CONTENTS

ROSATOM NEWS

TRENDS

NEW BUSINESSES

All Nations Welcome

In March, Russia hosted Atomexpo 2024, an international forum, which set a new record with the number of visitors and international delegations as nearly 4,500 delegates from 75 countries took part in the event. Burkina Faso, Mali, Niger, and Iraq joined the forum for the first time. The key topic at Atomexpo was Generation IV reactor technologies, with much discussion extending into international cooperation, small modular reactors, electric mobility, environment protection, digitalization, and other areas.

"Nothing can hold back the progress of nuclear technology, nothing can hold back Rosatom's progress, and nothing can hold back the progress of our country," Rosatom Director General Alexey Likhachev said at the opening of the forum.

The motto of the forum was Clean Energy: Creating the Future Together. **"Future and together are two key words in the motto. We will discuss the fourth generation of nuclear solutions, thermonuclear fusion, and other technologies. It is only together with all the countries that we can build a clean energy future for our planet,"** Alexey Likhachev emphasized.

IAEA Director General Rafael Grossi welcomed the guests via video link: **"Rosatom**

ROSATOM NEWS

Back to contents

is spurring innovation across Generation III+, Generation IV and small modular reactor technology. Three years ago, we took part in the first concrete pouring for the foundation of the world's first lead-cooled fast neutron reactor BREST-OD-300. The IAEA will always be involved in projects like that as we never miss technologies that are future-oriented and on the verge of deployment."

WNA Director General Sama Bilbao y León noted that increasingly more decision makers were recognizing the role of the world nuclear community in addressing such global challenges as, first, climate change, second, energy security and energy independence, and, third, energy equality and energy access. **"It is very important for us to demonstrate that the number of successful cases — nuclear projects delivered on time and on budget — is growing. Such cases do exist, and Rosatom, for example, can boast about success in delivering its projects at Akkuyu, Rooppur, El Dabaa, and so on. We should take advantage of this moment to promote nuclear technology in a way it deserves,"** she concluded.

Generation IV

Much attention at the forum was paid to Generation IV nuclear technologies. One of the key statements made at the thematic session was that the Generation IV concept extends beyond reactor technology to integrate, among other things, spent nuclear fuel recycling and waste management solutions.

Interest of the forum guests was also drawn to live broadcast from the construction site of Generation IV BREST-OD-300 reactor. It is being built as part of the Proryv (Breakthrough) project and will be integrated with a fuel fabrication/re-fabrication module (FRM) and a spent fuel reprocessing module. During the broadcast, a carbothermal synthesis line was test-launched at the FRM.

Cooperation with Russia

Representatives of many countries stressed the importance of nuclear cooperation with Russia at the plenary session. As noted by Hungarian Minister of Foreign Affairs and Trade Peter Szijjártó, Europe will lose its competitive power if it does not cooperate with Russia in the nuclear energy sector. According to his estimates, demand for electricity will double in Europe by 2030. It will be impossible to meet the growing demand with renewable energy sources only.

"If there is no nuclear cooperation with Russia, we will not be able to achieve our sustainable development goals," Peter Szijjártó said.

Turkey's Minister of Energy and Natural Resources Alparslan Bayraktar stressed the need to expand cooperation between Turkey and Russia. He noted that Turkey intended

ROSATOM NEWS

Back to contents

to work with Rosatom on the plans to build a nuclear station in Sinop. Rosatom will also assist Turkey in building an infrastructure for the deployment of SMRs, training professional staff and developing related industry sectors.

According to Belarus Minister of Energy Viktor Karankevich, Belarus and Rosatom collaborate not only in the construction of nuclear power plants, but also in additive technology, energy storage systems for the power supply and electric mobility applications, nuclear medicine, simulators, digital technologies, and so on.

Alexey Likhachev warned the international community against political divisions in the nuclear industry. He also emphasized the importance of raising public awareness and disseminating knowledge about nuclear technologies.

Topics discussed at Atomexpo 2024

Energy Track:
- Hydrogen economy
- Generation IV nuclear technologies
- Synergies between nuclear and renewables
- SMR deployment
- Nuclear infrastructure
- Closing the nuclear fuel cycle

Science Track:
- Fusion innovations
- Research reactor capabilities

Environment Track:
- Advanced eco technologies
- Nuclear sustainability
- Infrastructure and technologies for radioactive waste management and ultimate disposal
- Transformation of nuclear legacy sites

Education Track:
- Proactive staff training
- International nuclear education initiatives
- Educational partnerships

Industry Track:
- Lights-out factories
- Lithium: integration prospects
- Corporate innovations
- Independent electrical engineering
- International partnerships in composite materials and additive manufacturing
- Rare earth metals production

Digitalization Track:
- Digital factory and smart manufacturing
- Evolution technologies for information infrastructure
- Quantum technologies

Logistics Track:
- Future of electric mobility in cities
- Northern Sea Route capabilities

Healthcare Track:
- Nuclear technologies for food safety

Signed at Atomexpo 2024

Over 80 agreements were signed at Atomexpo 2024, which is almost twice as many as at the previous event and a record-high number since the first forum. Parties to the agreements have a broad global footprint, and the areas of cooperation are diverse. Here is our account of the agreements reached.

China

TVEL (Rosatom’s fuel division) and Chinese companies Limac Company Ltd. and Dalian Baoyuan Nuclear Equipment Co. Ltd. signed a memorandum of understanding for nuclear decommissioning and radioactive waste management. The partners are considering the possibility of jointly producing equipment for radioactive waste management and transportation.

TVEL, the National Operator for Radioactive Waste Management (part of Rosatom), the Russian Academy of Sciences Nuclear Safety Institute, and the Beijing Research Institute of Uranium Geology signed a memorandum of understanding for the ultimate disposal of nuclear waste. The Russian companies are planning to take part in China’s MONEH international research project. It provides for the monitoring and assessment of hydrogeological properties of rocks during the construction and operation of the Beishan Underground Research Laboratory.

Another memorandum of understanding was signed between Rosatom Healthcare Technology, China Isotope & Radiation Corporation, and CNNC Medical Industry Co., Ltd. The parties intend, among other things, to jointly develop and manufacture radiopharmaceuticals and equipment for nuclear medicine, train personnel, and establish medical infrastructure facilities, particularly Russian-Chinese friendship medical centers.

Rusatom Service (part of Rosatom’s power generation division) and China’s Jiangsu Nuclear Power Corporation (JNPC) signed two contracts, for the comprehensive maintenance of Tianwan Units 1, 2, 3 and 4 and for the cut-out and removal of irradiated surveillance specimens from the reactor pressure vessels of the same power units.

Belarus

Rosatom and the State Science and Technology Committee of Belarus signed an integrated cooperation program for nuclear non-energy and non-nuclear projects. The overarching goal is to ensure technological sovereignty of the Union State of Russia and Belarus by creating reliable supply chains.

ROSATOM NEWS

Back to contents

TVEL and the Belarusian Radioactive Waste Management Organization (BelRAO) signed a roadmap for the introduction of training courses and advanced training programs for the employees who will work at the radioactive waste repository facility in Belarus.

A cooperation agreement was signed with the National Academy of Sciences (NAS) of Belarus to conduct joint research at the MBIR multipurpose fast neutron research reactor in the International Research Center. The parties will outline potential areas of research, draft multilateral research programs, participate in the research and administrative activities of the consortium, and so on.

Another agreement with the Belarusian NAS provides for the cooperation in staff training, advanced and applied studies, surveys and engineering.

Rosatom and Giprosvyaz, Belarusian leader in network and system engineering, signed an agreement on strategic cooperation. The document provides for a comprehensive program for the development, production and testing of telecommunications equipment with plans to sell it in the Belarusian and other markets.

Kyrgyzstan

The governments of the Russian Federation and the Kyrgyz Republic signed an agreement on cooperation in remediating legacy uranium mining sites in Kyrgyzstan.

Rosatom and the Kyrgyz Ministry of Energy signed an agreement to develop and implement small-scale hydro generation projects with a capacity of up to 400 MW in several regions of Kyrgyzstan.

Rosatom's wind power division and the Kyrgyz Ministry of Energy agreed to develop and implement a project for the construction of renewable energy facilities with a capacity of up to 1 GW. The first step will be the construction of a 100 MW pilot wind farm in the Issyk-Kul region. Then the parties plan to assess other sites for the deployment of wind power plants with a total capacity of up to 900 MW.

ROSATOM NEWS

Back to contents

Mali and Burkina Faso

Rosatom Director General Alexey Likhachev, Republic of Mali's Minister of Energy and Water Bintou Camara, and Burkina Faso's Minister of Energy, Mines and Quarries Yacouba Zabré Gouba signed roadmaps to establish a dialog in peaceful uses of nuclear energy. After the parties set up a legal framework for international cooperation, they will consider the possibility of implementing nuclear power projects and using radiation technologies in agriculture and medicine in Mali and Burkina Faso.

Serbia and Kazakhstan

Rosatom and the Serbian Ministry of Health signed a memorandum of understanding and cooperation in nuclear medicine. The parties agreed to carry out joint non-energy projects to use nuclear technologies in healthcare with a focus on nuclear medicine. A special focus is made on the diagnostics and treatment of oncologies with peaceful atom technologies.

A similar memorandum was signed between Rosatom Healthcare Technology and the Healthcare Department of the Zhambyl Region (Kazakhstan).

Egypt

Rusatom RDS (part of Rosatom) and the Egyptian Med Pharma Group signed a roadmap on cooperation in promoting the Tianox nitric oxide therapy device in Egypt. The new stage of cooperation will help Egyptian medical institutions upgrade their equipment and improve the level of medical care for the people.

Hungary

Rosatom and the Hungarian Association for Public Information and Oversight (TEIT) signed a roadmap of activities for 2024. The parties plan to carry out projects in the fields of culture, education, environment and sports under the current memorandum of cooperation signed in 2014.

ROSATOM NEWS

Back to contents

Nicaragua

Rosatom Healthcare Technology and the Healthcare Department of the Nicaraguan Ministry of Health signed a roadmap for a joint project to build a cutting-edge nuclear medicine center in Nicaragua.

Rwanda

The Tomsk Polytechnic University (TPU, one of Rosatom's backbone universities) and the Rwanda Atomic Energy Board signed a memorandum of understanding. The parties agreed to develop cooperation in education, training and research in nuclear physics and other areas.

Syria

Rosatom and the Atomic Energy Commission of Syria approved an implementation plan for the memorandum of understanding signed in July 2020. It provides for the supply of medical radioisotopes, radiation technologies for commercial irradiation, personnel training, and so on.

Armenia

Rusatom Service and Haykakan Atomayin Elektrakayan (Armenian NPP) signed a contract for the supply of equipment and upgrade of the cooling system for the reactor of Armenian NPP Unit 2.

Algeria

Rosatom and the Ministry of Energy and Mines of Algeria signed a roadmap for cooperation in peaceful uses of nuclear energy. The roadmap lays down measures to develop scientific and technical cooperation and personnel training, and provides for meetings of working groups and technical tours. NL

To the beginning of the section

 Back to contents

Rare Earth Supply Chain

Rosatom is building an end-to-end production and supply chain in the rare earth sector, from ore mining to final products such as wind turbines and electric cars. Here is the story of how the entire chain works.

Located in Russia's northwestern region of Murmansk, the Lovozero Mining and Processing Plant (part of Rosatom's mining division) produces loparite ore. Loparite is a mineral containing titanium, tantalum, niobium, and rare earth elements (REE). The Lovozero MPP is Russia's only producer of REE-containing concentrate, which is then shipped to the Solikamsk Magnesium Plant (SMP) in the Urals.

The production at SMP is arranged to allow for the fullest use of commercial components contained in feedstock materials. When SMP produces magnesium, which is its primary product, it also obtains chlorine as a by-product. Chlorine is used to treat loparite concentrate and extract rare earth elements. The resulting rare earth chlorides then pass

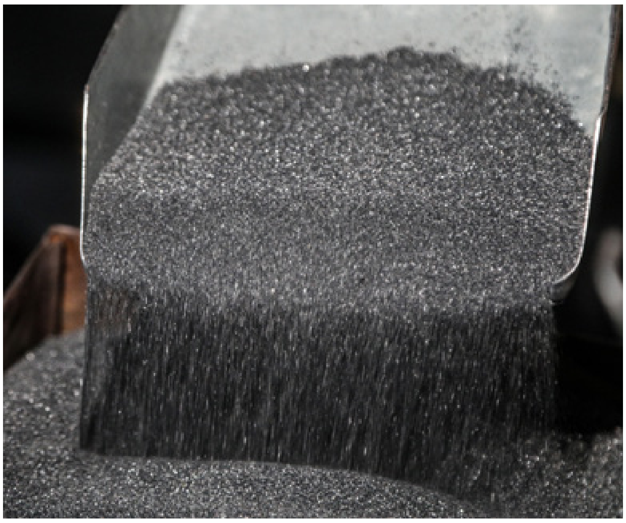
NEW BUSINESSES

Back to contents

several processing operations to be turned into a mixed rare earth carbonate, which is exported so far. SMP has already taken steps to set up a separation process in house and produce individual compounds of cerium, lanthanum, neodymium, praseodymium, and concentrates of middle rare earth elements (samarium, gadolinium, and europium).

Saint Petersburg-based company Rusredmet has built a pilot separation plant for mixed rare-earth concentrates on commission from SMP. The process flow is as follows: the mixed concentrate is dissolved in nitric acid. The resulting nitrate solution is electro-oxidized to extract first cerium and then other elements. The extraction is followed by precipitation, drying and annealing. The separation plant is expected to be put in operation in 2026.

Its planned capacity is 2,500 tonnes of cerium, lanthanum, neodymium and praseodymium compounds per year. Of these, 18% (450 tonnes) will be neodymium and praseodymium oxides, which is equivalent to 370 tonnes of metal. The individual compounds obtained will be used in various industries, particularly in glass-making, metallurgy and production of catalysts.



Another REE consumer industry should soon appear in Russia through Rosatom's efforts. This will be the production of permanent rare earth neodymium-iron-boron (NdFeB) magnets, in which neodymium and boron account for about half of the mass. According to the International Renewable Energy Agency (IRENA), production of rare-earth magnets consumed 29% of global REE supply in 2022.

Rusatom MetalTech (part of Rosatom's fuel division) is developing engineering documents for the first 1,000-tonne production line. The NdFeB magnet plant will be launched in Glazov (Russia) in 2028. With the second production line installed, the plant's capacity will increase to 3,000 tonnes of permanent magnets per year. This quantity will be enough to almost fully meet the needs of key Russian industries for these products.

According to analysts, the rare-earth magnet production market is now dominated by China, with a share of about 90%. The country's total production capacity is estimated at 300,000 tonnes of NdFeB magnets per year.

Consumer electronics, electric mobility (cars, scooters, etc.), and wind power generation are the industry sectors that consume most of the permanent rare-earth magnets. Experts agree that electric mobility and wind generation will be primary drivers of demand.

"With this large-capacity permanent rare-earth magnet production, we will fully supply Russian high-tech companies with top-quality magnets to achieve development goals for the domestic wind power and mechanical engineering industries, including the automotive industry," Rusatom MetalTech CEO Andrey Andrianov said at Atomexpo 2024.

NEW BUSINESSES

Back to contents

Rosatom is present in both of these segments. The wind power division of the Russian nuclear corporation builds wind farms in Russia. This March, the second 35 MW phase of Rosatom's Trunovskaya Wind Farm in the Stavropol Krai was connected to the national power grid. Consisting of 38 wind turbines, Trunovskaya has a total installed capacity of 95 MW. This is the ninth wind farm commissioned by Rosatom; their aggregate capacity exceeds 1 GW.

Rosatom is also engaged in electric mobility. Its subsidiaries are developing a complete electric drive system, which consists of an electric motor, a gearbox and an inverter placed into a single housing. **"We are upgrading chemical processes at our lithium production and developing our own batteries, electric drives and other components. While setting up the production of all key components, Rosatom is not going to become an electric car manufacturer at this time. But we call on all automakers to consolidate efforts and saturate the market with as many components as needed to make Russian-made electric cars competitive in price,"** TVEL President Natalya Nikipelova said at Atomexpo 2024.

To the beginning of the section

SMR Dashboard

The OECD Nuclear Energy Agency (NEA) has released the second edition of its Small Modular Reactor (SMR) Dashboard. This document outlines advancements in SMR technologies and organizes the data across multiple dimensions. While the SMR Dashboard could serve as a valuable reference for investment managers, it should be noted that there are significant inaccuracies concerning Russian SMR projects and technologies, which are leading in this field. Therefore, caution is advised when using this resource for investment decisions.

For the second edition of the Small Nuclear Reactor (SMR) Dashboard, NEA experts identified 98 SMR technologies around the world, but only 56 of them were analyzed: **"These are the SMRs for which the requisite publicly available information was assessable and for which the relevant designers were willing to participate."** The remainder include SMR technologies that are not under active development, may be without human or financial resources, or have been canceled or paused indefinitely. The assessments in the latest edition of the SMR Dashboard are based on progress up to a cutoff date of 10 November 2023.

The SMR data in the document is structured along several dimensions, including progress from concept towards commercial deployment, siting by country, site owners, fuel enrichment requirements, type of coolant, applications, and additional features.

Dive into methodology

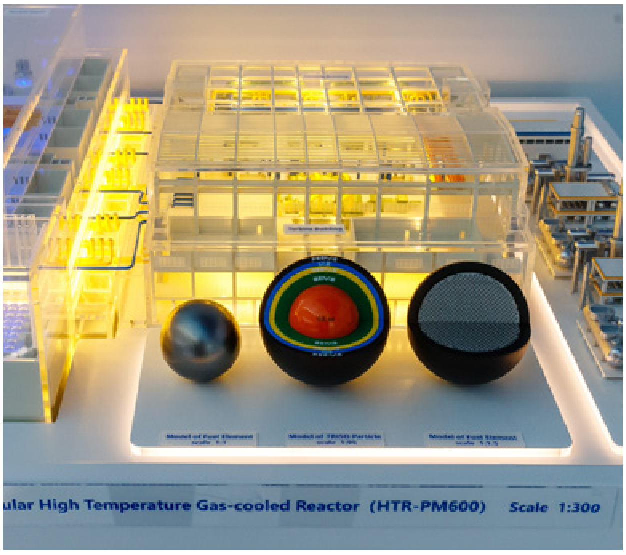
The number of the SMRs in operation is the first thing that surprises an attentive reader: **"There are three SMRs deployed and operating: the HTR-PM in China, the floating KLT-40S in Russia as well as the High Temperature Test Reactor (HTTR) in Japan."** The latter is, however, a research reactor, and research reactors are usually not referred to as SMRs — only power generation installations, including demonstration reactors, count as such. If the authors took the liberty of including them into the SMR ranks, they should at least have taken into account the MBIR multi-purpose fast-neutron research reactor which Rosatom is building in Dimitrovgrad (Russia), with interested parties invited to join the research program.

The mention of merchant ships as yet a potential application for the SMR technology also raises questions. What, then, about Sevmorput, the world's only nuclear-powered lighter carrier owned by Rosatom? It operates on the Northern Sea Route and delivers cargoes to destination ports.

Russian-designed RITM-400 reactors are not mentioned in the document either. The first of them will be installed on the Rossiya icebreaker of the Leader Project family. Production of the core equipment and control systems for the reactors has already begun. Discussions are underway to build an onshore modification of the RITM-400 reactor to supply power to the production facilities of the Russian mining giant Nornickel. The parties have entered into an agreement of intent and cooperation.

Finally, and most importantly, the SMR Dashboard does not mention the onshore small-scale nuclear power plant with the SHELF-M reactor, which is being developed by the Dollezhal Research and Development Institute of Power Engineering (NIKIET, part of Rosatom). Rusatom Overseas CEO Evgeny Pakermanov said at the Atomexpo 2024 forum that the front-end engineering phase for the SHELF design was completed, and so were a number of research and development programs related to the application of this technology. Since the deployment region (Chukotka) and the largest consumers have also been identified, the decision to launch the SHELF project is expected to be made later this year. The nuclear power plant with the SHELF-M reactor will supply power to the Sovinoye gold deposit and adjacent areas in Chukotka.

It should be also noted that, for some reason, the NEA SMR Dashboard calls NIKIET to be an independent developer of the BREST-OD-300 reactor. It is, however, a subsidiary of Rosatom. Speaking generally, Rosatom is working on no less than ten SMR designs, each at a different stage of completion.



Assessment circle

The authors use a circle divided into six concentric rings and six sectors to assess progress of each SMR design. Every sector captures a specific assessment dimension. Licensing is the first of them: **"The criteria for assessing progress in licensing closely follow international licensing norms, including pre-licensing interactions with regulators, design approval, construction and the issuance of operating licenses. A bonus is given to SMRs with licensing activities in multiple jurisdictions at any level."**

Siting is the second dimension: **"The criteria for assessing progress in siting reflects decisions by site owners and considers licensing readiness of sites for SMR construction. A bonus is given to SMR technologies making progress at multiple sites at any level."**

Financing is the third: **"The criteria for the financing assessments reflect both public announcements from reactor designers and financing reports from publicly available sources."**

Supply chain readiness is the fourth: **"The criteria for assessing progress in supply chain readiness consider increasing levels of commitment reflected in memoranda of understanding, binding contracts, and formal partnerships, joint ventures or consortia with suppliers or engineering, procurement and construction companies."**

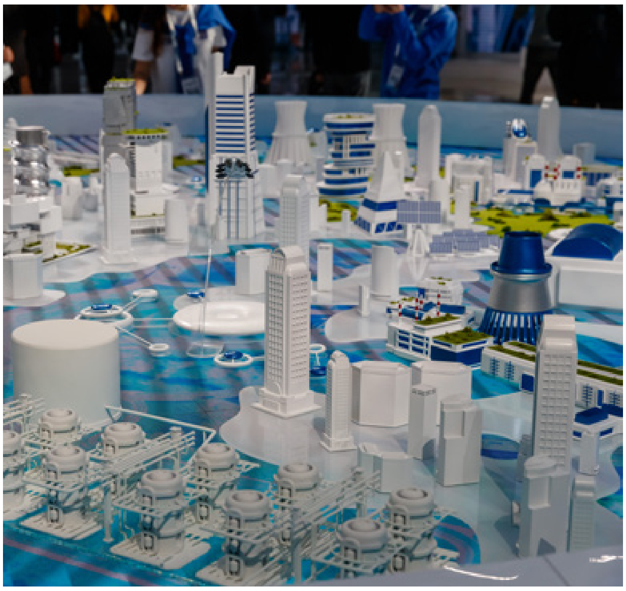
Engagement is the fifth: **"The criteria for engagement reflect the number of engagements with people and communities associated with the SMR project, evidenced by memoranda of understanding, endorsements, town hall meetings or benefit-sharing agreements."**

Fuel is the sixth: **"The criteria for assessing progress on fuel are based on progress towards the commercial supply of qualified fuel. Once a licensed and operating fuel fabrication facility exists for fuel, it is considered alongside others already being used in operating plants. For SMRs at this level of maturity, the next stages include contracts for fuel supply and a license to operate the reactor with the specific fuel."**

The above criteria do cover the key assessment dimensions and are capable of tracking progress in different SMR designs, but the metrics are questionable. For example, should a bonus be definitively given to SMR technologies making progress at multiple sites at any level? An example of Westinghouse might be recalled in this connection. The company failed to finish the simultaneous construction of large reactor units at two sites, so the Virgil C Summer project was suspended.

Licensing activities in multiple jurisdictions as a bonus also look ambiguous if we recall a scandal over NuScale. The company applied

Back to contents



to obtain a license for one design but proposed to build another one, which it planned to license later. Last November, the plans to build the US' first small modular reactor at the Idaho National Laboratory were canceled and NuScale was accused of providing misleading information. NuScale's claim to build SMRs in other countries is at least unethical in this context.

The engagement criteria are also questionable. The highest score is given if there is "evidence of ten or more engagement activities with civil society." First, it is not clear why ten. Second, it is not clear what counts as an engagement activity. The document reads as follows: **"Engagement activities in mainstream, non-nuclear media through videos, podcasts or interviews will be considered as well as memoranda of understandings, endorsements, town hall meetings and benefit-sharing agreements from the following stakeholder groups: national governments, subnational governments, indigenous governments, labor unions, non-governmental organizations, civil society organizations, community organizations, universities, end users and customers, and advisory boards."** Here is an example: an Orthodox church was built in Pevek (Russia) with support from the world's first floating nuclear power plant, Akademik Lomonosov. Should this be counted as one or several engagement activities?

We should also point out that the wording **"no recent information was readily available from verifiable public sources related to engagement activities"** with regard to the BREST-OD-300 design is inconsistent with reality. BREST-OD-300 is being built in the premises of the Siberian Chemical Plant (SCP), which is part of Rosatom's fuel division, so the depth of engagement should be measured by taking into account the activities of both companies — at least in Seversk where the plant is located. Considering the engagement of BREST-OD-300 separately from SCP or Rosatom's fuel division is as senseless as trying to measure the engagement of each individual reactor of a multi-reactor nuclear power plant. It should be noted that Seversk is a company town, so the SCP engagement in community life has been at the maximum level for many decades.

Waste wizard

NEA proposed a joint project on waste integration for small and advanced reactors: **"The NEA Joint Project on Waste Integration for Small and Advanced Reactor Designs (WISARD) aims to take advantage of the present unique window of opportunity to integrate waste management from the beginning of the SMR and AR design life cycle <…> The dedicated NEA WISARD platform will facilitate the collaboration and understanding between stakeholders throughout the plant life cycle, which will**

be the key to building a successful, sustainable program." The idea of building such a platform is certainly interesting, useful and promising. But if the platform membership is limited to OECD countries, other nations will likely develop their own SMR waste management systems or set up a similar platform within another association, such as BRICS, for example.

For now, SMR waste management is at the initial stage of development, as the Dashboard says: **"There was insufficient available information from verifiable public sources to assess the progress of SMRs in terms of waste management planning and readiness for end-of-life cycle management. Work on future editions of the NEA SMR Dashboard is expected to include the development of a methodology and criteria for assessing progress in this area."**

Introduction to SMRs

If the information on Russian designs were correct, the SMR Dashboard could be recommended to financial managers willing to learn more about the progress in SMR technology, to compare existing SMR designs across several benchmarks, and to approximate an answer to the question of whether it is worth investing in a certain technology or design. The document emphasizes three key advantages of nuclear power generation, which Rosatom representatives have been talking about for many years at different venues: contribution to decarbonization, stability of pricing, and production of electricity. **"SMRs will have an essential and increasingly important role to play supporting decarbonization targets,"** the authors of the SMR Dashboard write with confidence.

They also name the challenges faced by nuclear energy, which include delivering nuclear projects on time and on budget, unlocking access to significant amounts of capital at competitive rates, ensuring a healthy and resilient supply chain, and ensuring a skilled workforce.

This highlights the advantages of SMRs: due to their smaller size, they are safer, easier to build, and cheaper in absolute terms. In addition, they are easier to integrate into the existing grids, have more deployment options, and often have potential for additional applications, such as production of heat (as in Akademik Lomonosov) and isotopes.

The authors are sure that the SMR technology has two windows of opportunity. First, **"SMRs and advanced reactors with high levels of readiness will play a central role in getting to net zero by 2050 by supporting decarbonization efforts that are expected to gain pace in the 2030s and 2040s."** Second, **"SMRs and advanced reactors currently with lower levels of readiness could be deployed at scale from the 2040s to supply electricity, heat and hydrogen, and could contribute to long-term sustainability with advanced nuclear fuel cycles."**

To the beginning of the section