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Africa's Energy Future

As a gold sponsor of this year's African Energy Week, Rosatom took an active part in the event, having presented its key technologies at the exhibition and organized a panel discussion on energy transition in Africa. Representatives of the nuclear corporation were speakers at several conference sessions, while TVEL (part of Rosatom) and South Africa's AllWeld Nuclear and Industrial signed a memorandum of cooperation.

The African Energy Week, the continent's largest industry conference, was held from November 4 till 8 in the South African capital of Cape Town. The conference was attended by over 5,000 people representing energy companies, investment firms, and government agencies from different countries.

"Rosatom's participation in the African Energy Week 2024 emphasizes our commitment to building a sustainable energy future for Africa. We are ready to share our advanced technologies and expertise to help the countries of the continent develop safe, reliable and clean energy solutions. Together, we can ensure Africa's prosperity and preserve the

planet for future generations," commented Vadim Titov, President of Rosatom International Network.

The visitors to Rosatom's exhibition booth had an exciting opportunity to take a deep dive into Russian nuclear technologies. They could go on a virtual tour to the remote region of Chukotka and visit the world's only floating nuclear power plant Akademik Lomonosov. Another virtual 'nuclear' route went to the Novovoronezh Nuclear Power Plant in Russia. This journey was supported with an interactive augmented reality guide to Russian-designed nuclear stations equipped with VVER-1200 reactors. Those wishing to take a look into the bowels of the earth played a touch screen game in which they mined uranium by in-situ leaching.

The panel discussion entitled 'From Vision to Action: Navigating a Just Energy Transition for Africa Through Green Innovation' was dedicated to balancing energy security against social and economic development and global decarbonization goals. The panelists talked about diversification strategies for Africa's energy mix, integration of power generation systems with storage solutions, infrastructural challenges, and energy development pathways.

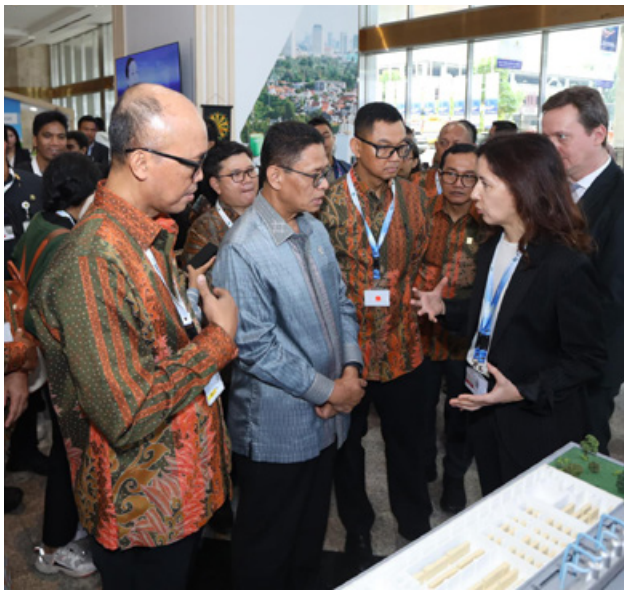
Needless to say that the discussion was centered around nuclear technology and the global experience of employing public-private partnerships in building nuclear power plants. "We are confident that nuclear technologies can play a key role in the energy transition on the continent, and we are pleased to share our experience in constructing El Dabaa NPP with other African countries. Watching this project unfold, we are all witnessing the successful application of advanced energy solutions to build a sustainable future," said El Dabaa Project Manager Mohammed Saad Dwiddar.

It should be recalled that El Dabaa is yet the only nuclear power plant under construction in Africa. The plant will have four units with VVER-1200 reactors. This nuclear construction project is governed by the contracts that came into effect in December 2017. In early November 2024, a molten core catcher for Unit 4 was delivered to the plant site. In October of the same year, the installation of a core catcher body started at Unit 3. A little earlier, in September, the assembly of an inner containment shell began at Unit 2. In the same month, Rosatom's mechanical engineering division cast the 'first steel' for the reactor, which will be installed at Unit 4, and went on to manufacture the reactor pressure vessel for Unit 2.

"Rosatom has long been present in Africa and believes that nuclear technology is an innovative solution that can play a pivotal role in providing a reliable, clean and sustainable source of energy for the development of African countries," commented Ryan Collier, CEO at Rosatom Central and Southern Africa.

On the sidelines of the forum, Eduard Nikitin, Director for Nuclear Decommissioning and Radioactive Waste Management at TVEL (part of Rosatom), and Mervyn Fischer, CEO of South Africa's power engineering solutions provider AllWeld Nuclear and Industrial, signed an agreement for joint R&D and commercial activities in the decommissioning of nuclear power plants and other nuclear and radioactive facilities. The cooperation between the companies will primarily cover the development of infrastructure for radioactive waste management (processing, storage and disposal), engineering, and production of components for the necessary equipment.

"The memorandum signed with our South African partners opens up new opportunities for joint projects both in South Africa and beyond. Rosatom has tremendous expertise in nuclear decommissioning and radioactive waste management. Our experience might be relevant to any country that operates nuclear stations, uranium mining sites or research reactors," Eduard Nikitin said.



Southeast Asia in Focus

Southeast Asia is one of the major international business destinations for Rosatom. Rosatom presents its capabilities to Myanmar, Vietnam and Indonesia and works on joint projects. Here is our account of this year's events.

Indonesia

Indonesia is studying technology solutions offered by the Russian nuclear corporation. This March, Rosatom experts participated in a seminar on advanced small modular reactor (SMR) technologies. The seminar was organized by the Bandung Institute of Technology and the National Research and Innovation Agency of Indonesia (BRIN). Speakers from the Indonesian government agencies presented updated plans for the nuclear power development in the country. Rosatom representatives, for their part, spoke about proven SMR technologies and other energy solutions.

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In September, Rosatom took part in the International Conference on Advances in Nuclear Science and Engineering (ICANSE) 2024, which was held in Indonesia, and organized a seminar entitled Indonesia Goes Nuclear. The discussion was devoted, in particular, to the inclusion of nuclear power in the National Energy Plan 2060.

“Russia has remained a very good friend of Indonesia since 1954 when we entered the nuclear era at the initiative of Indonesia’s first President Sukarno. We have been waiting to fulfill the dream of building the first nuclear power plant for 70 years. We see no other option but to adopt nuclear power if we want to meet our energy needs and also achieve our net zero goals by 2060. Rosatom has both the technology and manufacturing capabilities to deliver the project of the first nuclear power plant in Indonesia,” said Tri Mumpuni, member of the BRIN Board of Governors and head of the IBEKA Foundation.

This November, Anna Belokoneva, head of Rosatom’s office in Indonesia, spoke at the plenary session of the annual International Conference on Nuclear Science, Technology and Applications (ICONSTA) 2024, having presented Rosatom’s nuclear power solutions and explained the positive effects that nuclear power plants would produce on the country’s social, economic and technological development.

Later in November, Anna Belokoneva presented Russian energy solutions to the members of the government of the Indonesian province of Southeast Sulawesi and the National Energy Council of Indonesia. The participants of the meeting agreed to continue the discussion on the prospects of building a nuclear station in the province. It needs a reliable source of electricity to develop local mining projects, particularly nickel ore deposits.

Rosatom experts also took part in Electricity Connect 2024, one of the largest electric power exhibitions in Southeast Asia. The Russian nuclear corporation was honored with an award in the Best Nuclear Technology Vendor category.

Myanmar

Rosatom is working on a number of projects in Myanmar. The largest of them is the construction of a small-scale nuclear power plant. The legal basis for the project was laid by the intergovernmental agreement on cooperation in the peaceful uses of nuclear energy signed between Russia and Myanmar in February 2023.

This September, Rosatom Director General Alexey Likhachev met with Nyan Tun, Union Minister of Electric Power of the Union of Myanmar, on the sidelines of the Russian Energy Week. The parties praised the progress being made in the SMR project.

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Rosatom and Myanmar are also working on joint wind power projects.

In June 2023, at the Saint Petersburg International Economic Forum, Rosatom Renewable Energy (former Novawind), Myanmar's Ministry of Electric Power and Myanmar-based Zeya & Associates signed memorandums of understanding on the project to build a 200 MW wind farm.

In August 2024, Myanmar's capital Yangon hosted a science festival, the second in the country. To learn more about nuclear technology, Myanmar students and school children spent three days playing games, competing, and listening to lectures by leading scientists from Russia's National Nuclear Research University and a discussion on nuclear technology with Myanmar experts.

Rosatom and Myanmar also cooperate in personnel training: local students can get a bachelor's degree in Myanmar and enter a master's program in Russia. The parties agreed to organize intensive training courses: Russian teachers will come to Myanmar once every six months to give lectures and take exams in nuclear-related disciplines.

Vietnam

Rosatom is planning to build a nuclear research and technology center (NRTC) in Vietnam. In 2024, these plans were discussed twice at a high level. In June, Alexey Likhachev arrived in Vietnam as part of Russian President Vladimir Putin's state visit and met with Vietnamese Prime Minister Pham

Minh Chinh in the run-up to the Russian-Vietnamese summit. The Director General of Rosatom told the Vietnamese Prime Minister about the progress of the project and prospects for resuming cooperation in the nuclear power sector. The same day, Alexey Likhachev had a meeting with Vietnamese Minister of Science and Technology Huynh Thanh Dat to discuss the NRTC, cooperation in research and technology, and personnel training for Vietnam's nuclear sector. The next day, the parties signed an inter-agency memorandum setting a timeline for the NRTC project in Vietnam until 2027.

The second meeting with Huynh Thanh Dat took place in Russia in September. The parties discussed progress in the construction of the NRTC, nuclear fuel supplies for the Dalat Nuclear Research Institute, training of Vietnamese human resources in nuclear and related professions, and opportunities for expanding cooperation.

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Continuous Growth

Counting more than eighty in total, new businesses are taking an increasingly larger share of Rosatom's activities. For a year, this column has dealt with many of its new businesses. This issue, the last in 2024, offers you a summary.

Clean energy

Rosatom is involved with almost every major type of clean generation technologies. Apart from baseload nuclear power (including all the latest SMR projects), these include wind, hydrogen, biofuel, solar and hydro power solutions.

Rosatom builds wind farms on its own, with the key components of wind turbines — nacelles, their internals and blades — being produced by the subsidiaries of the Russian nuclear corporation. In Russia alone, Rosatom plans to commission about 1.7 GW of wind capacity by 2027.

However, its renewable energy projects are not confined to the domestic country only and extend abroad. Here is an example of just

a single country: in Kyrgyzstan, Rosatom is building a hydro power plant near Leylek and has signed an agreement for the construction of a 30 MW hydro power plant on the Chandalash River in the Jalal-Abad Region. A project has been launched to build a 100 MW wind farm near Lake Issyk-Kul. All in all, dozens of power plants are expected to be built under the two agreements signed earlier this year at Atomexpo, including 1 GW of wind capacity and 400 MW of hydroelectric capacity.

Rosatom is also working on the construction of biogas plants in Russia and Kazakhstan. Turning animal and food waste into energy and fertilizers, such plants exemplify a circular economy approach.

Energy storage systems

Electricity needs to be stored, not only generated. Rosatom is establishing an end-to-end supply chain to manufacture electricity storage systems for the transportation and electric power industries. The chain starts with lithium, and Rosatom is building a mine at the Kolmozerskoye lithium deposit in Russia and participating in the development

of lithium salt flats in Bolivia. Rosatom is also constructing two gigafactories in the Kaliningrad and Moscow regions. These will be integrated production sites for lithium-ion batteries with an annual capacity 4 gigawatt-hours each. The batteries from the two factories will be installed in Russian electric cars. One of them, appropriately branded as Atom, is being developed with input from Rosatom.

Environmental solutions

Rosatom has vast experience in the management of spent nuclear fuel (SNF) and radioactive waste (RW). The nuclear corporation builds and upgrades infrastructure facilities for SNF and RW processing, storage and disposal, and manages legacy facilities. As a recent example, the last removable core section of the liquid-metal cooled reactor, which used to be installed in nuclear submarines, was taken away from the naval base Gremikha.

The Russian nuclear corporation uses its end-of-lifecycle management competencies to deliver environmental protection and legacy management projects. For example, a number of legacy programs have been completed or are still running in Tajikistan (rehabilitation of the Taboshar uranium mining site and tailing dumps in the Sughd region of the country) and in Kyrgyzstan (rehabilitation of tailing dumps at the Kajy-Say, Taldy-Bulak, Tuyuksu and Dalniy mines). In Belarus, Rosatom is working on a technology and a pilot decontamination plant to rehabilitate a pesticide dump site near the town of Gorodok, Belarus.

New materials

In developing new materials and their applications, Rosatom focuses on three areas:

composite materials, additive manufacturing, and rare-earth elements (REE).

As for composite materials, Rosatom has set up and is now improving the end-to-end production of carbon composites, from crude oil to finished products. These materials are used to manufacture gas centrifuges for uranium enrichment, vehicle parts, sports equipment, building and road structures, wind turbine blades, and so on.

Additive manufacturing materials developed and produced by Rosatom comprise several types of metal powders for 3D printers, which are also manufactured in-house. The company also provides 3D printing services. Rosatom has introduced 3D printed parts into the nuclear fuel production process. For example, an impeller made by additive manufacturing is used in a pump involved in the UF6 sublimation process at the Siberian Chemical Plant.

As for rare-earth materials, Rosatom is building an integrated production chain reaching from ore to magnets. It is planned to launch a facility for the separation of mixed REE concentrates into individual compounds, and a magnet factory.

Cargo traffic on the Northern Sea Route

The Northern Sea Route (NSR) is conceived as a maritime trade route that would ensure year-round cargo transportation. To achieve this goal, Rosatom as the NSR operator establishes contacts with partner countries, particularly China. In November, the first meeting of the Russia-China NSR Cooperation Sub-Commission was held in Saint Petersburg. Earlier, an agreement was concluded with the

Chinese company NewNew Shipping Line to establish a joint venture for the construction of cargo ships. In partnership with the same company, Rosatom launched Arctic Express 1, a container transportation service between the ports of the two countries. Other countries are also interested in this cargo route.

The traffic on the Northern Sea Route is ensured by seven nuclear-powered icebreakers. Russia's unparalleled nuclear fleet is growing as Chukotka, a Project 22220 nuclear icebreaker, was floated out in November and the same-series Yakutia is expected to be commissioned soon. Another Project 22220 icebreaker Leningrad and a Project 10510 icebreaker Rossiya are under construction. Along with being the most powerful vessels, nuclear icebreakers have virtually no impact on the environment as they generate no harmful emissions.

Nuclear medicine

Offering the widest range of radioisotopes, Rosatom is the world's Top 5 supplier of source materials for the production of radio-

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pharmaceuticals. Among its customers are over 170 companies from 50 countries.

Rosatom is also building Europe's largest radiopharmaceuticals factory in Obninsk, Russia. The factory will produce both the most in-demand substances and innovative radiopharmaceuticals based on carrier-added and non-carrier-added lutetium-177, actinium-225, thorium-227 and other isotopes intended for the treatment of inoperable metastatic forms of malignant neoplasms.

Technologies

Rosatom is involved with the development of advanced solutions in robotics, digital services, quantum computers, and much more.

The Russian nuclear corporation has over 60 digital products in its portfolio, including robotic process automation (RPA), low-code programming, and optical character recognition (OCR) solutions.

Rosatom also provides digital automation solutions for nuclear construction projects. Analytical simulators supplied to nuclear stations abroad are among Rosatom's flagship products.

In addition, Rosatom is engaged in the development of emerging digital technologies, such as Big Data, Internet of Things, Artificial Intelligence, and others. Rosatom is also a leading Russian developer of digital solutions for smart cities, community management, transport, housing and utilities, and energy industry. The footprint of its projects covers over 200 cities in Russia and the CIS.

Russian nuclear companies use robotic systems, and robotic applications will definitely expand in the near future.

No less important are quantum technologies, a very specific area of focus. Rosatom acts as a coordinator for the Quantum Computing Roadmap being implemented since 2020 as part of the Digital Technologies federal project. In 2024, Rosatom researchers and their colleagues built a 50-qubit trapped-ion quantum computer. R&D efforts in this field are continuing.

In conclusion

Naturally, it is impossible to describe every new business in a short article. What should be stressed is that Rosatom, when looking for a new business area, is guided by many criteria, but the most important of them are sustainable development goals, such as affordable and clean energy, good health and well-being, responsible consumption and production, and climate action. NL

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Nuclear Gains Ground

The main trends that have been shaping the global nuclear landscape throughout 2024 manifested at COP29 held in late November in Azerbaijan. Interest in nuclear power is growing, with nuclear capacity additions announced and project financing raised. Politics continues to divide the global nuclear industry, but Russia initiates new integration opportunities.

Interest awakened

The role of nuclear power in the green energy transition is strengthening. This trend was commented by Kirill Komarov, First Deputy Director General for Corporate Development and International Business at Rosatom, speaking at COP29: “Rosatom sees demand for nuclear technologies growing in many regions of the world. Increasingly more countries are seeking to adopt nuclear power or expand its share in the energy mix. The increase in nuclear generation should be accompanied with an appropriate expansion of production facilities to supply the necessary

amount of core equipment for large and small nuclear power plants, with staff training, and with support from the financial sector. All this requires governments and businesses to join forces." Kirill Komarov also emphasized that nuclear power plants, wherever they operate, provide both low-carbon energy and energy security, being reliable sources of electricity with a predictable cost per kilowatt hour for decades.

The growing interest in nuclear power was reiterated right at the forum. Six countries — Kazakhstan, Kenya, Kosovo, El Salvador, Nigeria, and Turkey — joined the 25-nation ministerial declaration to triple global nuclear energy capacity by 2050. The goal had been stated a year before at COP28 in Dubai. The signatories to the declaration acknowledge: "Analyses from the OECD Nuclear Energy Agency and World Nuclear Association show that global installed nuclear energy capacity must triple by 2050 in order to reach global net-zero emissions by the same year." No less important is that the analysis from the International Energy Agency shows nuclear power more than doubling from 2020 to 2050 in global net-zero emissions by 2050 scenarios and shows that decreasing nuclear power would make reaching net zero more difficult and costly.

Turkey, it should be noted, is already contributing to the tripling of nuclear energy capacity. This is the country where Rosatom is building a four-unit nuclear power plant with a total electric capacity of 4,800 MW. Each unit of the plant will be equipped with a VVER-1200 reactor.

Kazakhstan's support for the initiative are not mere words either. In October this year, Kazakhstan residents voted at a national referendum in favor of building a nuclear power plant in the country. The government has set up an ad hoc commission to study proposals from technology vendors. Russia, which has long been Kazakhstan's reliable partner in the nuclear sector, has repeatedly declared its readiness to provide Russian nuclear technologies, maintenance services, and training support for the construction of a nuclear station.

Financing proposals

Nuclear project finance is a sore point for the industry. After the Fukushima accident, nuclear had not been favored by investors for a long time. It is not until recently that the attitude has begun to change, with a clear trend emerging this year.

At COP29, IAEA Director General Rafael Grossi signed a memorandum of understanding with Odile Renaud-Basso, President of the European Bank for Reconstruction and Development (EBRD). "Collaboration with financial institutions such as the EBRD is essential to attract investments needed for a low-carbon future and to make the exceptional benefits of nuclear energy safe, sus-

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tainable and affordable for everyone," Rafael Grossi said.

Earlier in September, 14 financial organizations made statements at the Climate Week in New York, expressing support for the long-term goals of increasing nuclear power generation and expanding nuclear industry as a whole to accelerate clean electricity generation.

This year has also become remarkable for the nuclear sector as IT giants have for the first time ever shown interest in investing in it. For instance, Google signed an agreement with the American start-up Kairos Power to purchase electric power from a yet-to-be-deployed fleet of small modular reactors with a total capacity of 500 MW (the financial terms of the agreement were not disclosed). Amazon led a USD 500 million funding round for X-energy. Microsoft signed a 20-year agreement with the US energy company Constellation to purchase power from the Three Mile Island nuclear power station. However, the station needs to be restarted first, which will require obtaining regulatory approvals and around USD 1.6 billion in finance, according to initial estimates.

Judging by Rafael Grossi's social media post after signing the memorandum with the EBRD, support for the nuclear industry from the financial community is still far from desirable: "Finance institutions must adapt and keep pace with what the market calls for — and there's a clear demand for nuclear. At the COP29 event on financing low-carbon tech, I stressed the urgent need to mobilize capital to triple global nuclear capacity by 2050."

Activity in Europe

Europe is an illustrative example of how the two trends outlined above are manifesting. As little as a few years ago, many European countries were lukewarm about nuclear, but the attitude is changing, and some projects have already secured funding.

At COP29, EnergoNuclear, a subsidiary of the Romanian energy company Nuclearelectrica, signed an EPCM contract with a consortium of American, Canadian and Italian companies for the construction of Cernavodă Units 3 and 4 with CANDU reactors. The money for the project was also raised as the USA, Canada, and Italy offered over USD 7 billion in export finance.

Poland, which is planning to build its first nuclear power plant, also received confirmation that it would be provided with financial support. The nuclear station with three AR1000 reactors is expected to be constructed in the north of Poland (on the Baltic Sea coast). The US Eximbank has expressed interest in providing USD 17 billion, the Polish government has promised to allocate about USD 15.7 billion, the US International Development Finance Corporation has signed a letter of interest for over USD 970 million.

However, these agreements with the American banks are still preliminary, and the total amount promised is not enough to finance the new construction, which is estimated to cost USD 40 billion.

Paks II in Hungary is yet the most advanced nuclear construction project in Europe. Being built by Rosatom, Paks II will have two power units with VVER-1200 reactors. Much work has been done on the site to prepare it for the foundation concreting. To date, workers have installed an impervious blanket to prevent groundwater ingress and are proceeding with excavation and soil compaction operations, erecting auxiliary buildings, and so on. The first concrete is expected to be poured in the first quarter of 2025.

Advanced reactor territory

Attempts continue to divide the nuclear community. The US and UK have signed a framework agreement to allow the Generation IV International Forum (GIF IV) to continue after the current agreement expires in February 2025. It was stated after the signing that GIF IV would exclude Russia from future nuclear R&D collaborations.

Given the sluggish progress in developing and deploying truly advanced reactor technologies in the US and especially in the UK, which intends to take a 'leading role' in GIF IV, the agreement can only cause a sense of embarrassment. For example, two units are currently under construction in the UK, but both of them are being built by France's EDF. The UK no longer has its own advanced technology for large reactors. The United States, in its turn, has no more reactors under construction after the much-troubled Vogtle 3 and 4 were finally commissioned.

It is of fundamental importance for the global nuclear industry how Rosatom interprets the term 'Generation IV'. A vigorous discussion of what it is took place at the Atomexpo forum in Sochi, Russia, in April this year. Alexander Lokshin, First Deputy Director General for New Nuclear Energy Products at Rosatom, said at the forum that Generation IV should not include reactors alone, but systems that would address the two main challenges of the present-day nuclear industry, minimizing waste and maximizing the use of energy contained in natural uranium. This is the principle followed by an experimental power production facility, which is being built in Russia, The facility will include a fast neutron BREST-OD-300 reactor, and fuel reprocessing and fuel fabrication modules.

Important is that Rosatom has initiated a new nuclear power platform. In October, heads of the largest nuclear companies and agencies from the BRICS member countries held their first meeting in Moscow. "We propose to join forces under the BRICS Nuclear Platform, a voluntary alliance of companies, professional nuclear communities and NGOs

supporting the development and deployment of nuclear technologies," Rosatom Director General Alexey Likhachev explained the purpose of the new association at the meeting. The primary goal of the new platform is to introduce and promote best practices and advanced approaches in the energy and non-energy applications of civil nuclear technology in the BRICS and BRICS+ markets, and to develop mechanisms and models that would stimulate nuclear projects. "I am confident that the cooperation within the new association will be fruitful for the BRICS and BRICS+ countries," Orpet Peixoto, Deputy Chairman of the Supervisory Board of the Brazilian Association for the Development of Nuclear Activities (ABDAN), said at the forum in support of the initiative.

In addition, Rosatom's Deputy Director General for Human Resources Tatiana Terentyeva presented an international mentoring and cooperation platform at the COP29 youth session on climate change education. "The platform will enable young people to share knowledge, dreams and opinions, meet like-minded people and even take on leadership roles for the next generations. Young leaders are the cornerstone of tomorrow's energy landscape, and their enthusiasm can solve the most complex challenges," Tatyana Terentyeva said and invited the session attendees to visit the World Atom Week 2025, which will be dedicated to the 80th anniversary of the Russian nuclear industry. NL

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Forward momentum

Installation of a core catcher, or melt trap, has recently begun at Unit 4 to reach another milestone for the El Dabaa construction project. The ceremony marking the event and held in the New Administrative Capital of Egypt was attended by Rosatom's top managers and the country's high-ranking officials.

Egyptian Minister of Electricity and Renewable Energy Mahmoud Esmat reiterated that the El Dabaa nuclear power plant project was under close supervision and the works were on schedule, with every project stage and grid connection to be finished to deadline. Mahmoud Esmat also explained Egypt's energy strategy, saying it was based on a balanced diversification between energy sources and included renewables to reduce carbon emissions. The minister emphasized the importance of using civil nuclear technologies to ensure sustainable development and achieve the targets set, particularly in electricity generation.

The core catcher is itself a long-lead piece of equipment. It consists of several components weighing a total of 700 tonnes (its body alone weighs 155 tonnes).

Commenting on the beginning of the installation, Rosatom chief Alexey Likhachev pointed out that the core catcher was a key safety component of Generation III+ power units. "It is symbolic that we are starting its installation at Unit 4 on the Nuclear Power Day celebrated in Egypt on November 19. Construction works are progressing at full speed at each of the four units of Egypt's first nuclear power plant in compliance with the international requirements. Rosatom makes safety a priority in its every project, and the Egyptian construction site is no exception for us," Alexey Likhachev said.

El Dabaa is not Rosatom's only project with several power units being built concurrently, in a conveyor-like fashion. Two VVER-1200 reactors are simultaneously under construction in each of Bangladesh and China. Four power units of the same type are being constructed in Turkey. In early December, workers installed the main components of the reactor pit, a dry shield and a support frame, at Akkuyu Unit 4. They will ensure maximum reliability of the reactor operation. Hungary, which operates four power units with VVER-440 reactors, plans to pour the 'first concrete' for the fifth and sixth units with VVER-1200 reactors as soon as next year. Six power units with VVER-1200 reactors are currently in operation: two at each of the Novovoronezh and Leningrad nuclear power plants in Russia, and another two at Astravets in Belarus.

Insight into El Dabaa

Involvement of local companies in the ambitious project of building Egypt's first nuclear plant was discussed at the 5th Egyptian Nuclear Industry Development Forum held in early December in Cairo as part of the Nuclear Energy Week. The forum is held annually by Rosatom's Engineering Division and the Nuclear Power Plants Authority (NPPA) of Egypt. It was attended by about 180 people representing over 50 companies from Russia, Egypt, Saudi Arabia, South Korea, and France.

The attendees discussed the El Dabaa NPP construction process, Rosatom's procurement system and procurement specifics of the project, local sourcing for the needs of the nuclear power plant, and engagement of local suppliers.

"El Dabaa NPP is one of the largest nuclear construction projects. It will meet Egypt's growing electricity needs and ensure its energy security. We are pleased that more and more local companies are involved in the project to build the continent's first nuclear power plant with Russian Generation III+ technology as this will make Egypt a regional

technology leader," said Alexey Kononenko, Vice President of AtomStroyExport (ASE) and Director of El Dabaa Construction Project.

The suppliers and Rosatom representatives also discussed the prospects of nuclear technology in Egypt, development of the El Dabaa NPP infrastructure, proceedings of the joint local content committee, and the application of Russian and international standards in the production of equipment. Individual sessions were dedicated to the cooperation in consortium with Korea Hydro and Nuclear Power (KHNP) and the role of the El Dabaa project in achieving the UN Sustainable Development Goals. NL

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Solid Foundation for Future

Construction works at all four Akkuyu power units are going as scheduled. In early December, workers finished installing the main components of the reactor pit, a dry shield and a support frame, at Unit 4. They will ensure maximum reliability of the reactor operation.

Each of these reactor pit components was installed using a heavy crawler crane. The entire process took eight hours.

“The installation of the reactor support frame and dry shield belongs to the project milestones scheduled for 2024. Installing such large-size structures is a complex, extremely demanding process, requiring the highest qualified personnel and the most precise accuracy. The experience gained by our staff from doing the same job at the earlier built power units enabled them to complete the

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installation on time. We continue to work intensively on the construction of the reactor pit at the fourth unit of the plant," said Sergey Butskikh, CEO at Akkuyu Nuclear.

The dry shield is a thick-walled cylinder-shaped steel structure filled with special-grade concrete resistant to high temperatures (up to 500 °C). Surrounding the reactor pressure vessel, it reduces thermal loads and ionizing radiation exposure on the concrete reactor pit. The dry shield makes it possible for the reactor to operate even under extreme conditions, for example, in an earthquake with a 9-point intensity on the MSK-64 scale. Being 6.7 meters in outer diameter and more than 5 meters high, the entire structure (excluding the concrete filler) weighs 30 tonnes.

The support frame secures the reactor pressure vessel in the concrete pit and reliably protects the reactor from external impacts. Weighing 145 tonnes (excluding the filler), it has an outer diameter of over 10 meters and a height of over 1.5 meters.

Workers continue to build the reactor pit at Unit 4, concreting its cavities and installing control channels.

Akkuyu is not Rosatom's only project with several power units being built concurrently, in a conveyor-like fashion. Two VVER-1200 reactors are simultaneously under construction in each of Bangladesh and China. Four similar units are being constructed in El Dabaa, Egypt. In late November, installation of a molten core catcher, or melt trap, at Unit 4 of the Egyptian nuclear power plant. Hungary, which operates four power units with VVER-440 reactors, plans to pour the 'first concrete' for the fifth and sixth units with VVER-1200 reactors as soon as next year.

Six power units with VVER-1200 reactors are currently in operation: two at each of the Novovoronezh and Leningrad nuclear power plants in Russia, and another two at Astravets in Belarus.

Best staff for the first power station

Akkuyu Nuclear keeps training engineering personnel for the Turkish nuclear power plant. In late November, 42 students holding bachelor's degree from Turkish universities were enrolled on a three-year master's program at the National Nuclear Research University (MEPhI, Rosatom's backbone university) and the Moscow Power Engineering Institute (MPEI).

Students were selected based on their academic performance and the relevance of their prior degrees. Every candidate was interviewed by the MEPhI and MPEI academic staff. The students will major in Nuclear Physics and Technology, Electrical Engineering and Technology, Thermal Engineering and Technology, or Nuclear Power Engineering and Thermal Physics.

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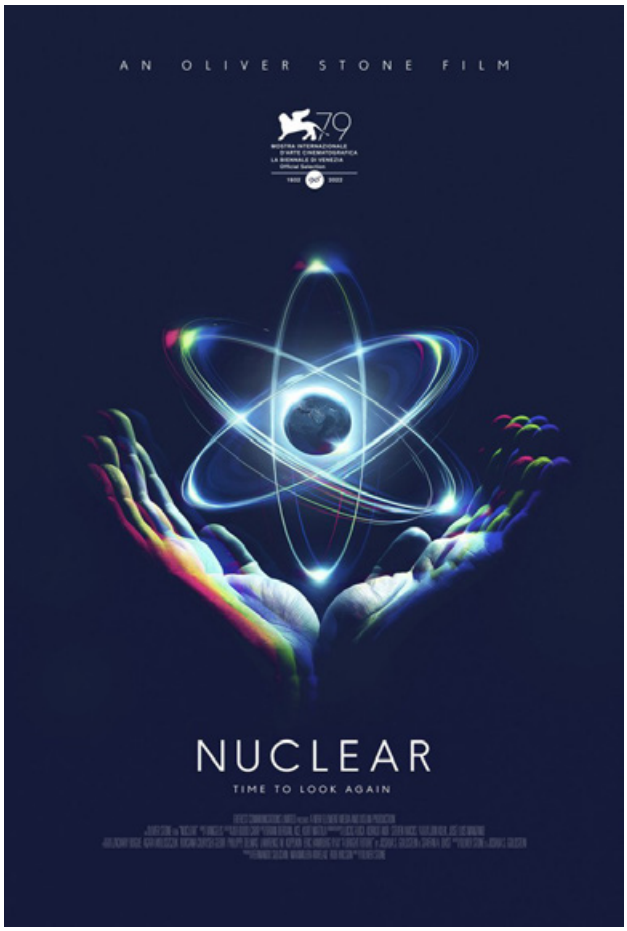
Before their program started, the students had a meeting with the representatives of Akkuyu Nuclear and the universities. They were told about the curriculum, internship, and working conditions at Akkuyu Nuclear. The meeting was joined by the graduates from the Akkuyu NPP Operating Staff Training Program, who shared their experience of studying at Russian universities.

"We continue to meet our obligations under the intergovernmental agreement to train operating personnel for the nuclear power plant. More than 300 qualified engineers have graduated from the program to date. All of them are employed either in the project team or on the construction site of the Akkuyu NPP and gaining one-off experience, which they will be able to use for the benefit of their country in the future. Deep theoretical knowledge of engineering disciplines allows Turkish professionals to be active contributors to the project and win prestigious professional awards," Sergey Butskikh said.

The professional training program for the Akkuyu personnel was launched in 2011. Training is tuition-free for the would-be Turkish engineers and is covered by the Russian government. Akkuyu Nuclear pays scholarships to its future employees, provides visa support, covers medical insurance and annual flight costs to Russia and back.

Talking about atoms

One of Rosatom's primary missions is to raise awareness about nuclear power and radiation technologies. In November, Rosatom organized screenings of Oliver Stone's documentary Nuclear Now at three Turkish universities (Sinop University, Ankara's Haci Bayram Veli University and Tarsus University). The



documentary took its director three years to make. The movie talks about the importance of nuclear power in creating a clean and sustainable future. "Having watched the movie, I now understand what nuclear power is, how this industry has evolved and what progress it has made throughout its history. The movie helped me gain 'atomic' awareness," Zeynep Nisa Şirin, a logistics student at Tarsus University, shared her impressions.

Two universities also hosted the Global Atomic Quiz, an educational initiative of Rosatom, after the movie screening. This year's quiz was held both online and offline, with about 25,000 people from 100 countries taking part.

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Paks II Picks Up Pace

The Paks II NPP project has made much progress over the past year, with many milestones passed at the construction site, meetings held between Rosatom head Alexey Likhachev and the Hungarian leadership, and Russian and Hungarian parties mutually taking part in business events. Here is our short review of 2024.

Construction

In April, work began in Russia to manufacture a reactor for the first power unit of the plan as Rosatom steel makers proceeded with forging a batch of blanks for the shells, an important structural element of the reactor pressure vessel. Paks II CEO and Chairman Gergely Jákli, who was present at the start of production ceremony, said: “We are working to ensure that the new power units at the Paks NPP will be connected to the grid by the early 2030s. The work is simultaneously underway at the construction site in Hungary

and thousands of kilometers away from it, in Saint Petersburg."

In August, the first piece of large-size equipment, a molten core catcher, arrived at the Paks II construction site. Being an important part of the passive safety system, the core catcher is installed at the bottom of the concrete pit, right under the reactor, and filled with the sacrificial material. In case of a core meltdown, the core catcher reliably retains corium fragments and keeps them inside the reactor containment.

"It is deeply symbolic that the first piece of large-size equipment that has arrived at the Paks II construction site belongs to the plant's safety system. The foundation for safe and reliable operation of the country's new nuclear station is therefore laid long before it is connected to the grid," said Vitaly Polyanin, Vice President of AtomStroyExport (ASE) and Director of Paks II Construction Project.

Works at Units 5 and 6 of the nuclear power plant are proceeding on schedule as soil excavation and stabilization operations are underway and auxiliary buildings being erected.

The first concrete for Unit 5 is scheduled to be poured in the first quarter of 2025.

In late November, the Hungarian Atomic Energy Authority (OAH) approved a preliminary safety analysis report (PSAR) for the Paks II project. The approval received allows for the first concrete pouring at the construction site. Commenting on the approval of the Paks II PSAR, Hungarian Minister of Foreign Affairs and Trade Péter Szijjártó stressed that this was one of the most important milestones in the nuclear power plant construction. In order to prepare the preliminary safety assessment report, it was first necessary to install an impervious blanket and analyze data obtained after the soil stabilization. Szijjártó emphasized that the PSAR was "a profound document of half a million pages." The minister recalled that, once the first concrete was poured, the Paks II NPP would be officially classified as a nuclear power plant under construction according to the IAEA standards.

Business activity

In late February, Rosatom organized a seminar for potential suppliers to the Paks II Nuclear Power Plant. It was attended by over 350 representatives of 180 companies from Hungary and other countries. The attendees were told about the partnership options and terms, supplier requirements, contracting and on-site operating procedures. Paks II CEO and Chairman Gergely Jákli said: "New market opportunities are opening up for the companies involved in the project as many countries in Europe and around the world have made a decision to extend the service life of their operating power reactors or build new nuclear power plants."

In late March, the Russian Association of Nuclear Host Communities and the Hungarian

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Social Monitoring, Information and Community Development Association (TEIT) signed a roadmap of joint activities for 2024 on the sidelines of the ATOMEXPO 2024 international forum. The parties plan to carry out joint projects in the fields of culture, education, environment and sports under the current memorandum of cooperation signed in 2014.

"The development of sister ties between Russian and Hungarian cities strengthens contacts between municipalities and delivers tangible results in improving the quality of people's life, creates new opportunities for the development of communities, and builds trust in nuclear energy among local people," emphasized Géza Filvig, Chairman of TEIT and Mayor of the Hungarian city of Kalocsa. Russia and Hungary have several sister cities. They are Novovoronezh and Paks, Polyarnye Zori and Kalocsa, Desnogorsk and Gerjen, Volgodonsk and Tamási.

In September, Rosatom experts spoke at a business forum in Budapest about the opportunities for cooperation between the Russian nuclear corporation and its international partners. The event was attended by representatives of over 50 large companies, both current and potential suppliers to the Paks II project from Hungary, Russia and other countries, as well as ministries, agencies and business communities of the two countries.

Alexander Merten, Senior Vice President for International Business Development at AtomStroyExport, said that Rosatom was a global leader by the number of power reactors under construction abroad. The nuclear corporation has secured orders for 33 large power reactors and 6 small modular reactors in 10 countries. "We feel the support of the Hungarian government. Paks II is for us a strategic construction project and the first Generation III+ VVER-1200 project in the EU, so it is given special attention," Alexander Merten emphasized.

Vitaly Polyanin, *Vice President of AtomStroyExport and Director of Paks II Construction Project:*

"The project passed three major milestones in 2024 as the soil stabilization phase was completed at Unit 5, a molten core catcher for the same unit was delivered to the site, and production of the reactor pressure vessel began. Intensive preparations are currently underway to pour the first concrete."

Meetings and negotiations

Paks II is one of the priority areas of the Russian-Hungarian cooperation, for which reason the project is under the spotlight of attention from the Hungarian government. Rosatom Director General Alexey Likhachev

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has had regular meetings with Hungarian Minister of Foreign Affairs and Trade Peter Szijjártó throughout the year.

At a meeting in March, the parties praised the pace of work at the new Paks NPP power units. “We are proud that a truly international project is being implemented in Paks. Apart from the Russian general contractor, the chain of subcontractors includes German, French, Austrian, Swedish and American companies,” Peter Szijjártó said at the meeting.

At a meeting in July, Alexey Likhachev and Peter Szijjártó emphasized the importance of continuous dialogue and acknowledged the interest in the project delivery from both project stakeholders and international partners. Paks II is the first in the European Union to receive a construction license for Russian-designed nuclear power units.

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Péter Szijjártó, *Minister of Foreign Affairs and Trade of Hungary:*

“We plan to increase the share of electricity from nuclear to 70% — this will happen in the next decade.”

** from the speech made at the Saint Petersburg International Gas Forum*

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Year in Review: Preserve and Increase

Armenia intends to expand its existing nuclear infrastructure and is interested in nuclear capacity additions. Russian and Armenian nuclear engineers have a long record of cooperation, and Rosatom is ready to help Yerevan in its initiatives.

Earlier this year, Armenian Prime Minister Nikol Pashinyan announced the country's intention to develop nuclear energy and called the option of deploying small modular reactors interesting. In August 2024, the Armenian Cabinet of Ministers decided to establish a standalone state-run company that would deal with the construction of a new power unit at the Armenian NPP. Minister of Territorial Administration and Infrastructure Gnel Sanosyan noted that the company would analyze feasibility studies of the construction project, hire personnel, negotiate with international partners, and operate the new plant.

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The Armenian NPP is so far the only one in the country. Located near the town of Metsamor, 30 kilometers from Yerevan, the plant operates a single unit and is one of the main electricity sources for Armenia, accounting for up to 40% of the national power output. The design service life of the operating second unit expired in 2016. Following a sweeping upgrade and retrofitting program with input from Rosatom, the service life of the power unit was extended by 10 years. In the autumn of 2023, the Armenian government approved a new program to extend its life until 2036. The life extension contract was signed with Rosatom Service (part of Rosatom) in December 2023.

The work at the plant began in 2024 as Rosatom installed surveillance specimens into the reactor pressure vessel of Unit 2 in July. These are test pieces made of steel identical to that of the reactor. The specimens will be removed in 2025 and analyzed in the laboratory for any changes in their properties. The specimens will be lab-tested annually, according to Rosatom Service CEO Evgeny Salkov. "We scrupulously follow safety priorities: starting from 2025, our engineers will annually extract specimens from the reactor of the Armenian NPP and monitor their properties and changes in their structure. This is how we ensure reliable control and detailed monitoring over one of the most important installations of a nuclear power plant," he said. The data obtained from the specimens will be used to make a decision on the extension of the reactor's service life.

In autumn, Rosatom experts proceeded with an inspection of the on-site radioactive waste storage facility as part of the extension program. The facility has accumulated solid radioactive waste generated by the operating plant since its commissioning in 1980.

Cooperation with Russia

In the expiring year, Russian and Armenian nuclear engineers have, as always, worked in close contact across many areas.

In October, Rosatom held a seminar in Yerevan to present its technological capabilities for the construction of new nuclear capacity in Armenia. Rosatom experts spoke about the social and economic effects of building Russian-designed power reactors and how capacity additions could be integrated into the national grid.

"The capacity Armenia needs can be achieved with either small modular reactors RITM-200N or medium power reactors VVER-600 based on the design of Russia's Kola II NPP. Having analyzed the Armenian energy system, I can say that the existing power grid needs no huge infrastructure investments to integrate even a large power unit with a VVER-1200 reactor. Each of the solutions has its advantages and disadvantages, and Rosatom, together with Armenian experts, is ready to select the one that would best suit Armenia's interests," said Mikhail Turundayev, Director of Rosatom International Network office in Armenia.

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Rosatom presented two development scenarios (with and without a new nuclear station) for the Armenian energy system until 2037. If the new reactor is put in operation, Armenia will be able to export up to 1,250 MW of electric power annually. But if the government drops the idea of building a new power plant, the country will be forced to import electricity.

The participants of the seminar also discussed the involvement of local suppliers in the nuclear construction project. According to Rosatom representatives, local companies will have an opportunity to participate in every project phase, from site surveys, engineering, construction and installation to procurement of equipment, supply of materials, logistics, and commissioning.

In autumn, Rosatom organized a mathematical modeling contest, REPEAT HackAtom, in Yerevan. Seven teams from the Armenian technical universities took part in the contest to demonstrate their mathematical modeling skills in providing digital solutions for the industry, one of Rosatom's leading edges. The tasks required using REPEAT, Rosatom's flagship digital product for 1D modeling. In particular, the contestants had to simulate the operation modes of the national energy system. The winning team was REACTIVE MINDS from the National Polytechnic University of Armenia.

Russian and Armenian nuclear engineers also conduct joint research programs. This autumn, Armenia hosted the Mathematical Modeling and Computational Physics 2024 conference organized by Russia's Joint Institute for Nuclear Research (JINR) and Armenia's Alikhanian National Scientific

Laboratory, Yerevan State University and the Informatics and Automation Institute of the National Academy of Sciences of Armenia. The conference was attended by over 150 scientists from 18 countries.

In November, the National Academy of Sciences and JINR organized the 50 Years of Cold Fusion international conference. JINR Director and member of the Russian Academy of Sciences Grigory Trubnikov emphasized that the 50th anniversary of the first experiments on cold fusion was symbolic for every nuclear fusion laboratory all over the world. The conference sections were dedicated to cold fusion of superheavy elements, heavy ion reactions, as well as physical and chemical properties of superheavy elements. Scientists discussed fusion mechanics, the current state of superheavy element fusion facilities in the world's leading research centers, and prospects for experimental and theoretical research.

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