:30 Coffee Break

10:45 **Panel 2: The Future of Central Europe's Energy Mix**

- Tim Yeo, Chairman, **New Nuclear Watch Institute.**
- Krisztián Szarvas, Technical Director, **Paks II.**
- Csaba Kiss, Deputy CEO, Chief Generation Officer and Chief Nuclear Officer, **MVM Hungarian Electricity Ltd.**
- Miroslav Lopour, Senior Energy Expert and Business Economist, **Deloitte Central Europe**

12:00 Lunch

13:00 **Deloitte Presentation**
Michal Zeman, Senior Consultant, Energy & Resources, **Deloitte Central Europe**

13:30 **Panel 3: The Nuclear Option for South East Europe**

- Costis Stambolis, Executive Director, **Institute of Energy for South East Europe**
- Sasa Medakovic, Member of the Management Board, **Krško Nuclear Power Plant**
- Ionut Purica, Executive Director, **Romanian Advisory Center for Energy and Environmen**

14:30 Coffee Break

15:00 **Panel 4: Enhancing Energy Security by Keeping the Balance**

- Keith Everhart, Energy Analyst, Renewables Integration and Secure Electricity, **International Energy Agency**
- András Lengyel, Director and Head of Energy & Utilities Advisory Practice, **PwC**
- Nikola Sobotková, Business Development Manager, **NUVIA**

16:00 **Closing Keynote Address**
William D. Magwood, IV., Director-General, **OECD Nuclear Energy Agency**

16:30 End

ORGANISER New Nuclear Watch Institute

NNWI is an industry supported think-tank, focused on the international development of nuclear energy as a means for governments to safeguard their country's long-term sustainable energy needs. We strongly believe that nuclear power is without which the binding Paris Climate Agreement objectives cannot be achieved and is therefore an essential part of the global solution to the challenge of climate change.

NNWI
New Nuclear Watch Institute

We believe that the right way to secure widespread recognition of the benefits of nuclear energy is to encourage the widest possible and best-informed debate about energy and climate change. This debate shouldw highlight the benefits of nuclear power and its far-reaching applications that go far wider than simply the provision of low carbon electricity to tackle climate change. They include decarbonising transport, heating and industrial applications while continuing bringing high value solutions in agriculture and medicine.

WELCOME ADDRESS

It is a pleasure to welcome everyone to this year's Forum – the first we have held in Budapest in partnership with the Institute of Energy for Southeast Europe. We are very grateful to Deloitte and E-Infra for their support.

It is appropriate to hold a Forum on "Fuelling the Energy Transition with Nuclear" in Hungary, one of the European Union member states which is committed to making nuclear an important part of its energy mix. Since NNWI's last Forum in London in October the revival of the nuclear energy industry, both in Europe and further afield, has gained momentum and is spreading to more countries.

The concerns about security of energy supply which were aggravated by the invasion of Ukraine have remained even though the mild winter in Europe meant that the worst fears about price rises have not materialised. By contrast, anxiety about climate change is growing in the face of stark scientific warnings about an imminent rise in global average surface temperature to above the 1.5C goal set by the Paris Accord in 2025.

Recent weather events in several parts of the world have been a reminder that the tipping point at which climate change becomes dangerous and irreversible may be closer than previously thought. The need to accelerate the clean energy transition and ensure that net zero is reached by mid-century across Europe and in advanced countries around the world is obvious. Despite this scarcely any governments have yet set out detailed credible policies for achieving these aims during a period when demand for electricity will continue to rise steadily.

The presentations and the Panels in today's Forum will explore how some of the gaps in the commitments made by European nations can be filled - particularly in Central and Southeast Europe, parts of which remain heavily dependent on fossil fuels for electricity generation. It will consider the important contribution which nuclear energy can make, alongside the continued growth of renewable energy capacity, to cutting greenhouse gas emissions, stabilising energy prices and strengthening energy security.

There is no room for complacency about the world's willingness or ability to overcome the challenges faced by humanity in the 2020s. Time is certainly not on our side. At least, however, at NNWI we can try to ensure that decisions about the choice of the energy mix preferred by the governments of the countries in which we work are made on the basis of a rational appraisal of the facts and a realistic analysis of risks they involve.

Success in overcoming the climate threat is not guaranteed. It will require change on a bigger scale and at a faster pace than anything yet seen.

As Charles Darwin pointed out in the 19th century the survival of a species depends not on its strength nor even on its intelligence but on its adaptability. Hopefully today's Forum will help to identify some of the ways in which the energy industry must adapt.

Tim Yeo

PARTNER

The Institute of Energy for South-East Europe

The Institute of Energy for SE Europe (IENE) is a nonprofit organization active throughout South East Europe, focusing on energy policy and analysis but also on information dissemination.

IENE aims to promote a broader understanding of the major energy and environmental issues in the region. A key objective of the Institute is to contribute towards the implementation of the European Union's sustainable strategy which combines economic and social development, security of supply, environmental protection and climate change mitigation.

Further information on the Institute, its mission and vision and its various activities can be found in **www.iene.eu.**

IENE
INSTITUTE OF ENERGY
FOR SOUTH-EAST EUROPE

WELCOME ADDRESS

As an organisation which covers energy activities across South East Europe we are delighted that we have the opportunity to join forces with the New Nuclear Watch Institute, a forward looking group, which seeks to promote nuclear power globally as a safe and zero emission form of energy.

We welcome this latest initiative which aims to broaden the discussion by holding the event in the centre of Central Europe, at Budapest. The location is important as Hungary is highly supportive of nuclear power together with a small group of countries in the SEE area.

As I explain in my accompanying article the SE European region already has a solid background in nuclear power generation with six countries covering a distinct part of their electricity needs from nuclear power. This is a fertile ground on which to base further expansion and as latest research suggests by the end of this decade the total installed nuclear capacity in the broader region, including Hungary, will have doubled at a level of 13,6 GW. This is not an insignificant number for zero emission nuclear power which together with enhanced renewable capacity,is expected to contribute substantially in lowering GHGE's emissions in this part of the world.

The path towards decarbonisation in SE Europe is arduous,to say the least,given the region's high dependence on solid fuels which until now have covered the bulk of its electricity needs. It is true that over the last five years or so there have been consistent efforts by governments and investors to introduce renewable energy sources, notably solar photovoltaics and wind. Yet, with the exception of Greece,Romania and Turkey, their impact is still to be felt. But by augmenting existing infrastructure and introducing new nuclear capacity to the regional grid one could accelerate the decarbonisation drive and also provide much needed stability in the form of base load which nuclear is uniquely placed to deliver.

I very much look forward to the Budapest conference on "Fueling the Energy Transition with Nuclear" as an important partnership endeavour with NNWI, through which we aspire to help increase public awareness and also achieve better understanding in the energy sector itself on the constructive role of nuclear power when it comes to meeting the huge challenges posed by climate change. Also, we hope that this timely event will help incentivise governments and public bodies at large as to the true benefits of wider nuclear power use.

Costis Stambolis

SPONSOR

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Deloitte Central Europe is a regional organization of entities organized under the umbrella of Deloitte Central Europe Holdings Limited. The subsidiaries and affiliates of Deloitte Central Europe Holdings Limited are among the region's leading professional services firms, providing services through more than 11,000 people in 39 offices in 18 countries.

Deloitte's Energy & Resources consulting team excels in providing comprehensive advisory services across the energy sector, with a special focus on nuclear energy. Currently the team is assessing the readiness of the nuclear ecosystem in the EU for reaching the climate goals.

Deloitte.

WELCOME ADDRESS

Deloitte is honored to be connected with the New Nuclear Watch Institute and contribute to the 2023 conference on Fueling the Energy Transition with Nuclear.

As the world faces the pressing challenges of climate change, resource depletion, and energy security, it is essential to seek innovative solutions that can meet our growing energy demands while minimizing environmental impact. The nuclear industry stands at the forefront of this movement, and this conference aims to illuminate the pathways to a successful energy transition. It is already offering a reliable, low-carbon source of power that can support the transition to a more sustainable and resilient energy system.

We believe that sustainability should be at the core of every business strategy and acknowledge that addressing energy transition requires collaborative efforts, innovative thinking, and a commitment to change as we saw during last year's Forum. Through this conference, we aim to foster a similar dialogue among industry leaders, policymakers, and experts, allowing them to share deep industry insights, best practices, and innovative ideas that will shape the future and drive the transition forward. It requires us to think differently, challenge existing norms, and embrace innovative technologies and practices.

The nuclear sector offers a significant potential to tackle the energy transition head-on. With its low carbon footprint and long-term power generation capabilities, nuclear energy can play a significant role in ensuring a sustainable future.

From discussions on next-generation advanced nuclear technologies to accelerating the energy transition, to the future of CEE energy mix while enhancing energy security by keeping the balanced synergies between nuclear and renewable energy sources, this conference will provide a much needed platform for knowledge exchange, networking, and collaboration. Together, we will deepen our understanding of the transformative potential of nuclear energy and chart a course towards a cleaner, more sustainable energy future.

ZDENĚK OBRUČA

DIRECTOR

CONSULTING AND ENERGY ADVISORY

Zdeněk is a Director in the Consulting function and Leader of the Energy advisory team at Deloitte Czech Republic.

For more than 10 years, he has been focusing on transformation projects across the entire energy value chain. At present, he mainly deals with large consulting projects in the electric power industry, especially in the areas of production and consumption optimization, transformation, renewables and energy distribution.

Before joining Deloitte, Zdeněk worked at ČEZ, where he served as chairman of the board of directors of its Romanian distribution company and as a member of the board of directors at ČEZ Romania.

MICHAL ZEMAN

SENIOR CONSULTANT

ENERGY & RESOURCES

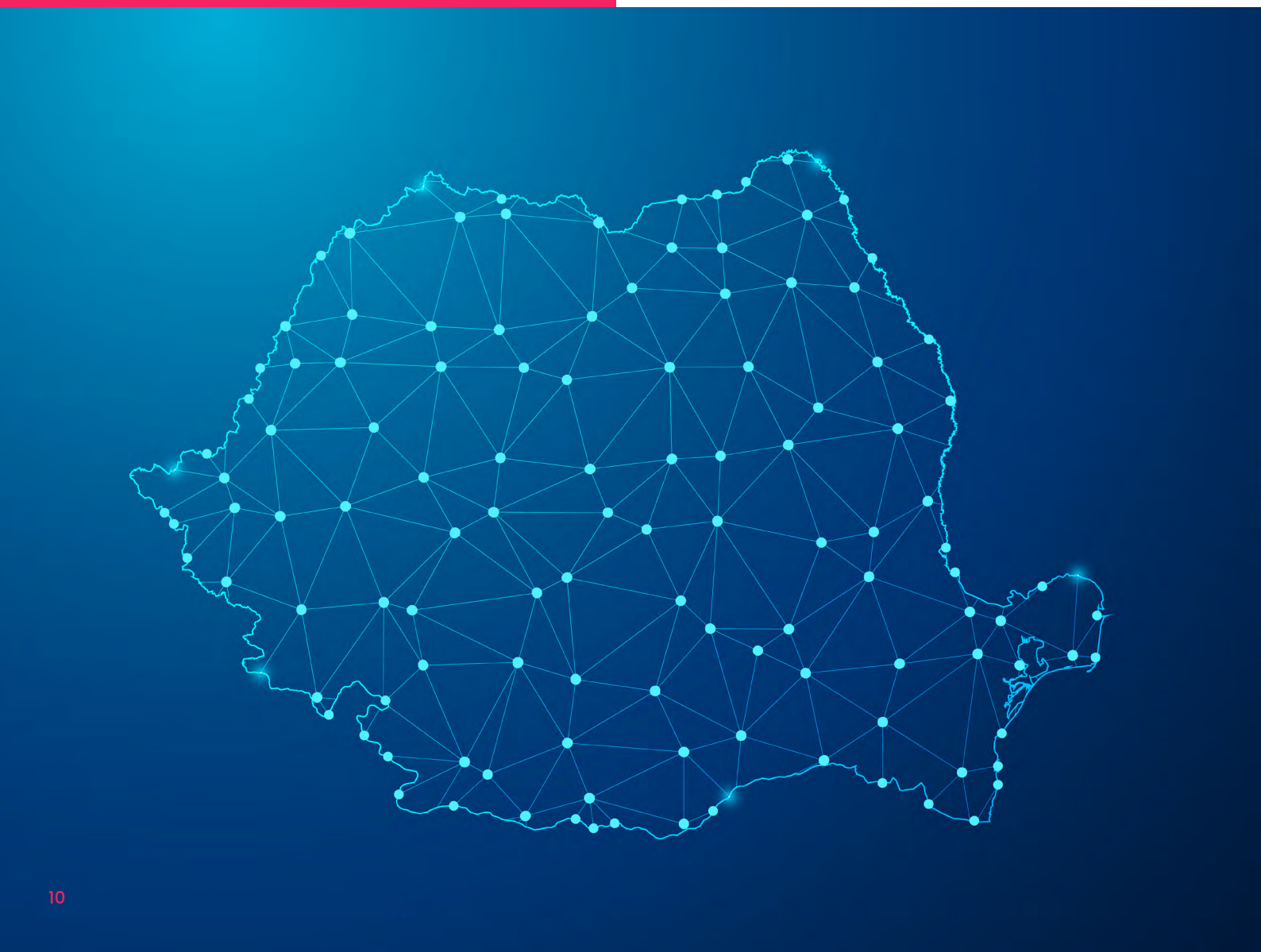
Michal as a senior consultant in the Deloitte Czech Republic Energy consulting team focuses mainly on nuclear energy and engineering, conventional sources, hydrogen production, natural gas supplies, and the EU ETS emissions trading system.

Michal has a background in nuclear engineering and more than 5 years of experience in the nuclear energy field and project management of research projects. His work focused mainly on advanced reactors, burnable absorbers, and energy storage. In recent years, he has worked at the Ministry of Industry and Trade of the Czech Republic, the International Atomic Energy Agency in Vienna, and the Czech Institute of Informatics, Robotics, and Cybernetics. During his time at Deloitte, he addressed the issue of the new nuclear power plant, the readiness of the European nuclear ecosystem, hydrogen production, natural gas supplies in case of disruption, and others.

SUPPORTER E-INFRA

With over 15 years of experience, Nova Power & Gas is a green energy producer, an integrated supplier of electric energy and gas and a distributor of natural gas. Nova Power & Gas delivers electricity and natural gas to a wide array of residential and industrial consumers. The company's mission is to provide fully integrated service packages, including dispatching, energy efficiency and full services & consultancy in all types of energy projects. Nova Power & Gas is a member of E-INFRA, a Romanian infrastructure Group, specialized in energy, civil and telecom projects.

E-INFRA is the holding Group of 5 companies: Nova Power and Gas - Power production, electricity & natural gas supply energy and gas trading, natural gas distribution infrastructure, Electrogrup - General EPC, infrastructure turn-key projects professional services, Direct One - fiber optic infrastructure and data carrier services, Netcity - Bucharest underground fiber-optic telecom infrastructure, WESEE- Turn-key & maintenance services for wind parks.



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It's ON! We create the energy of tomorrow

At Nova Power & Gas, a company with 100% Romanian capital, we believe in providing good energy and simple services for both homes and businesses. That's why we constantly invest in the natural gas distribution infrastructure and renewable energy production, to ensure a better future for all.

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KEYNOTE ADDRESS

Fueling the Energy Transition with Nuclear

WILLIAM D. MAGWOOD, IV
DIRECTOR-GENERAL
OECD NUCLEAR ENERGY AGENCY (NEA)

Mr Magwood took up his duties as Director-General of the Nuclear Energy Agency (NEA) on 1 September 2014. He has extensive experience in both the regulatory and developmental aspects of nuclear energy, including at the international level.

From 2010 to 2014, he served as one of the five Commissioners appointed by the US President and confirmed by the US Senate to the US Nuclear Regulatory Commission (NRC). While a commissioner, he advocated the importance of nuclear regulatory independence and the necessity of maintaining strong, credible and technically sound nuclear regulation in the United States and all countries that use nuclear power.

Biography

Prior to his appointment at the NRC, from 2005 to 2010 he provided independent strategic and policy advice to US and international clients on energy, environment, education, and technology policy issues. From 1998 to 2005, Mr Magwood was Director of the US Government's civilian nuclear energy programme at the US Department of Energy (DOE). During his tenure, he established the Idaho National Laboratory; created activities that reversed the decline of US nuclear technology education; and launched important initiatives such as the Generation IV International Forum (GIF) and the US "Nuclear Power 2010," which helped restart nuclear plant construction in the United States. He was also actively involved in the work of the NEA, serving as a Steering Committee Bureau member from 1999 to 2005, including a term as Chair of the Steering Committee from 2004 to 2005.

Prior to his experience at the DOE, Mr Magwood managed electric utility research and nuclear policy programmes at the Edison Electric Institute in Washington, DC, and was a scientist at Westinghouse Electric Corporation in Pittsburgh, Pennsylvania. Mr Magwood, a US national, holds Bachelor degrees in Physics and English from Carnegie Mellon University and a Master of Fine Arts from the University of Pittsburgh.

NUCLEAR ENERGY: THE FUTURE IS NOW

Increased use of nuclear energy is being explored by many countries around the world as they address both their commitments to reduce carbon emissions and their essential need to assure energy security for their economic and societal well-being.

Analysis by the NEA has highlighted that tripling global nuclear energy capacity provides a practical path towards enabling countries to meet their net zero goals by 2050. Reaching 1160 gigawatts of global installed nuclear capacity by 2050 will require a combination of long-term operation, large-scale Generation III, small modular reactors (SMRs), and non-electric applications such as nuclear-produced heat and hydrogen.

While large scale nuclear power plants remain important, SMRs are expected to play a key role in hard-to-abate sectors such as: off-grid heat and power in remote regions and mines; high temperature heat in heavy industries; and potentially, marine propulsion for merchant shipping.

The NEA is working with its members and partners to forge a common understanding of key issues in this field. These analyses provide important input to decision makers that seek to lower barriers to SMR deployment.

SPEAKERS

ABOUT PANEL 01

CHIRAYU BATRA
CHIEF TECHNOLOGY OFFICER
TERRAPRAXIS

HENRI PAILLERE
HEAD, PLANNING AND ECONOMIC STUDIES SECTION
IAEA

ALIKI VAN HEEK
SUSTAINABLE ENERGY BUSINESS RESEARCH
NUCLEAR-21

ALEXIS HONNER
BUSINESS DEVELOPMENT MANAGER
ROLLS ROYCE SMR

Chirayu Batra is a Nuclear Engineer with extensive experience on advanced reactor technology development. He worked as a nuclear engineer and a Project Officer on advanced reactor technologies at the International Atomic Energy Agency (IAEA) for over 7 years. He has led the planning, organizing and implementing several IAEA's activities and projects in the field of Small Modular Reactors (SMR) and their applications, including their coupling with renewable and non-electric applications. He also served as the first scientific secretary for the IAEA's platform on small modular reactors and their applications, where he coordinated the development of the IAEA's medium-term strategy for near term deployment of small modular reactors as well as the international SMR Coordination and Resource Portal for Information Exchange, Outreach and Networking (SCORPION).

He has also led the IAEA's activities on codes and standards, design engineering and manufacturing of components for SMRs. He served as member of several international scientific committees and regularly provided technical insights.

Chirayu has experience in advanced reactor modelling and simulations and also coordinated several international benchmark studies on modelling and simulations and led the IAEA's initiative on open-source nuclear codes for reactor analysis (ONCORE) as well as IAEA's project on nuclear power plant simulators. He has trained over 1000 professionals from across the world on system engineering and physics and technology of advanced reactors. He also served as the lead trainer for IAEA's integral PWR simulator.

Dr. Henri PAILLERE has over 27 years of experience in the nuclear energy sector and is currently working as Head of the Planning and Economic Studies Section at the International Atomic Energy Agency which he joined in February 2020.

Before that, Henri worked at the OECD Nuclear Energy Agency in Paris between 2011 and 2019, as Senior Analyst and Deputy Head of the Division of Nuclear Technology Development and Economics. He was also the head of the Technical Secretariat for two international initiatives, the Generation IV International Forum, and the International Framework for Nuclear Energy Cooperation.

Prior to these positions, he worked at the Alstom Power Company and at the French Alternative Energies and Atomic Energy Commission (CEA). He holds a PhD from Universite Libre de Bruxelles (Belgium), and an engineering degree from Ecole Nationale Superieure de techniques Avancees (France).

Aliki van Heek holds an MSc in Applied Physics from The Netherlands and a PhD in Nuclear Engineering from Germany. She worked for 23 years at ECN and NRG in the Netherlands in various roles, including Programme Manager 4th Generation Nuclear Energy Systems and Team Manager Decommissioning and Radioactive Waste Management.

For seven years until May 2023, she was a Unit Head 3E Analysis within the Planning and Economics Studies Section at the International Atomic Energy Agency, with 3E standing for Energy, Economics and Environment.

In this role she supported IAEA Member States' understanding of how nuclear energy technology can contribute to socio-economic and sustainable development, climate change mitigation and energy security of supply.

As associate at Nuclear-21, she is now in charge of Nuclear-21's international activities regarding the role of nuclear in sustainable energy systems including the options for small modular reactors with energy products of electricity, heat and hydrogen in both nuclear expanding, replacing and newcomer countries.

Alexis joined Rolls-Royce SMR in 2022 after a 16 year career in the Aerospace & Defence industry. In that time he undertook multiple roles, starting as an Engineer and subsequently seconded into UK Defence Science & Technology Laboratories developing advanced defence capability programmes. Upon returning to industry, he has spent 10 years in market-facing roles covering Strategy, International Business Development, Market Analysis and Competitive Intelligence.

In 2017 Alexis commenced a 3-year secondment with the UK Government, spanning the Department for International Trade, Ministry of Defence and Defence Equipment & Support. He has extensive experience in export programmes, relationship management, complex sales, prime contracting, localisation and government-government partnering through the UK working in Europe, the US and Middle East.

SPEAKERS

ABOUT PANEL 02

TIM YEO
CHAIRMAN
NEW NUCLEAR WATCH INSTITUTE

KRISZTIÁN SZARVAS
TECHNICAL DIRECTOR
PAKS II.

CSABA KISS
DEPUTY CEO, CHIEF GENERATION OFFICER AND CHIEF NUCLEAR OFFICER
MVM HUNGARIAN ELECTRICITY LTD.

MIROSLAV LOPOUR
SENIOR ENERGY EXPERT AND BUSINESS ECONOMIST
DELOITTE CENTRAL EUROPE

Tim has a longstanding commitment to the nuclear energy industry dating back three decades to when he was Minister of State for the Environment with responsibility for climate change policy in the UK Government. He later served in the Shadow Cabinet as Shadow Secretary of State for Trade and Industry before being elected as chairman of the UK Parliament Energy and Climate Change Select Committee.

Tim is Chairman of ElecLink Limited, a subsidiary of Getlink SE, which owns and operates a 1GW electricity interconnector between France and Britain. He is a consultant and former Executive Chairman of Powerhouse Energy Group plc, a listed UK company developing technology to convert plastic waste into hydrogen. Tim is the Honorary Ambassador of Foreign Investment Promotion for South Korea and has worked in China on climate related projects including the design of China's carbon trading markets and on carbon capture utilisation and storage with the UK-China (Guangdong) CCUS Centre.

Krisztián graduated in energy engineering and mechanical engineering at the Budapest University of Technology and Economics. He joined the Paks Nuclear Power Plant (the existing NPP in Hungary) as a young engineer, where he spent 15 years in various positions in operational and technical support areas, and then in 2012 he was invited to the then newly established Paks 2 project. From the beginning of the project, in addition to technical issues, he also dealt with procedure-related strategic issues.

Previously, he was actively involved in the work of EUR Association (European Utilities Requirements), updating the nuclear safety requirements for LWRs.

In his current position, he manages the technical directorate, which is responsible for the expert review and acceptance of technical and detailed design documents and licensing documentation. The managed area includes the entire power plant systems, including the civil parts. Among the tasks, the biggest challenge is the compliance of the VVER 1200 design and licence applications with the relevant HU, EU and international requirements.

Csaba Kiss Ph.D, as Deputy CEO, he is Chief Generation Officer and Chief Nuclear Officer of the MVM Hungarian Electricity Ltd. He holds a Ph.D. degree in Technical Sciences from Vienna University of Technology in Austria, and a MBA degree from Buckinghamshire New University in the UK.

Mr. Kiss has a +35 years career in the power generation industry, has had a solid management and business leadership experience since 1999 as Executive Managing Director and Plant Manager of operating different power plant portfolios and businesses in Hungary and Italy.

As a Managing Director he had worked with major multinational integrated utilities (AES and E.ON), and Power Service companies (Alstom and GE). He was involved in the operation and project development of new nuclear, coal, biomass, oil, gas power plants, co-generation (CHP), CCGT, steam/ranking cycle, gas-motor, wind, hydro and PV power plant technologies as well.

Mr. Kiss has international working experience in conducting business and managing projects in the U.S., Brazil and Europe. He is a Board Member of the Nucleareurope, Chairman of the Executive Committee of Hungarian Nuclear Association (Atomfórum Egyesület), Vice Chairman of the Executive Committee of COGEN Europe Association, Vice Chairman of the COGEN Hungary Association (MKET), Chairman of the Hungarian Scientific Energy Association of Hungary (ETE) and a member of the World Nuclear Association (WNA) Advisory Board.

Miroslav has worked in the Deloitte energy consulting team as a business economist for more than 10 years. He is responsible for leading the Energy strategy unit and acts as a senior energy expert in the company and for clients.

He predominantly specializes in the strategy and finance of the power sector, national energy strategies and balances. His work entails the mapping of energy market development and its consequences on the energy system.

His focus on nuclear was related to building a new nuclear unit in the Czech Republic within both timeframes of consideration and covered financing and state policy measures. Miroslav was also extensively involved with preparatory projects for the nuclear waste fuel repository system. As an economist, he is dedicated to understanding sector dynamics and their main determinants in technology, policy or costs.

SPEAKERS

ABOUT PANEL 03

COSTIS STAMBOLIS
EXECUTIVE DIRECTOR
INSTITUTE OF ENERGY FOR SOUTH EAST EUROPE

SASA MEDAKOVIC
MEMBER OF THE MANAGEMENT BOARD
KRŠKO NUCLEAR POWER PLANT

IONUT PURICA
EXECUTIVE DIRECTOR
ROMANIAN ADVISORY CENTER FOR ENERGY AND ENVIRONMENT.

Costis Stambolis is a founding partner of the Athens based Institute of Energy for SE Europe (IENE) while he currently serves as Chairman and Executive Director. He also serves as a full member of the Greek government's standing committee on Energy and Climate Change (NECP). Costis has over forty years' experience in the broad energy sector having worked under various capacities on renewables (solar and wind), natural gas, energy market analysis and energy policy.

He holds graduate and postgraduate degrees from the Architectural Association in London and from the Said Business School at Oxford University. He is also the founder and managing editor of Energia.gr, Greece's foremost energy portal.

Saša has been a member of the Krško NPP Management Board since the end of 2019. Prior to that, he was Director General of the State Office for Radiological and Nuclear Safety in the Republic of Croatia. He also held a number of other functions: he was a member of the European Nuclear Safety Regulators Group (ENSREG), vice-chairman of the Management Board of the Fund for financing the decommissioning of the Krško Nuclear Power Plant and the disposal of NEK radioactive waste and spent nuclear fuel, head and member of number of EU expert delegations and groups and an expert of the International Atomic Energy Agency.

Prior to joining NPP Krško, he worked in the area of nuclear engineering in nuclear regulatory body, Enconet and at the Faculty of Electrical Engineering and Computer Science. Saša Medaković, who lives in Zagreb, has a master degree in Nuclear Engineering (Faculty of Electrical Engineering and Computer Science, Zagreb) and has over 25 years of experience in the field of nuclear energy, of which more than 15 years have been in leadership positions.

Presently an Executive Director of the Advisory Center for Energy and Environment, Dr.Purica was also personal adviser of the Minister of Research, the Minister of Economy and, previously, the Minister of the Environment and an expert for the Parliament of Romania, also President (State Secretary) of the Romanian Nuclear Energy Agency (top level security clearance). He is a member of the EU Advisory Group for Energy and of the World Energy Council study group for energy scenarios 2050 and was a member of the steering committee of the Global Threats Study Network financed by Dpt.of Defence and managed by Virginia Tech. USA, also a senior researcher in the Romanian Academy's Institute for Economic Forecasting. Moreover, he is a corresponding member of the Academy of Romanian Scientists (AOSR) Section of Technical Sciences.

Previously he worked as a project officer for energy and infrastructure in the World Bank, in Romania and the Balkans (e.g. energy assessment in Kosovo 1999), being trained in project guarantees, value at risk, procurement to complete his expertise in engineering acquired as director for international projects of the Romanian Power Company RENEL and senior engineer managing a joint Atomic Energy of Canada LtdIMG-Bucharest quality engineering group for the manufacture of nuclear reactor components for the CANDU units in Romania. He worked also as an international researcher (under the ICTP TRIL Program) for ENEA Rome – the Italian Commission for Energy New Technology and Environment – and as an associate researcher at ICTP Trieste.

SPEAKERS

04 ABOUT PANEL

KEITH EVERHART
ENERGY ANALYST, RENEWABLES INTEGRATION AND SECURE ELECTRICITY
INTERNATIONAL ENERGY AGENCY

ANDRÁS LENGYEL
DIRECTOR AND HEAD OF ENERGY & UTILITIES ADVISORY PRACTICE
PWC HUNGARY

NIKOLA SOBOTKOVÁ
BUSINESS DEVELOPMENT MANAGER
NUVIA

Keith has been an Analyst in the International Energy Agency's Directorate of Energy Markets and Security since 2019, where he focuses on power market design and electricity security in the context of clean energy transitions. He co-authored a report on the role of nuclear power in future energy systems titled "Nuclear Power and Secure Energy Transitions" which was released in June 2022.

He also served as an Economist in the Office of Enforcement at the US Federal Energy Regulatory Commission from 2006 to 2011 and as an economic consultant to utilities on issues of competition in global electricity markets from 2011 to 2019.

András is Director and Head of Energy & Utilities Advisory Practice at PwC Hungary, with more than 20 years of experience in the energy industry. He has a deep understanding of the technical, legal and business environment of the energy & utilities sector both in Hungary and the CEE region.

Before joining PwC, András was Head of Strategy and Regulatory Affairs at MAVIR, the Hungarian Electricity Transmission System Operator. He is Secretary of Smart Future Innovation Cluster dedicated to energy innovation. András is a key member of the ESG management team in PwC Hungary and Net Zero management team of PwC CEE.Andras has participated in more than 100 energy & utilities consulting projects

Nikola is a Business Development Manager at NUVIA company, specializing in radiation protection. With three years of experience, she plays a role in driving business growth and forging strategic partnerships. As a member of the young generation within the Czech Nuclear Association and Women in Nuclear Czech Republic, Nikola actively advocates for the popularization of nuclear energy. Her passion lies in educating the public about the numerous benefits of nuclear technology.

Nikola's upcoming presentation will highlight NUVIA's work in radiation protection, showcasing their innovative solutions. Through her presentation, she aims to emphasize the essential contributions of the young generation in advancing the nuclear industry.

ARTICLES

Advancing Nuclear Through a Product-Based Deployment Strategy

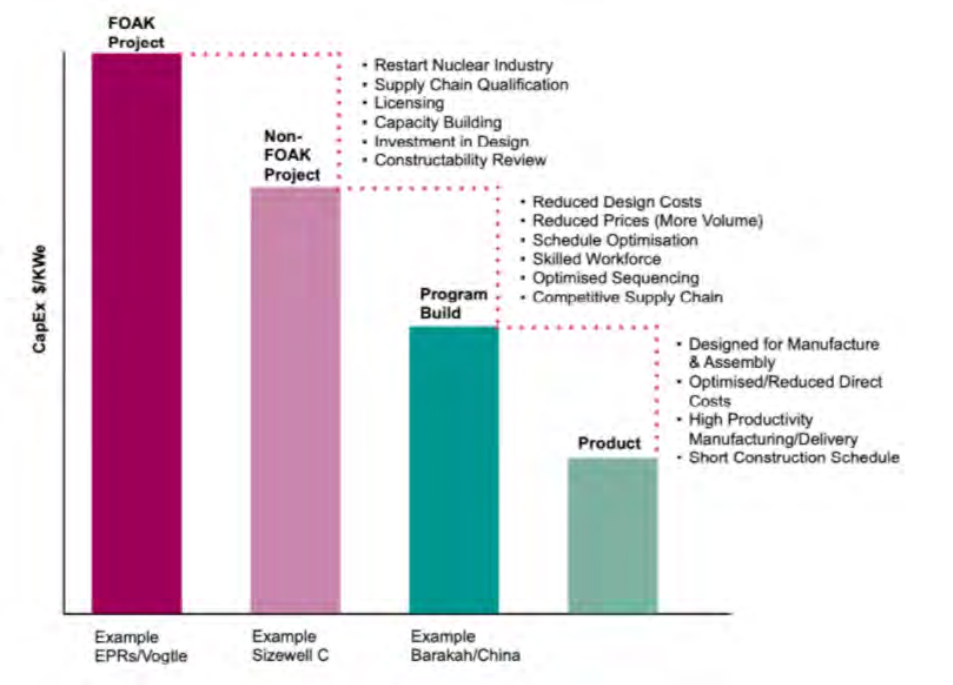
Chirayu Batra, Chief Technology Officer, TerraPraxis

Since the beginning of the commercial nuclear power sector in 1951, the nuclear industry has employed conventional, project-based delivery models. These traditional methods necessitate bespoke design, invariably implicating the incurrence of substantial costs, unpredictable regulatory reviews, and large budgetary and scheduling risks that could prevent the viability of most of the projects. The model was designed for utilities as the prime and only customer. However, the commoditization of the electricity market as well as requirements of customers other than utilities demands a transformative shift in the traditional nuclear deployment model from "project-based" to "product-based".

A product-based deployment strategy presents a paradigm shift in the nuclear industry, offering a pathway to commercially low-risk,rapid, cost-effective, repeatable, and scalable solution that aligns with industry aspirations and achieves global decarbonization targets.

The product-based model revolutionizes the nuclear sector by systematically addressing core issues of high capital expenditure and delayed project delivery timelines. Product-based deployment operates on the principle of standardization, utilizing an established design for the nuclear reactor, various structures, components, auxiliary buildings around the reactor, the supply chain required for construction, and the delivery process. The inherent consistency of product-based deployment reduces capital costs,increases process efficiency, and provides a more predictable and manageable construction schedule, mitigating the risk of budget and time overruns, key factors that have traditionally hindered the progression of nuclear power projects. 'Repeatable builds', rather than bespoke designs", presents a paradigm shift in the nuclear industry that allows for economies of scale..

Figure 1 Product based deployment: pathway to fast, low-cost, repeatable and scalable nuclear (Source: Beautiful Nuclear, LucidCatalyst, 2022)



Successful implementation of product-based deployment requires innovation by all stakeholders across the supply chain and the adoption by nuclear regulators as well. Product-based licensing can facilitate a "license once, build many '' strategy, paving the way for the large-scale deployment of nuclear power worldwide, independent of geographical location or technology.

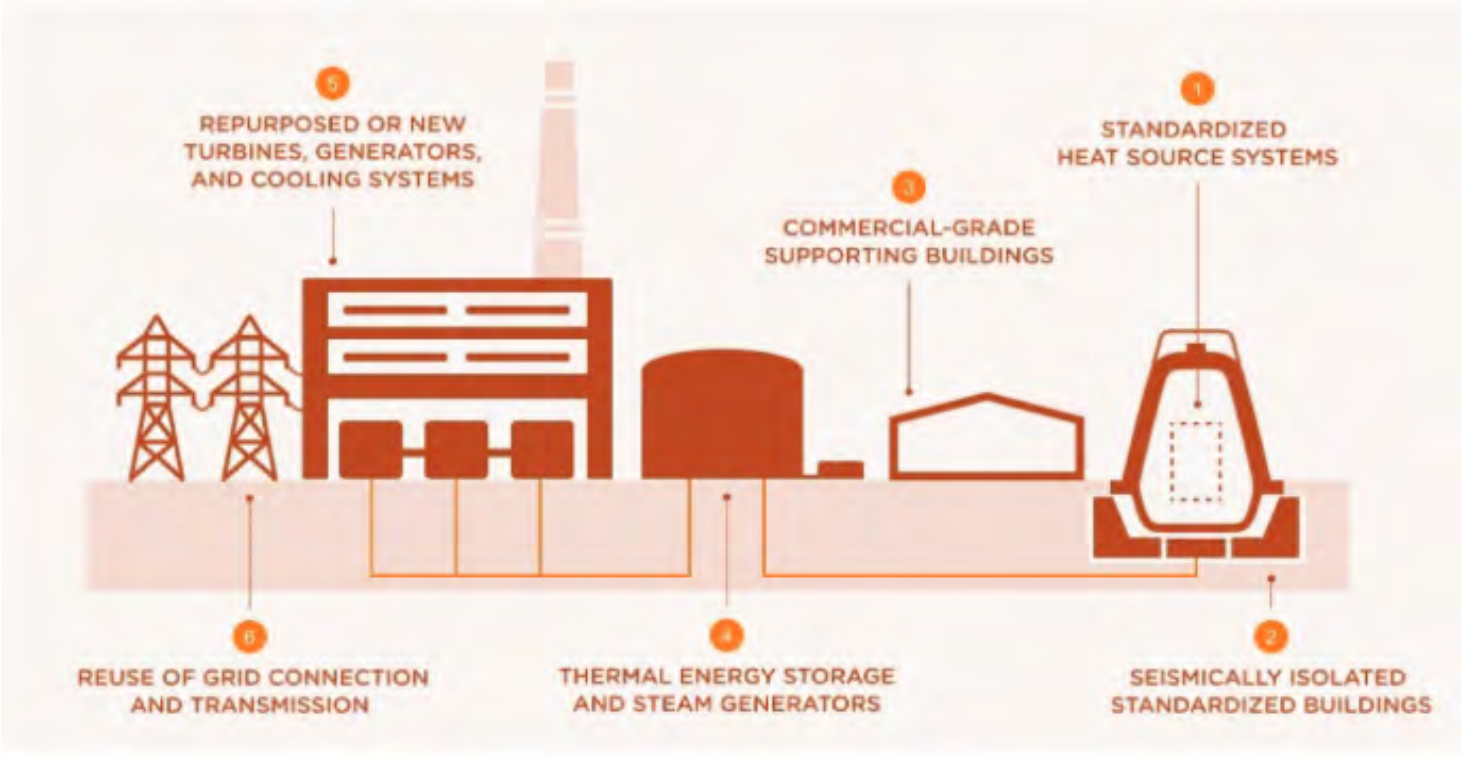
As an example, coal-fired power plants, with their present contribution of 2 terrawatts (TW(e)) to global generation capacity, remain an integral facet of the energy matrix. Abrupt decommissioning of these plants is a globally untenable strategy due to their significant economic contributions and the practical, financial, and political challenges inherent in such an approach. Instead, a more viable strategy for minimizing risk during energy transitions lies in repurposing existing infrastructures with high-density clean energy to maintain or increase the energy output of existing sites.

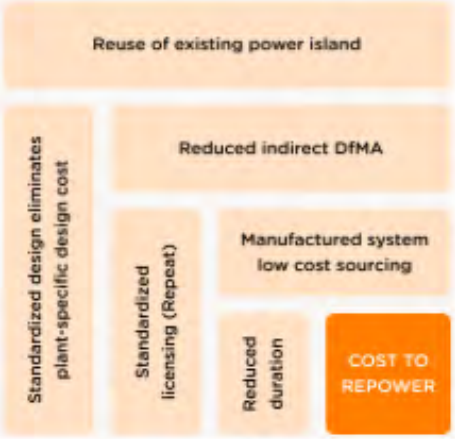
This includes repowering existing coal power plant sites with zero-carbon advanced heat sources such as advanced nuclear reactors. By a thorough understanding of this market and the associated customers, and by employing a product-based deployment strategy, the coal-fired power plants can be repowered with emission-free nuclear reactors. Existing infrastructure, industry knowledge, workforces, capital, and supply chains can be leveraged to deliver emission-free energy to millions of people worldwide.

The nonprofit TerraPraxis has assembled a world-class consortium of partners, governments, regulators, academics, and industry stakeholders— to design a fast, low-cost, and repeatable project delivery model for repowering 2,400 coal plants worldwide. The REPOWER system embraces key design innovations to enable standardization while accommodating coal fleet diversity.

These include ‘kit-of-parts’-based design, standardization of supporting systems across multiple heat source vendors, a ‘universal connector’ heat transfer and storage system, and seismic isolation. Repowering Coal will deliver a substantial portion of the clean electricity required to achieve Net Zero by 2050 by replacing coal-fired boilers at existing power plants with advanced heat sources, which are expected to be ready for deployment by 2028.

The result of this repowering will be carbon-free power plants that are cheaper to operate than before, and to ensure continuity for communities reliant on these plants for energy, jobs, and continued economic development.





Combined emissions reduction and value creation by Small Modular Reactors in energy-intensive industry

Aliki van Heek, Luc Van den Durpel, Nuclear-21

The energy-intensive industry in Europe is facing a double challenge of both securing energy supply and decarbonizing this. Nuclear power, especially by means of Small Modular Reactors, could play a significant role in responding to this challenge, however, only if it is accompanied by a certain value creation. Nuclear-21 analysed this challenge for the provincial government of Limburg in The Netherlands for the 2030-2035 time frame.

We included the projected energy needs, both electricity and heat, the possible role as well as challenges for nuclear energy and the various nuclear energy options to be considered for the Province of Limburg, having a large chemical industry cluster. Possible use, planning and geo-technical preconditions for such nuclear units were included as well. Three energy system development scenarios were developed, and represented in a roadmap, taking into account the expansion of off-shore wind power and the high voltage grid as part of the Dutch national energy policy.

Firstly, we confirm that a timeline for the integration of nuclear energy in the energy mix towards the 2030-2035 time frame is only realistic for nuclear power plants, large and small, based on mature light-water cooled (LWR) technology as applied in the operating Dutch nuclear plant Borssele. Large nuclear power plants are almost impossible within this time frame, partly because of too limited cooling water capacity in Limburg. However, small modular reactors (SMR) would be essential options.

Secondly, the nuclear energy option should be embedded in an integrated energy system with objectives to both strengthen the robustness of the electrical network in Limburg and offer an appropriate and sustainable heat mix to both industry and the built environment, as well as enabling both new energy vectors such as hydrogen and synthetic fuels. Three scenarios have been developed, one based on renewables and imports without nuclear, one with larger SMR (200-300 MWe) and one with both larger and smaller SMR (20-50 MWe). Also the impact of the use of process heat and district heat has been calculated: market value, conservation of natural gas and avoided CO2 emissions as a function of the amount of supplied energy.

Besides the techno-economic analysis, we also conclude that the Dutch government has a role in strengthening the nuclear ecosystem already present in the Netherlands and drawing up a strong programme for enhanced knowledge-building in all areas required for the realisation of multiple nuclear plants in the near and longer future. The possibly significantly increasing demand for SMRs from the 2030s onwards can be expected to be hampered by the limited capacity in the supply chain of critical components. This may create a situation of 'first come, first served' with also an opportunity for strategic positioning for the Dutch industry in such a supply chain.

The approach and methodology, being applicable to other regions as well, both in the Netherlands, Europe and beyond, is of increasing relevance given the challenges that the energy-intensive industry and the society at large has with regard to our energy future.

Decarbonizing towards net zero: the role of advanced reactors

Henri Paillere, Head, Planning and Economic Studies Section, IAEA

In the context of the climate emergency and the global energy crisis, nuclear power is increasingly seen as an indispensable part of future low-carbon energy systems, able to support the integration of large shares of variable renewables by providing reliable and dispatchable power.

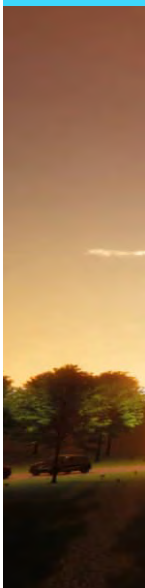
Even if wind and solar are often cheaper than new nuclear on a levelized cost of electricity basis, the attributes of nuclear power (dispatchability, reliability, flexibility) help to reduce the overbuild of renewable and storage capacity, and hence reduce the cost of the energy transitions. According to the International Energy Agency, without additional nuclear power, the clean energy transition becomes more difficult and more expensive. But nuclear power has also an untapped potential, that of helping to decarbonize beyond electricity.

Nuclear power is not only a source of low-carbon electricity, but also – and foremost – a source of low-carbon heat that can substitute fossil fuel applications, in the building (e.g., district heating) and industry sectors (e.g., process steam). It can also help produce low-carbon hydrogen, through electrolysis or, using heat, through the more efficient high temperature steam electrolysis. But for this potential to be realized and contribute to net zero objectives by 2050, advanced reactors, such as Small Modular Reactors able to target these markets, need to reach the commercial stage in the coming decades.

There is unfortunately a chicken and egg dilemma here: for policymakers to put in place the framework needed to accelerate the technical demonstration of advanced reactors, facilitate their licensing across different jurisdictions and attract investors, they need to be convinced that nuclear power is an option that needs to be seriously considered when addressing the challenge of decarbonizing hard to abate sectors.

This is where modelling of energy transition scenarios that consider the full potential of nuclear power needs to be further developed. Addressing the full range of scenario options, and assessing the costs and risks associated with different net zero pathways, could help inform policymakers and convince governments that advanced reactors have a role to play in decarbonizing the world's energy systems by 2050 and beyond.

This is the rationale for the Atoms4NetZero initiative launched by the IAEA Director General Rafael Mariano Grossi at COP27 in November 2022. Through this initiative, Member States but also industry and other organizations, are invited to partner with the IAEA to develop and analyse energy transition scenarios using Agency energy modelling tools or other tools, as well as investigate the feasibility of deploying advanced reactors to decarbonize hard to abate sectors. The progress of this initiative will be reported at the forthcoming Second International Conference on Climate Change and the Role of Nuclear Power: Atoms4NetZero, which the Agency is hosting on 9-13 October 2023, as well as at COP28 in December 2023, where the Agency will invite its partners to showcase the role of nuclear power to mitigate climate change on its Atoms4Climate pavilion.



Rolls-Royce SMR: Clean, Affordable Energy for all

Alexis Honner, Business Development Manager, Rolls Royce SMR

The world faces a global energy emergency driven by rising prices, uncertainty and instability of supply, overreliance on hydrocarbons and older nuclear power stations reaching the end of their operational lives. New nuclear has a vital role to play in fuelling the energy transition that will deliver the right mix of clean and sustainable energy that can provide reliable, affordable power for generations to come while meeting our net zero commitments.

Rolls-Royce Small Modular Reactor (SMR) is delivering a radically new approach to deploying proven nuclear technology, economically and efficiently for a wide range of electricity and industrial applications including power, heat, and transport. Rolls-Royce SMR takes well-understood technology and applies a unique manufacturing philosophy to its fabrication and assembly. The Rolls-Royce SMR offers a fully modularised, standardised, factory-built product that is affordable, deliverable, and investable. Using pressurised water reactor technology (the most operated reactor type in the world), standard fuel, and incorporating Rolls-Royce's unrivalled experience in the design and manufacture of compact nuclear reactors for propulsion systems, the Rolls-Royce SMR will produce 470MWe of always-on power to achieve decarbonisation of the whole energy system.

The Rolls-Royce SMR is the only product that takes a fully modular approach to deploying proven nuclear technology. A highly competitive source of 'always on' clean energy for grid and industrial uses. Reducing project risk and providing certainty through a repeatable, factory-built product with low capital cost designed to attract traditional forms of capital through a low-risk solution.

The Rolls-Royce SMR is a market leading product offering a fully modular, factory-built power plant. Around 90% of the complete plant will be transported to site by road as prefabricated, pre-tested modules from our specialised factories and assembled, under cover, on-site within a 'site assembly factory'. The modular approach, combined with our unique turnkey solution under one managed Engineering, Manufacturing, Assembly (EMA) contract, significantly reduces both cost and schedule and increases build certainty. With the highest output of any SMR, the Rolls-Royce SMR is the fastest, most affordable way of bringing new nuclear power online, delivering the capacity and credibility required to ensure nuclear becomes a core part of the future energy transition.

The Rolls-Royce SMR is currently progressing through the UK's independent regulatory assessment process (Generic Design Assessment – GDA) to ensure the design meets the highest standards of safety, security, safeguards and environmental protection. As the only 50Hz SMR design to have formally commenced licensing globally, the Rolls-Royce SMR is on track for first deployments in Europe in the early 2030s. Having successfully completed GDA Step 1 in March 2023, the Step 2 detailed technical assessment is now well underway supported by our team of over 600 experienced nuclear professionals.

At 470MWe, the Rolls-Royce SMR produces more low-carbon energy than any other SMR on the market but remains the most flexible solution for grid and industrial uses – decarbonising industry and underpinning renewable sources with reliable, affordable always-on power to fuel the energy transition.

Rolls Royce SMR

THE FUTURE OF EUROPE'S ENERGY MIX

Tim Yeo, Chairman, New Nuclear Watch Institute

The last two years have been challenging for Europe's energy industry. A sudden spike in gas prices caused pain for domestic and business consumers alike. Countries which had complacently begun to depend too heavily on imported Russian gas suddenly found their security of supply at risk. While this was happening the climate change threat continued to grow relentlessly.

These events will all impact on the future energy mix. Europe is a leader in the global response to climate change. Its early recognition of the need to diversify away from fossil fuels led to a big increase in its renewable capacity. It created the world's largest and most liquid carbon emissions trading system.

Much more must be done to meet its challenging net zero targets. Solar and wind will continue to attract private investment to finance further expansion. Onshore wind which, like solar, does not require a subsidy faces resistance in countries like France and Britain. Allowing more pragmatic local decision making would probably stimulate faster growth and this would be desirable.

All modern economies require an uninterrupted 24/7 supply of power. Until low cost, large scale, long term and flexible electricity storage is available there will be limits on the proportion of any nation's electricity which can be produced from intermittent renewable sources.

It is therefore encouraging that the European Commission has finally abandoned its traditional hostility to nuclear and included it in the EU taxonomy for sustainable activities. This confirmation that nuclear poses no threat to human health or the environment is an overdue acknowledgment of reality.

The need to increase the proportion of electricity generated by almost zero carbon sources is turning the tide. Nuclear will become a bigger part of the energy mix as new plants under construction or planned in France, Finland, Slovakia, United Kingdom, Poland, Hungary, Romania and Czech reach completion over the next decade.

Within ten years nuclear will also benefit from the rollout of advanced small modular reactors. These will be able to be deployed in a wider range of locations than larger plants and will bring the benefits of nuclear to many communities, including some in isolated regions, for the first time.

Oil's role will soon start to diminish as the electric vehicle revolution gathers speed and this may happen faster than is currently expected. By 2040 nearly all cars and light vehicles will be electric while heavy trucks and buses are likely to switch to hydrogen. This will leave aviation as the only large industrial customer for oil.

This prospect casts doubt on the wisdom of continued oil exploration. The world cannot safely use all the existing known oil reserves and any future oil discoveries in the North Sea will never compete on price with Middle East oil fields. Giving corporate tax breaks for fossil fuel exploration is not compatible with treating the climate threat seriously and will probably lead to stranded assets in years ahead.

Gas will remain an important transitional fuel until mid-century. Its use thereafter will depend on the affordability of carbon capture utilisation and storage, a technology which at present requires large subsidies. The role of gas in heating may also be challenged if green hydrogen falls in price as far as its supporters claim may happen.

The pace of change in Europe's energy mix will vary from one country to another but the direction of travel will be the same everywhere. The clean energy transition is under way and is here to stay. It has the potential to strengthen energy security and stablise prices as well as cutting greenhouse gas emissions and improving air quality.

There will be losers as well as winners and some parts of the energy industry will inevitably contract but investors will find plenty of opportunities for profitable growth as the clean energy transition accelerates.

Nuclear technologies that can meet the sustainability challenge must come to the fore

Csaba Kiss, Deputy CEO, Chief Generation Officer and Chief Nuclear Officer, MVM Hungarian Electricity Ltd.

It is now recognised worldwide that energy is a crucial factor in our lives. Humanity's increasing use of energy for mechanical work, industry, heating and lighting is one of the most characteristic features of the development of civilisation today.

There is a demonstrable correlation between the standard of living of the population of each country and per capita energy consumption, with productivity being closely related to kW per worker.

The unprecedented speed of industrial development, the mechanisation of households and agriculture, the rapid development of transport and the rapid expansion of communications are constantly creating new energy consumers. At the same time, the constantly growing supply of available energy sources is not keeping pace with this rapid growth in demand, at least if we consider the classic energy sources (coal, oil, natural gas, wood, hydroelectricity, etc.). On the contrary, there are already fears of stock depletion in many places. Moreover, environmental challenges need to be met. Technologies that can meet the sustainability challenge must come to the fore.

It is therefore understandable that experts and lay people alike are increasingly asking:

WHAT WILL THE FUTURE ENERGY SUPPLY OF HUMANITY LOOK LIKE, WHAT DOES THE FUTURE HOLD FOR HUMANITY IN TERMS OF ENERGY?

It is clear that we will only be able to control our energy needs by making extensive use of nuclear energy. This not only offers a reassuring option for our security of supply challenges, but also a viable alternative to our sustainability and environmental challenges by providing a carbon-free energy transition.

The MVM Group is the flagship of the Hungarian national energy and climate policy and the implementer of the Hungarian energy strategies. In my presentation, I will present the MVM Group's power plant developments and highlight how nuclear energy serves both Hungary's and the MVM Group's sustainability objectives.

Manoeuvrability requirement of nuclear power plant units

Krisztian Szarvas, Technical Director, Paks II. Nuclear Power Plant Ltd.

In a power grid, as much electricity as the consumers demand must be available at any given moment. Since electrical power can only be stored on an industrial scale to a limited extent, it is a serious task to guarantee a constant performance balance. Due to the rise of weather-dependent renewable energy, maintaining the balance is an increasing challenge. That is why it is also expected of nuclear power plant units that their performance can be changed and "manoeuvred" within certain limits.

The balance of the grid is created, among other things, by changing power plant productions. In maintaining the balance at all times, individual power plants participate in different ways, the nuclear power plants operating today are primarily base power plants, i.e. they operate continuously at their rated output. This is the most cost-effective and simplest operating mode, so the majority of nuclear power plants, operating with a small change in their output most of the time, only play a role in maintaining the grid frequency. At the same time, there are already nuclear power plants that are not only involved in maintaining the grid frequency, but also very often in its restoration, so they execute the automatic or manual frequency restoration command of the system controller, i.e. they change their performance, that is, they manoeuvre. In addition to frequency maintenance and restoration activities, schedule tracking also occurs more and more frequently, primarily due to the increasing number of weather-dependent electricity producers and the new rules of the electricity market. This means that there are periods when a given power plant is unable to sell part of its electricity, so a power change must be included in its schedule.

The NPP units can be down load when the supply is too high, mainly during sunny or windy periods, and when the demand is too low, which is mostly typical on weekend nights.

Newly built nuclear power plants are subject to stricter requirements than existing ones. In addition to the fact that the new units must also be able to participate in frequency maintenance and recovery, as well as the load following mode, this must be possible in the range of 50-100% of the nominal power. There are several solutions to ensure that the NPP originally designed for basic power plant operation can be operated in load following mode. Implementation is a complex process affecting the entire power plant. It is important to note that participation in frequency maintenance and restoration is also beneficial for the operator from an economic point of view.

In order to enforce the requirements mentioned above and to realize the manoeuvrability of the new units in the best possible quality, the units originally intended for basic power plant operation must be redesigned. From the point of view of the designer, this modification is a high-priority, multidisciplinary design activity, during the implementation of which energy market and reliable power supply must also be taken into account.

Joint nuclear programs – successful story

Saša Medaković, Member of the Management Board, Krško Nuclear Power Plant

In order for civilian nuclear programs to be successful (safe, secure, environmentally and publicly acceptable), a number of prerequisites must be met before an actual nuclear power plant can be deployed, regardless of size or type. These prerequisites for nuclear infrastructure development are very well defined and described in the IAEA milestone document and include among others human resource development, industrial involvement, legal framework, etc. Each of these milestones requires significant effort and time.

For countries with relatively small energy consumption and electrical grids, which is the case with most countries in Southeast Europe, it is reasonable to assume that joint efforts in meeting the milestones will increase the chances of successfully starting or upgrading a civilian nuclear program. From the point of view of a relatively small country, resource sharing would be of great benefit and significant time savings before a new nuclear power plant could be ordered. Cooperation between countries to develop nuclear capabilities is not a new thing and has been a practice in the past, but it has usually been between the buyer country and the supplier country.

One of the rare examples of successful cooperation between the countries in implementing and exploring a joint nuclear power program is between Slovenia and Croatia in Krško NPP on Slovenian territory. Like today, lack of resources, energy crisis and a grooving need for secure, affordable and clean energy has been brought to the center of attention of decision makers. Two countries made a joint effort and a decision to start a joint nuclear power program. Originally, two locations were planned for nuclear power plants, Krško in Slovenia and Prevlaka in Croatia.

In the following years, a nuclear power plant was successfully built and put into commercial operation in 1983. It was a Westinghouse PWR NPP Krško with a capacity of 700 MW. Due to a combination of different reasons, the second project was finally canceled in 1987 after the Chernobyl disaster. In 2023, after 40 years of operation, NE Krško received a license for long-term operation for at least another 20 years. All this time, for more than 50 years, the nuclear power plant has been successfully managed on the principle of 50-50 partnership and consensus with the full support of the original supplier and the supplier country.

The Krško nuclear power plant is a living example of successful cooperation that enabled something at that time no country could do alone. The implemented model ensured a long-term stable environment and synergy that proved to be a key element for the success of the nuclear energy program.

Watching the evolution of the Nuclear power generation – the Romanian program

Ionut Purica, Executive Director, Advisory Center for Energy and Environment

When talking about optimality one needs to define the criterion on which the optimum is analyzed. In the case of nuclear power there have been two main criteria considered as a function of the needed use of the power plants.

One such criterion is the flexibility of the power device required by the use in defense systems and remote supply needs such as in the Antarctic. In this case the ease of manufacturing, deployment and use is the key to optimality. The unit power is thus relatively small.

The other criterion is the thermodynamic efficiency considered for the civilian use of nuclear power plants. This case leads to large scale power units that take a long time to build and have high costs. Their advantage is seen in the impact on the whole energy system especially as base load cover.

The impact of the power system structure change in the last years given by the penetration of renewables having low or no emissions but being very volatile has shifted the thermodynamic optimality to flexibility of the nuclear power balancing the economic advantages in the new power systems.

One such trend is seen in the Romanian nuclear power development that is not only finalizing the 2 units at the Cernavoda NPP but also implementing Small Modular Reactor technology in the power system. Associated with the large amount of renewables installed in the power system the more flexible SMR power plant is likely to improve the security of the system operation with a no emission technology. Thus, the goal of decreasing power sector emissions is achieved without sacrificing security of supply.

We should stress that the Romanian nuclear program that started in 1957 with the first research reactor outside the USSR at that time, continued with a Triga reactor and various research facilities including the design of a lead cooled fast breeder small reactor. On the power plant line the availability of Uranium ore allowed the processing of fuel for the CANDU (natural Uranium, heavy water moderated and cooled) reactors of which 2 700 MW units are in operation and other two under construction. The recent agreement to build a SMR (Nu Scale technology) based NPP is in line with the trend described above related to the large percentage of renewable energy implemented in the last years in the system.

Romania is contributing to the power system stability of the region and also to the strong emission reduction of its economy.

Nuclear Energy's Role in Secure Low – Carbon Power Systems

Keith Everhart, Energy Analyst – Renewables Integration and Secure Electricity, International Energy Agency

Nuclear energy can help to ease the transition to a more secure, sustainable and affordable energy system, particularly in light of today's global energy crisis that has caused many countries to re-orient their energy strategies away from relying on imported fuel. While the IEA's Net Zero Emissions by 2050 (NZE) expects wind and solar to lead the transformation in our energy systems, they will require complementary generation sources providing key system services to integrate into the power system due to their variable and intermittent nature.

Nuclear and other dispatchable power sources provide these services to electricity systems, including stability, short-term flexibility and adequate capacity during peak demand periods. The need to procure these services will increase sharply as the share of variable renewables increases. For example, in an analysis of a carbon neutral power system in China, nuclear would provide only 10% of total electricity produced in 2060, but supply almost half of the required inertia, a key component of system stability.

The IEA's recent report on the nuclear industry, titled "Nuclear Power and Secure Energy Transitions" makes it clear that less nuclear power would make net zero ambitions harder and more expensive: The Low Nuclear Case variant of the NZE considers the impact of failing to accelerate nuclear construction and extend lifetimes. In this case, nuclear's share of total generation declines from 10% in 2020 to 3% in 2050. Solar and wind would need to fill the gap, pushing the frontiers of integrating high shares of variable renewables.

It would put additional strain on clean energy supply chains: for every 1 GW reduction in nuclear capacity in the Low Nuclear Case, an additional 3.5 GW of capacity from other sources is needed, with a greater call on critical minerals for both power generation technologies and grid infrastructure. More energy storage and fossil fuel plants fitted with carbon capture, utilisation and storage (CCUS) would also be needed. As a result, the NZE's Low Nuclear Case would require USD 500 billion more investment and raise consumer electricity bills on average by USD 20 billion a year to 2050.

We recommend that policy makers in countries that see a future for nuclear energy ensure that policies and markets align with their vision. Governments should create financing frameworks to mobilise capital at an acceptable cost with fair sharing of risks between investors and consumers. As well, they should design electricity markets to fully reflect the value of all services needed for secure system operation. They should also promote efficient safety and waste management regulations in order to build public support. Finally, they should accelerate the development and deployment of small modular reactors, which have the potential to become a low-cost, secure and low emissions source of electricity, heat and hydrogen.

The Future of the energy mix in Central Europe: Nuclear Power's Key Role in the Net Zero Transition

Miroslav Lopour, Senior Manager, Energy and Resources, Deloitte Central Europe

Europe is at a crossroads when it comes to shaping its future energy mix landscape as it races towards achieving net-zero emissions. It is essential for the region to effectively decide how its energy mix will be composed and how individual energy sources will be integrated to play their important part. Amidst this transition, nuclear power emerges as a key player, offering a reliable and low-carbon solution.

IEA predicts that 50% of global total energy consumption will be covered by electricity. 90% of which will be delivered by renewables with the rest allocated to nuclear. EC declared that nuclear share should be around 15% in the target electricity mix. This demonstrates that nuclear should have relevant standing in decarbonizing scenarios offering options for the CEE energy future.

Yet the development of the nuclear industry represents more a story of a dying dinosaur rather than a trending technology sector. European nuclear capacity and production are on a long-term decline. New builds suffer from construction delays and budget overruns. Only a handful of units were commissioned in the last 20 years. 83% of European nuclear capacity is more than 30 years old and most will be at or near the end of their lifetime around 2050. The nuclear industry lost the appeal for new talents. Annual nuclear capacity additions for 2050 represent nearly four times recent averages, which underlines the magnitude of the challenge it has to overcome.

The situation in Central Europe is not much rosier. Countries unanimously support energy security and the role of nuclear in their energy mixes. However, the last decade proves more of a lost window of opportunity where very few new sources were put on the market. The region struggles even with renewables and the capacity of the energy sector is rather shrinking as the power plant fleet is slowly closing down. Many interpret this as the reason to launch new nuclear builds and renewal units built in the 70s and 80s. On top of that Poland is striving to build the whole nuclear competence. The question is if we have enough dedication to bring this ambition to fruition.

In order to achieve such targets for nuclear, various factors will have to be overcome to allow a new nuclear CEE renaissance. Firstly, nuclear is unfortunately not the right solution for providing energy security for the 30s decade, as the region will be slowly moving into an energy deficit with a diminishing coal fleet. Nuclear will be able to contribute at the end of the decade and may face fierce competition from other sources.

Secondly, integration with renewables will be important for a clear business case as most surely nuclear will be facing enormous solar capacity in the summer months when the solar boom will finally overtake CEE as it did in Western Europe. Wind capacity will also make the manoeuvring room smaller. Thirdly, nuclear is striving to implement new concepts of parallel builds and unit standardization to drive down final CAPEX costs, this is ultimately challenged by more demanding licensing processes, safety guarantees and NIMBY effects. CEE is still very friendly towards nuclear, but building any kind of large new infrastructure poses a challenge in itself. Increasing demands and fragmented nuclear licencing and building permitting in CEE will be bogging down any quick progress.

Central Europe stands at a critical juncture in shaping its future energy mix. Nuclear power, despite the challenges it faces, plays a key role in the region's net-zero transition. However, revitalizing the nuclear sector requires a concerted effort, including streamlined regulatory processes, investment in new reactor technologies, and the integration of nuclear power with renewable energy sources. With the right strategies and a sense of urgency, Central Europe can pave the way for a sustainable and resilient energy future. We have to transform new nuclear ambition into a meaningful environment for investors and the industry to overcome all challenges which new nuclear units face in the lengthy construction process.

Nuclear Power has a Vital Role to Play in SE Europe

Costis Stambolis, Chairman and Executive Director, Institute of Energy for South East Europe (IENE)

In SE Europe, there are five countries (Bulgaria, Hungary, Romania, Slovenia and Croatia) that currently operate nuclear power plants (NPPs), while Turkey is expected to build no fewer than 3 NPPs over the next decade. Nuclear power remains a viable option for growth because it offers important baseload capacity and supports the EU's decarbonization policies. The zero emissions from operating NPPs contribute to the region's efforts to curtail GHG emissions. This means that nuclear energy has an important role to play in the SE European energy and electricity mix over the next decades.

In the aftermath of the tragic accident at Fukushima NPP in March 2011 and operational security reviews, which have since been conducted by the SEE countries that host NPPs, the use of nuclear power in the region is unlikely to diminish over the next decade. Neither Bulgaria nor Romania nor Hungary are likely to shut down the Cernavoda, Kozloduy 5-6 and Paks 1, 2, 3, and 4 power plants respectively on account of safety concerns.

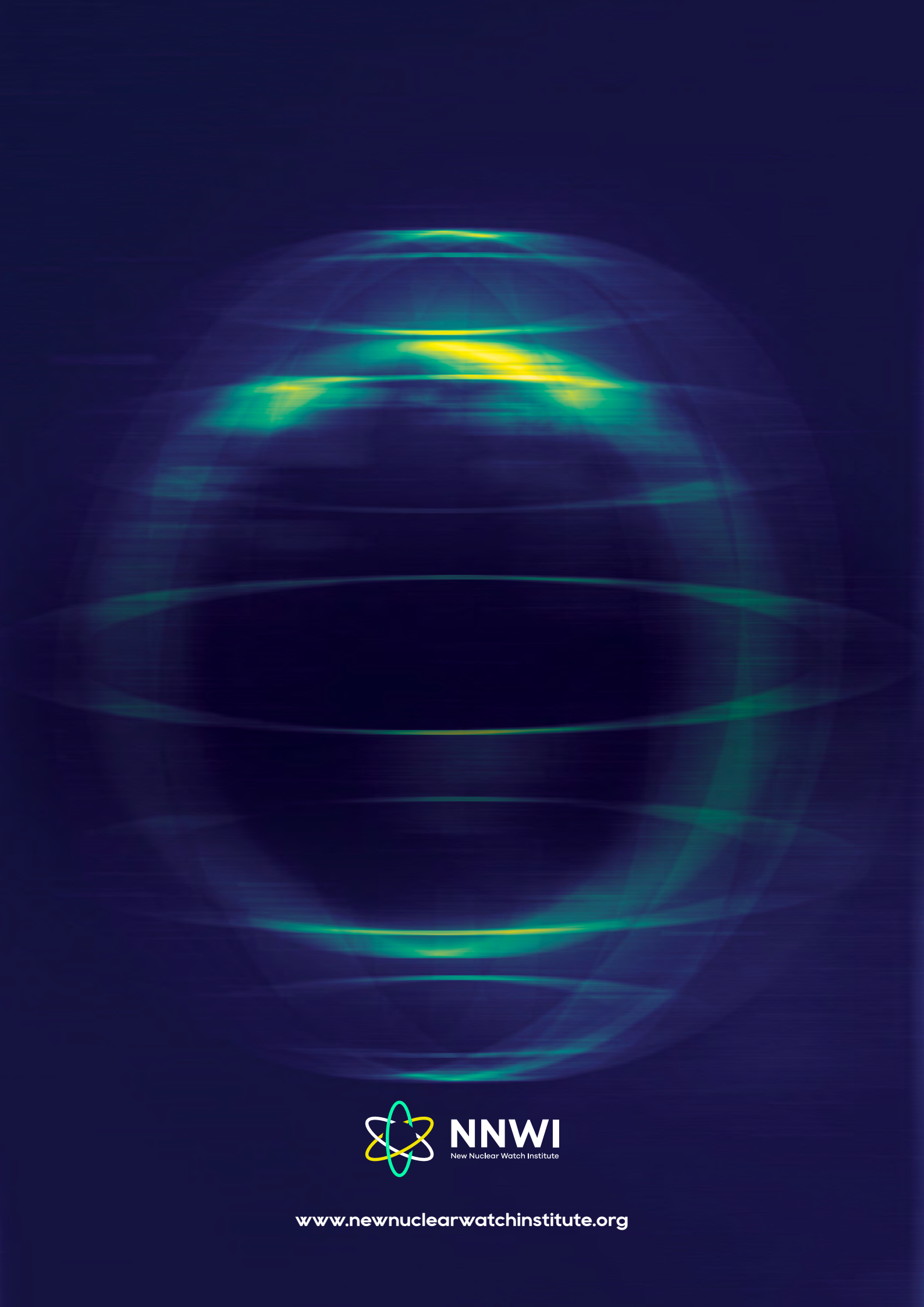
The same applies for Croatia and Slovenia, which, between them, share the Krško NPP. Both governments are very well aware of the fact that a decrease in the participation of nuclear power in their electricity generated portfolio cannot be easily replaced by renewables or be compensated by an increase of coal generated electricity due to the equally burdensome environmental costs. If they are to reduce the participation of nuclear power in their total electricity mix, both states have as an alternative the increase of imported gas, magnifying their already high dependence on gas.

Theoretically, the participation of nuclear generation in the regional electricity mix is set to diminish significantly as the rising demand of Bulgaria and Romania will be covered by increased volumes of natural gas and, to a lesser extent, RES. However, this might change as both Romania and Turkey are definitely going ahead with plans to increase their nuclear installed capacity, which will result in two major nuclear power generation complexes with 6 GW of new installed capacity to be operated by 2030.

On the strength of current plans the installed nuclear capacity of SE Europe, Including Turkey, will have increased substantially by the end of this decade as some 6,700 MWe of new plants will have been added to the region's existing nuclear power capacity of 7,096 MWe. With the new capacity coming from Hungary, Romania and Turkey. The almost doubling of SEE's nuclear power potential by 2030 will no doubt contribute substantially to the decarbonisation effort. Such a positive development should be viewed in the context of the ongoing massive expansion of renewables capacity in all countries in the region. Hence nuclear power can work in tandem with RES and can have a major effect in decarbonising SEE's electricity infrastructure.

In view of the fact that investment in the nuclear power sector is of strategic importance and the long time framework required, such decisions should not be subverted by short-term political priorities against regional, economic and safety considerations. In this sense, the Fukushima anti-nuclear rationale does not appear to hold in the case of SE Europe. For countries already involved in nuclear power development (ie Bulgaria, Hungary, Croatia, Slovenia, Romania, Turkey) the road ahead is unlikely to be obstructed by revised risk assessments.

Developing further nuclear power generation in the region will be a real challenge as not all countries favour this option. Detailed studies need to be undertaken to identify the real potential pitfalls of nuclear energy but also to assess the compatibility of nuclear and RES in the context of achieving actual decarbonisation in the electricity sector.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