



CONTENTS

ROSATOM NEWS

[Power of Action](#)

[Atoms Grow in Appeal](#)

TRENDS

[Nuclear Needs Finance](#)

NEW BUSINESSES

[3D Printed Reactors](#)



Power of Action: Year 2023 in Review

In 2023, the Russian nuclear corporation either launched or pushed notably forward a number of its projects that are of great importance for individual countries and industries, and for the future of nuclear technology in general. Here is our account of last year's achievements made by Rosatom.

Improving access to electricity

The commissioning of Belarusian NPP Unit 2 with a Generation III+ VVER-1200 reactor was a central event of 2023. The nuclear station was transferred to the customer and has been operating successfully. Nuclear power made 25% of the country's energy mix in the reporting year to reach 40% in the future.

In May, first concrete was poured for the basemat of El Dabaa Unit 3 in Egypt. In August, the Egyptian Nuclear and Radiological



ROSATOM NEWS

[Back to contents](#)

Regulatory Authority issued a construction license for the fourth power unit. Core catchers, each a centerpiece of the passive safety system, were installed at the first two units.

In April and October, fresh nuclear fuel was delivered to the Akkuyu NPP in Turkey and the Rooppur NPP in Bangladesh, respectively. This means that the two countries joined the ranks of emerging nuclear nations. The delivery of nuclear fuel was praised by the heads of the states.

In August, the Hungarian project owner Paks II Nuclear Power Plant Ltd published a notice of amendments to the Paks II NPP construction contract to signal the project transition to the main construction phase.

Closing the nuclear fuel cycle

Mixed uranium-plutonium oxide (MOX) fuel rods for VVER reactors were loaded into a research reactor for in-pile tests. Following a series of irradiation experiments on the new fuel, Rosatom researchers will justify the cost efficiency and safety of its use in VVER



reactors. These reactors are a backbone of the Russian nuclear power sector and also in wide use abroad. For now, Russia produces MOX fuel for fast neutron reactors only. MOX fuel for VVER reactors is another step towards closing the nuclear fuel cycle.

One more step towards the same goal is the production of pilot MOX fuel assemblies containing americium-241 and neptunium-237. These minor actinides belong to the most toxic radioactive elements created in the process of irradiating nuclear fuel. The pilot fuel assemblies will be loaded into the reactor in 2024.

The third step is a 100% MOX fuel core of the BN-800 reactor at the Beloyarsk NPP.

What is more, the 100,000th fuel assembly for VVER-440 reactors was produced by Rosatom in 2023. There are 22 reactors of this type in the world, including five in Russia and 17 in other countries. VVER-440 power units account for half of power production in Hungary and for more than a half in Slovakia, in which Mochovce 3 with a VVER-440 reactor was brought online in January 2023. Electricity prices in those countries are among the lowest in the European Union, according to European energy market regulators.

Another momentous event was the refueling of the world's first floating nuclear power plant, Akademik Lomonosov.

Healthy life and food

Rosatom is a Top-5 player in the global isotope market. For instance, its share in the cobalt-60 market reached 30% after the production of this isotope started at the Kursk and Smolensk nuclear power plants. Rosatom supplies all

ROSATOM NEWS

[Back to contents](#)

domestic needs for isotopes and ships them to over 50 countries, expanding the range and geography of supplies. In 2023, the Leningrad NPP obtained a license for the production of lutetium-177, an effective substance for diagnostics and treatment of certain cancers, while the Leipunsky Institute of Physics and Power Engineering (part of Rosatom) increased the output of actinium-225. Also last year, Rosatom began to supply technetium-99 generators to Belarus and germanium-68/gallium-68 generators to India.

The Russian nuclear corporation is building a nuclear research and technology center (NRTC) in Bolivia. It includes, among other things, a pre-clinical cyclotron facility capable of producing 11 radioactive isotopes, including fluorine-18, technetium-99m, gallium-68, copper-64, zirconium-89, and iodine-124. Its capacity is enough for over 5,000 diagnostic procedures per year and makes it the largest cyclotron in Latin America. Another NRTC facility is a multi-purpose irradiation center capable of treating up to 70 tonnes of produce per day to extend its shelf life. Rosatom is also working to build multi-purpose irradiation centers in Uzbekistan and Bangladesh.

Northern Sea Route

The record-high cargo traffic on the Northern Sea Route (NSR) exceeded 36 million tonnes in 2023. Transit freight also stood at its highest ever, having reached 2.1 million tonnes. Oil was the primary transit freight on the NSR. Last year, also for the first time ever, two nuclear icebreakers, Taimyr and Sibir, escorted a 169,000 DWT Capesize ship with 164,500 tonnes of iron ore concentrate on board to Cape Dezhnyov. The voyage ended on September 6.



In June, Rosatom and DP World signed an agreement for the joint development of Eurasian logistics and container transit on the NSR. Later, at the COP28 Conference in the UAE, the parties signed a strategic partnership agreement to establish an international logistics operator.

New energy

In June, a framework agreement was signed with the Bolivian state-run company Yacimientos de Litio Bolivianos (YLB, Bolivian Lithium Deposits) to build a lithium carbonate production facility in the Salar de Pastos Grandes in Bolivia. A similar agreement for the lithium production in the Salar de Uyuni was signed in December.

Science of the future

In February, Rosatom's multi-purpose fast research reactor project was included into the



ROSATOM NEWS

[Back to contents](#)

international BRICS GRAIN (Global Research Advanced Infrastructure Network) platform. Initiated by Russia, the platform provides BRICS researchers with access to mega-science projects.

In July, researchers presented a 16-qubit trapped-ion quantum computer. It can already be used to make calculations, for example, to model the dependence of potential energy of two atoms on the distance between them.



Atoms Grow in Appeal

The UN Climate Change Conferences have been held for 28 years, but nuclear fell under the spotlight of the parties only as little as two years ago. Nuclear technology is now seen as instrumental in achieving carbon neutrality and energy security. At COP28, Rosatom joined a nuclear capacity tripling initiative, presented its latest small-scale nuclear generation solutions, and signed several agreements.

To be tripled

Rosatom joined the Net Zero Nuclear Industry Pledge calling for the tripling of the world's nuclear capacity by 2050. The document was signed by 123 companies and organizations operating in 140 countries. **"We recognize**

Year by numbers

33 projects in 11 countries in Rosatom's pipeline

22 projects in 7 countries in the construction phase

Approx. USD 14 billion in expected revenue



ROSATOM NEWS

[Back to contents](#)

the urgent need to address climate change, and nuclear power is a proven, fast and sustainable solution to decarbonization challenges. By joining the nuclear companies' pledge, we reaffirm our commitment to working with national governments and stakeholders to triple nuclear capacity by 2050," said Kirill Komarov, First Deputy Director General for Corporate Development and International Business at Rosatom (for more on the nuclear funding initiatives read Nuclear Needs Finance in this issue).

Great interest in small reactors

Rosatom organized an SMR day at COP28 to present small-scale nuclear generation solutions. Although there are more than 70 different designs of small modular reactors (SMRs) in the world, Rosatom is the only company that produces commercial SMRs and offers its international customers time-proven small-scale generation solutions that can be customized in terms of power and equipment for any application or geographic location.

"We are convinced that nuclear energy will underlie the low-carbon energy mix, for which all of us strive. And small-scale nuclear generation will take a rightful place in the nuclear power industry of the future as a reliable technology. I am confident that Rosatom's small-scale nuclear capacity solutions will become an effective and environmentally safe choice for those countries that, for a number of reasons, have never considered nuclear generation before," Rosatom Director General Alexey Likhachev said in a video message to the SMR Day visitors.

Having watched a colorful multimedia presentation about Yakutia, the guests learned about the nature of this Arctic region and the culture of its people. This is where Rosatom intends to build Russia's first onshore small-scale nuclear station with the latest RITM-200N reactor. The station, which will give a boost to the local development, is being built with care for the fragile northern ecosystems. According to the plans, it will produce its first electricity in 2028.

It is noteworthy that, while COP28 was in progress, Rosatom began to manufacture stainless steel structures with a total weight of over 165 tonnes for the Yakutian small-scale nuclear power plant. "We are already making a reality what others are still planning," AtomEnergomash CEO Igor Kotov stressed.

Rosatom also presented other small-scale nuclear generation projects. The world's only floating nuclear power plant Akademik Lomonosov has been supplying power to the Chukotka city of Pevek for four years, having generated over 700 million kWh of electricity. A virtual tour of the plant was organized for the SMR Day guests.

ROSATOM NEWS

[Back to contents](#)

Another major project is the construction of new floating SNPPs with RITM-200M reactors for Baimsky GOK, a large mining and processing facility in Chukotka. They are planned to be put in operation in 2029.

One more small-scale nuclear power plant, this time with a SHELF-M microreactor, will be built to supply power to the Sovinoe gold deposit. It is expected to feed its first electricity to the grid in 2030.

Over 160 guests from 30 countries attended the SMR Day event, which is an indication of strong international interest in Russian small-scale nuclear generation solutions. Among the panel session speakers were Director General of the World Nuclear Association Sama Bilbao-y-Leon, and representatives of relevant ministries and energy companies from different countries. The panelists discussed how small-scale nuclear generation could help regions and industries overcome many of development constraints.

Tight business schedule

Rosatom representatives took part in other sessions held in the Russia Pavilion. The Energy Day organized by the Russian Ministry of Energy was held there on December 6. On December 8, Rosatom organized the Atom Day for Future Generations. Top managers of the Russian nuclear corporation, Russian and foreign experts shared their views on the role of nuclear technology in ensuring energy transition across countries. On December 10, Rosatom representatives participated in the Day of Science-Based Approach to Climate Policy organized with support from the Russian Ministry of Economic Development. On the same day, Yuri Olenin, Deputy Director General for Science and Strategy at Rosatom,

spoke at the panel session on the role of science in tackling climate change. Employees of the Russian nuclear corporation also spoke at the discussions organized by Egypt and Turkey, and at the panel sessions on youth and gender issues.

New agreements

Rosatom and DP World signed a global strategic cooperation agreement on the sidelines of COP28. That was the second agreement concluded by the nuclear corporation with the Dubai-based leading provider of transportation and logistics services. According to the agreements, the parties intend to set up an international logistics operator to improve commodity exchange and create seamless transportation and logistics chains in the Russian and international markets, primarily in the BRICS countries. In delivering the goal, the parties will rely on Russia's logistics infrastructure, including the Northern Sea Route, and infrastructure of other Eurasian countries, as well as the Middle East, Africa and South America.



ROSATOM NEWS

[Back to contents](#)

In addition, Rosatom and the South African state-run energy company Eskom signed an agreement to establish strategic partnerships as part of the international Alliance of People-Centered Organizations. The companies will join efforts in implementing HR

projects and initiatives and will coordinate activities in developing a human-centered approach to personnel training. [NL](#)

[To the beginning of the section](#)

NEW BUSINESSES

[Back to contents](#)



3D Printed Reactors

This article starts the New Businesses column dedicated to Rosatom's relatively new business dimensions that extend beyond its conventional activities, such as nuclear construction and operation and the nuclear fuel cycle. This time we will tell you about additive manufacturing.

Global additive manufacturing market

Additive manufacturing is the process of creating objects by adding material (metal, plastic, sand and polymer mixtures, concrete, etc.) layer by layer.

In 2022, the sectors leading in the use of additive manufacturing were automotive engineering (15.8%), consumer staples (14.5%), and aerospace (13.9%), according to Wohlers Associates. In 2021, they were aerospace (16.8%), medicine (15.6%), and automotive

NEW BUSINESSES

[Back to contents](#)

engineering (14.6%). Power engineering ranked sixth in each of those years, but its share rose slightly from 7% in 2021 to 7.8% in 2022.

In 2022, the global additive manufacturing market totaled USD 18 billion, including services (USD 10.7 bn), 3D printers and equipment (USD 3.8 bn), and materials (USD 3.3 bn).

Rosatom and additive manufacturing

On February 17, Rosatom and the Russian Government signed an agreement to develop the additive manufacturing segment as part of the Technologies of New Materials and Substances roadmap.

Pursuant to the agreement, the Russian nuclear corporation will concentrate its efforts on several aspects of the 3D printing technology. First, Rosatom will be engaged in the production of metal powders and equipment for such production. Another area will be the development of metal 3D printers. Third, the company will promote the application of this technology in the nuclear industry in both Russia and other countries.

In 2014, CNIITMASH (part of Rosatom) won a grant from the Ministry of Education and Science and presented the first Russian 3D printer in 2016. It uses the selective laser melting (SLM) technology.

In 2019, Centrotech (also part of Rosatom) test-piloted a dual-laser dual-material 3D printer. Later, the company began to manufacture metal powders for 3D printing. Its Kaplya (Russian for 'drop') pilot unit for the production of stainless steel, heat-resistant steel, aluminum and copper alloy powders



was put in operation in November 2020. The unit is assembled from Russian-made components. Chemical and physical tests on the particle size distribution, flowability, density, particle shape and other parameters of the powders confirmed that they fully meet all the applicable requirements and are not inferior in quality to alternatives. Since 2020, the company has been producing around 20 tonnes of powder per year. The pilot project was found successful, and Rosatom is planning to expand production.

Centrotech will specialize in stainless steel powders, while Chepetsk Mechanical Plant (part of Rosatom) will focus on heat-resistant alloy and titanium powders. A commercial production unit is already being manufactured and expected to be commissioned in 2024.

Having produced the first pilot printers, Rosatom spent several years upgrading them, including with the components manufactured by Rosatom's subsidiaries and partner companies. In May, Rosatom's subsidiary



NEW BUSINESSES

[Back to contents](#)

Rosatom is working to improve its reactor technology with 3D-printed products. Much has already been done. For example, four printed parts — an impeller, a terminal box, a displacer and an elbow piece — will be tested next year to validate their performance. The first two pieces are parts of the pumps, while the other two are installed in the steam generators. The next step will be to justify and formalize their use in RITM-200 reactors. It is expected that as early as 2025 they will be installed in the reactors designed for small-scale nuclear power plants and nuclear icebreakers. Many components of small modular reactors might be 3D-printed in the future. Rosatom's subsidiary Gidropress is already working on this task.

integrating additive manufacturing solutions and services presented Russia's largest 3D printer developed in partnership with the Saint Petersburg State Marine Technical University. Using the direct metal deposition (DMD) technology, the printer can make products weighing up to 6 tonnes, particularly complex-shaped reactor parts. The DMD printer is equipped with two industrial robotic arms and a positioner.

In November, Rosatom presented an upgraded version of its RusMelt 310M 3D printer that makes items from metal powders with the SLM technology. Its key components, including lasers, scanners, sensors, control systems and software, are Russian-made. The next goal is to develop another RusMelt-branded printer with a 600x600x600 mm chamber.

Nine commercial printers have been ordered by customers, which means Centrotech will be working at full capacity for about a year to fulfill the orders. Meanwhile, new orders keep coming in.

Additive manufacturing advantages:

- Faster production time as no intermediate operations (such as blanking, machining, joining, etc.) are needed
- Up to 80% less material used
- Less complex structure (a single piece instead of several parts or assemblies)
- Improved product performance (less chance of failure due to fewer joints). It is also possible to reduce weight and use bimetallic printing to get a combination of properties
- Reduced R&D time due to quick hypothesis testing
- As a consequence, shorter time to market and faster operationalization
- As a consequence, higher profit

NEW BUSINESSES

[Back to contents](#)

Rosatom is also investing much effort into raising awareness about additive manufacturing among the technical staff of mechanical engineering companies and consumers of their products. For this purpose, Rosatom initiated the foundation of the Additive Manufacturing Development Association. It provides, among other things, consulting services to different stakeholders (government agencies, manufacturers, consumers, etc.), accumulates analytical information, and prepares regulatory improvement proposals.

Developing the Russian additive market, Rosatom is also promoting its products — printers and powders — to international consumers in friendly countries. Negotiations with some of them are already underway. 

[To the beginning of the section](#)

TRENDS

[Back to contents](#)

Nuclear Needs Finance

As was stated at this year's UN Conference of the Parties (COP28), nuclear energy is underfunded. As a consequence, its potential to generate clean and safe electricity, the need for which is growing year by year, has not been realized. The sector needs long-term, inexpensive and reliable finance to make nuclear generation affordable.

Tripling twice

Two statements on the tripling of nuclear generation were signed at COP28. The first one was signed by top-rank officials from 22 countries. The threefold increase is needed to achieve zero greenhouse gas emissions, or carbon neutrality, worldwide by around mid-century and limit the temperature rise to 1.5 °C.

The signatories committed, among other things, to work together to advance a global aspirational goal of tripling nuclear energy



TRENDS

[Back to contents](#)

capacity from 2020 by 2050, recognizing the different domestic circumstances of each participant, and to take domestic actions to ensure nuclear power plants are operated responsibly and in line with the highest standards of safety, sustainability, and non-proliferation, and that fuel waste is responsibly managed for the long term. The signatories also intend to mobilize investment in nuclear power, including through innovative financing mechanisms, inviting the World Bank and shareholders of other international financial institutions to encourage the inclusion of nuclear power in their organizations' energy lending policies.

The second statement on tripling nuclear capacity by 2050, the Net Zero Nuclear Industry Pledge, was signed by over 120 companies operating in 140 countries, with Rosatom among them.

The signatories to the Net Zero Nuclear Industry Pledge recognize that **“by ensuring nuclear has access to climate finance equal to other clean energy sources, governments can enable nuclear capacity deployment at scale worldwide.”** They also **“ask govern-**

ments, the World Bank and multilateral development banks to ensure nuclear energy has access to climate finance equal to other clean energy sources.” With this financial support, the nuclear industry will increase its contribution to climate change mitigation by deploying more capacity around the world.

“It is now time to move forward: let's translate ambition into pragmatic policies, good intentions into affordable financing, and deadlines into on-time on-budget delivery of new nuclear energy projects,” said World Nuclear Association Director General Sama Bilbao y León on the occasion of signing the Net Zero Nuclear Industry Pledge.

“We recognize the urgent need to address climate change, and nuclear power is a proven, fast and sustainable solution to decarbonization challenges. By joining the nuclear companies' pledge, we reaffirm our commitment to working with national governments and stakeholders to triple nuclear capacity by 2050,” said Kirill Komarov, First Deputy Director General for Corporate Development and International Business at Rosatom.

The reference to the World Bank in the both commitments is not accidental. Who else but this international financial institution should finance projects that contribute to solving such global problems as climate change?

Moreover, the World Bank has once financed the construction of a nuclear power plant. **“It is a little known fact that the World Bank financed a nuclear power plant. On September 16, 1959, the Bank made a loan equivalent to USD 40 million for the construction of a 150,000 kilowatt atomic power plant in Italy (Loan 0235). This was Italy's first nuclear power plant, and the Bank's loan**





TRENDS

[Back to contents](#)

financed almost two-thirds of the cost of construction. The project also included civil works, a substation and about 60 miles of transmission lines.” Of course, the initial “It is a little known fact” may provoke a sad smile at best because, since the loan was made, more than sixty years have passed, two major energy crises have broken out and blown over, confirming the importance of nuclear power for the global economy, and even the World Bank’s Loan for Nuclear Power brochure, from which the above quote was taken, has gone through two editions, but there has never been a second case of financing a nuclear station.

Nevertheless, nuclear power plants are being built, which means money is allocated for them. Rosatom is a global leader in new build, so it has the most relevant experience.

Examples of finance

A government-backed export loan was provided to finance the construction of the two-reactor Belarusian NPP. The loan agreement between Russia and Belarus was signed on November 25, 2011. Its terms were amended in July 2020 and then in March 2023 to make the loan available until the end of 2023. The principal will be repaid starting from April 1, 2024 in thirty equal installments every 6 months. The interest rate was changed from mixed to fixed (3.3%). The both power units of the Belarusian NPP have been put in operation.

Construction of the Rooppur NPP in Bangladesh is also financed with a government-backed loan. In July 2016, the Russian Government approved a USD 11.38 billion credit facility to cover up to 90% of each of the contracts for the supply of goods and services



in 2017–2024. The terms of the loan provide for a 10-year grace period, with repayments to begin in 2027 and be made semi-annually. The first batch of nuclear fuel was delivered to Rooppur last October.

To finance the Akkuyu NPP in Turkey, which is being constructed on a build-own-operate (BOO) basis, Rosatom obtained ‘sustainable’ loans from commercial banks for the first time in the history of the nuclear industry. In March 2021, Akkuyu Nuclear (part of Rosatom) procured two 7-year loans of USD 200 million and USD 100 million with Sovcombank. In April of the same year, Otkritie Bank provided a 7-year USD 500 million non-revolving credit facility to the company. The terms of the loans require Akkuyu Nuclear’s compliance with certain sustainability covenants to enjoy a lower interest rate. Last December, a commissioning permit was issued for Akkuyu Unit 1.

Other options

Two funding models are much discussed worldwide for new nuclear construction.



TRENDS

[Back to contents](#)

These are the Contract for Difference (CfD) and the Regulated Asset Base (RAB).

With the first mechanism, the government guarantees an electricity price to the investor. This harbors both a risk and a benefit. If the market price is lower than the guaranteed price, the government will compensate the generating company for the difference. But if the price is higher, it is the generating company that pays the difference. The disadvantage of this funding option is that the nuclear project owner will bear all the up-front construction costs and risks.

Under the RAB model, capital costs are partially charged to consumers by increasing end tariffs already during the construction of new facilities. Another portion of capital costs is compensated by the government. Thanks to this combination, the payback period shortens, tariffs do not grow too sharply, and the investor receives his money back. One of the RAB advantages is the possibility to obtain loans at a lower rate due to the return of investment guarantee.

The RAB model was initially developed in the UK to acquire infrastructure investors and then spread to other countries. This mechanism was widely used to finance nuclear stations in the USA in the 1970s and 1980s. Some of those projects were successful while others faced cost overruns, completion delays and even abandonment. Such was the sad example of Virgil C. Summer Nuclear Power Station Units 2 and 3 built by Westinghouse. The company went bankrupt due to project delays and cost overruns, and its major shareholder, Japan's Toshiba, suffered heavy losses and was forced to sell off many of its assets (including Westinghouse), and the owners of V. C. Summer decided to stop the construction.

The two models are still used to finance the erection of nuclear power stations in the UK. For instance, Hinkley Point C is financed through a CfD, but the station admittedly has funding problems. The news came last December that China General Nuclear Power Corp. (CGN) suspended payments to fund the facility, so the financing burden might be shifted entirely to the French EDF. CGN has the right to do so, because the cost overruns reached the level agreed in the contract allowing the investor to stop payments. According to Bloomberg, the completion of the project may require financial assistance from the British Government.

The RAB option in the UK is governed by the Nuclear Energy (Financing) Bill adopted in March 2022. It is aimed to “provide for a new model for financing new nuclear power stations in the UK”. **“The Bill creates a framework for a Regulated Asset Base (RAB) model to be used. The RAB model is expected to allow private investors, such as pension funds and insurers, to finance new nuclear projects, and reduce reliance on overseas investors. New nuclear power**



TRENDS

[Back to contents](#)

stations financed through the RAB would be funded by a charge on electricity suppliers, who are expected to pass the cost on to consumers,” says the bill summary.


The first nuclear power station in the UK to be financed under the RAB model will be Sizewell C, the British regulator Gas and Electricity Markets Authority said in November 2023. This station, however, was not immune to the funding problems either. CGN was forced to withdraw from the project under pressure from the British Government. It was reported late last November that the UK invited some UAE financial institutions to invest in Sizewell C, but there is still no certainty about the new investor as different funds were named among candidates.

Sustainable finance opportunities

Opinions of the heads of state and government participation in the projects play a central role in the current nuclear construction funding models. The government participates by either providing long-term low-interest funds directly or giving public guarantees that loans will be made available.

Sustainable, or green, finance instruments offering lower rates to the investors in ESG-compliant projects are gaining in importance. Speaking on the COP28 sidelines, nuclear industry leaders called for financial institutions to revise their nuclear policies and secure green and ESG investments into large and small nuclear power plant projects to expand nuclear generation capacity, which would result in lower emissions and improved energy security.

Overall, green finance was a key topic of Russia's agenda at COP28. **“Our agenda embraces financial instruments, green bonds, tax preferences, and budget spending. What we are focusing on is that no climate issue of any country cannot be solved at the expense of another. We will defend our agenda,”** Russian Minister of Finance Anton Siluanov said.

A wider range of available green finance instruments will lead to a broader use of Russian nuclear technology in building safe and reliable nuclear generating capacity, thus contributing to economic growth, more affordable electricity supply and higher quality of life. 

[To the beginning of the section](#)