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Fourth First Concrete at El Dabaa

First concrete pouring for the basemat of Unit 4 started at El Dabaa Nuclear Power Plant. With all four units of the plant now under construction, El Dabaa is one of the largest nuclear construction sites worldwide and the largest in Africa.

Russian President Vladimir Putin and Egyptian President Abdel Fattah Al-Sisi took part in the first concrete ceremony at Unit 4 via video link. The leaders of the two countries gave the go-ahead for concrete pouring.

“We will contribute towards creating advanced production facilities and qualified jobs, and solving social issues. We will do it together as the new energy system allows all this to be done. This is truly a flagship project in the best traditions of our bilateral cooperation,” Vladimir Putin said. El Dabaa will be capable of generating up to 37 bil-

lion kWh of electricity, which is about 10% of the country's total energy needs. According to Vladimir Putin, the two presidents keep the project under constant control.

Abdel Fattah Al-Sisi called the event "a brilliant page in the book of close cooperation between Egypt and Russia" and noted that the nuclear plant construction was progressing faster than scheduled. **"The global energy crisis proves the importance of Egypt's strategic decision to revive its national nuclear power generation program as it contributes to securing a safe, cheap and long-lasting source of energy in a way that reduces dependence on fossil fuels and avoids price fluctuations,"** the President of Egypt said.

Rosatom Director General Alexey Likhachev, who was on the nuclear plant site, welcomed the guests and said: **"Today is a landmark event in the history of Egypt's nuclear power industry and Russian-Egyptian relations. With the first concrete poured for the foundation of Unit 4, construction of the country's first nuclear power plant, the largest cooperation project of our countries after the Aswan Dam, has reached full speed. Now all the four power units of El Dabaa NPP are under construction. This means that our Egyptian site has become one of the two largest nuclear construction projects in the world."**

Mohamed Shaker, Minister of Electricity and Renewable Energy of Egypt, emphasized that the first concrete pouring at Unit 4 resulted from political support from the leadership of the two countries, round-the-clock hard work and dedication of the teams.

At adjacent reactors

Foundation works were completed at the nuclear island of El Dabaa Unit 1, and erection of the buildings has begun. In 2023, the first piece of equipment, a core catcher for Unit 1, was delivered to the site and installed. The core catcher for Unit 2 was installed in the same year. In May 2023, the first concrete was poured at Unit 3. Construction of cooling water supply and discharge canals is currently in full swing at the site.

The plan for 2024 is to begin the installation of the inner containment at Unit 1 and install core catchers at Units 3 and 4.

More than 16,000 people are involved in the construction of the nuclear power plant. There will be twice as many of them at the peak of construction. The local content, i. e. contribution of local businesses to the project, is 20% in Unit 1 and will grow to 35% in Unit 4.

On a solid foundation of law and technology

Construction of El Dabaa NPP is governed by a package of contracts that came into effect on December 11, 2017. Russia will build the plant and also help Egypt train national personnel. More than 90 Egyptian students have been trained in nuclear professions in Russian universities, and about 150 more are currently being trained. Overall, the Russian nuclear corporation will train about 2,000 professionals as part of the project. Rosatom will also provide operation and maintenance support during the first 10 years of the plant operation, supply fuel during the entire service life of the nuclear power plant, and build a dry storage facility for spent nuclear fuel.

All the units will be equipped with Generation III+ VVER-1200 reactors (1200 MW water-cooled water-moderated reactors). Their protection systems will be both active and passive, including core catchers, passive core flooding systems, emergency core cooling systems, etc.

Four units with the same-generation reactors are operating in Russia, two reactors at Novovoronezh and two at Leningrad nuclear power plants. A two-unit nuclear power plant is operating in the Republic of Belarus. Its first and second units were connected to the national grid in November 2020 and May 2023, respectively.

BREST Gets Based

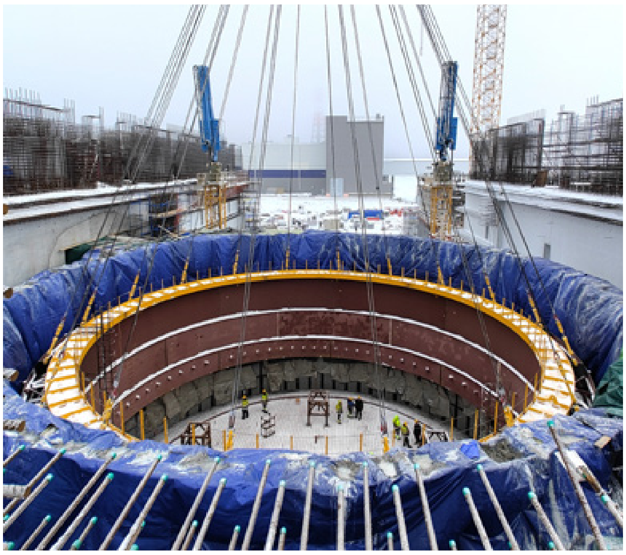
Installation works have begun at the world's first lead-cooled fast neutron reactor. Its safety will be ensured through the action of natural laws and inherent properties of structural materials. Reactors with such safety performance are classified as Generation IV.

Closing the fuel cycle

BREST-OD-300 (Russian acronym for a '300 MW passively safe lead-cooled fast reactor for pilot demonstration purposes') is part of a pilot power production facility (abbreviated ODEK in Russian) under construction in Seversk, Tomsk Region, in the premises of the Siberian Chemical Plant. ODEK will also include a spent fuel processing unit and a fuel fabrication and refabrication unit. They will produce fuel assemblies for BREST, which will use mixed uranium-plutonium nitride (MUPN) fuel made from depleted uranium and reactor-grade plutonium by carbothermal synthesis.

ODEK is the first embodiment of the Proryv ('Breakthrough') Project aimed at changing the nuclear generation paradigm by closing the nuclear fuel cycle with fast neutron reactors. The project provides for the development of integrated nuclear power facilities that will consist of a nuclear power plant and fuel reprocessing (spent fuel conversion into fresh fuel) units.

Such facilities will be designed in a way that excludes the possibility of accidents requiring evacuation of local residents. The nuclear power plants should be competitive with other types of generation. The use of depleted uranium and irradiated nuclear materials for the production of fresh fuel will make it possible to close the nuclear fuel cycle. This concept will maximize the use of energy contained in natural uranium and reduce radioactive waste. Improved safety and lower waste will make nuclear power even more eco-friendly, cost-efficient and socially acceptable.



News from the site

This January, a steel baseplate was installed to evenly distribute the loads from the reactor components on the concrete structures at the RPV bottom. The two halves of the plate were delivered from Saint Petersburg and joined at the construction site.

This was followed by sinking the lower tier of the RPV protective structure into the reactor pit. It will hold heat-insulating concrete and serve as an additional protective barrier outside the coolant circuit. The surface temperature of the structure must not exceed 60 °C and the background radiation must not exceed the natural level.

"Unlike conventional light-water thermal reactors of the VVER family, the BREST fast reactor has an integrated layout. Its pressure vessel is not an all-metal structure as VVERs have, but a concrete and steel structure with steel cavities to accommodate primary circuit components. The space between the cavities is filled with concrete step by step during the construction process," explains Vadim Lemekhov, Chief Designer of the Proryv Project.

And more…

Almost all the components of the reactor unit are either being, or about to be, manufactured. Some of the reactor control and protection systems have already been produced. The pilot modification of the main circulation pump has been tested to demonstrate it is capable of pumping over 11 tonnes of molten lead per second, although there were doubts about the possibility of achieving this performance measure. Russian nuclear engineers have also developed

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new and more effective codes to replace foreign codes used earlier.

Rosatom is conducting an extensive fuel testing program, with fuel rods irradiated and then undergoing post-irradiation studies. Much work is underway to substantiate the use of MUPN fuel and increase its burnup. Meanwhile, the MUPN production technology is being finalized at the fuel fabrication and refabrication unit.

Plutonium dioxide bred in the 1970–1990s and stored at the Mayak site will be used to make this fuel. Its stockpile is sufficient for the first load and some subsequent reloads. Fuel irradiated at BREST will be used to produce new MUPN batches after that.

Recruitment of BREST personnel has begun, with two training simulators already in place. A full-scale simulator will be built later.

Future planned

"This year, we plan to complete tests on the pilot main circulation pump and obtain a production permit for the pumps to be installed at the reactor unit," Evgeny Adamov, Science Director of the Proryv Project, told the nuclear industry newspaper Strana Rosatom. Also in 2024, pre-commissioning operations are going to be completed at the fuel fabrication and refabrication unit. Production of the first fuel core will begin next January.

BREST is scheduled to go critical in late 2026. As Vadim Lemekhov told Atominfo.ru, preparations for the first criticality are expected to take four months.

Although the work at the ODEK is in full swing and there is still much to be done, development of a commercial fast neutron reactor BR-1200 is underway. **"The calculations made and experiments conducted as part of the feasibility studies are basically sufficient to make high-probability predictions for the BR-1200 design,"** Vadim Lemekhov says with confidence. It is quite possible that a nuclear power plant with a BR-1200 reactor will be built in the Southern Urals before 2045. NL

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New Sea Lanes

Providing services to freight carriers on the Northern Sea Route (NSR) has evolved into one of Rosatom's new business dimensions. As the NSR infrastructure operator, the Russian nuclear corporation ensures safe navigation, including with icebreaker escort, builds ports and develops logistic partnerships with international companies to promote a new sea lane linking Europe and Asia.

Rosatom's primary task is to ensure safe and regular navigation on the shortest route between the western part of Eurasia and the Pacific Ocean. The NSR length is 5,600 miles, while the full distance from Murmansk to Chinese ports via the NSR is 7,000 miles (versus 12,500 miles via Suez).

Safe navigation on the NSR is impossible without icebreakers. They ensure the delivery of cargo for major oil, gas, coal and copper mining projects in the Russian Arctic. Icebreakers break a path through the ice for tankers, gas carriers and dry cargo ships carrying their cargo westwards and eastwards. Since they are powered by nuclear energy, they do not emit fuel combustion gases and are more powerful, that is, capable of breaking through much thicker ice than diesel-electric icebreakers.

In late January, the Baltic Shipyard laid the keel of another Project 22220 icebreaker, Leningrad. Its name commemorates the courage of defenders and residents of Saint Petersburg (Leningrad in the years of World War II) during the Siege of Leningrad. The solemn keel laying ceremony was timed to coincide with the 80th anniversary of the end of siege. **“Today, Russia has an unparalleled icebreaker fleet, the largest in the world. This represents our distinct competitive advantage and immense opportunities for the development of logistics and industry and creation of new jobs, as well as for the comprehensive improvement of Arctic cities and towns, implementation of global-scale projects, and international cooperation with our partners, friends and everyone who wants and is ready to work with Russia,”** Russian President Vladimir Putin said at the event.

Three Project 22220 icebreakers — Arktika, Sibir and Ural — escort ship convoys on the NSR so far. Another two icebreakers, Yakutia and Chukotka, are under construction and will be commissioned in 2024 and 2026, respectively. Construction of one more icebreaker of the same design is on the plan. It will be laid down next year. Rosatom’s icebreaker fleet also includes nuclear-powered icebreakers Taimyr, Vaigach, Yamal, and 50 Let Pobedy.

Overall, cargo traffic on the NSR grew significantly, from as little as 3.93 million tonnes in 2013 to 36.254 million tonnes last year, up from the plan of 36 million tonnes. **“We owe the record-high cargo traffic on the Northern Sea Route to our partners, primarily NOVATEK whose LNG accounts for more than half of the cargo carried. Gazprom Neft and LUKOIL, which redirected their freights from west to east, also played a major role in increasing the traffic. As a result, we reached our target of 36 million tonnes before the New Year,”** Rosatom Director General Alexey Likhachev said.

Cargo transit also showed growth. **“Cargo transit on the NSR rose back to the 2021 level and then hit a new high,”** said Rosatom’s special representative for Arctic development Vladimir Panov. In 2023, cargo transit reached 2.13 million tonnes. The primary cargoes were oil, iron ore concentrate and LNG. **“Transit cargoes point to the relevance of the Northern Sea Route as their growth is the most essential result for the marine logistics business,”** Vladimir Panov emphasized

International carriers also show increased interest in the Northern Sea Route. For example, the Chinese NewNew Shipping Line made eight voyages on the NSR using ice-class vessels purchased for this purpose in

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2023 and transported about 100,000 tonnes of cargo between Chinese ports and Arkhangelsk, Saint Petersburg and Murmansk.

With three coastal voyages made, the Northern Sea Route now offers regular transportation between northwestern and far eastern Russian ports.

Rosatom also provides port infrastructure improvement services on the NSR and is working ahead of plans in this field. The capacity of Arctic ports has grown to reach 40 million tonnes. Rosatom has dredged the Gulf of Ob, is engaged in the construction of a coal terminal for the Syradasay coal deposit, and has signed contracts for dredging services in the Bukhta Sever port and building a cargo terminal and a berth for floating power units at Cape Nagleynyn.

The Marine Operations Headquarters (part of Rosatom) integrates all incoming information on ice and weather conditions to establish optimal routes. The number of information sources will increase as data from onboard stations and drones will be added to conventional satellite data. The monitoring stations onboard icebreakers will scan ice around the vessel on which they are installed, while drones will collect information at a distance of up to 100 km from the icebreaker.

To make the navigation on the NSR as safe and convenient as possible, Rosatom is developing a single digital service platform. It will collect and process all the NSR-related data, from weather forecasts and emergency situations to navigation permits and optimal routing.

Last year, the Marine Operations Headquarters issued 1,218 permits (1,163 in 2022). Speaking at the keel-laying ceremony for the Leningrad icebreaker, Alexey Likhachev stressed that the Northern Sea Route was of vital importance for Russia on the back of growing demand for safe and reliable transportation routes in the world. “This is exactly what we offer to our partners — a fast, safe and competitive route,” he said in conclusion. NL

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The Future of Small Modular Reactors

Media outlets around the world are quoting at length from the report "Scaling Success: Navigating the Future of Small Modular Reactors in Competitive Global Low Carbon Energy Markets" released last December by the New Nuclear Watch Institute, a British think tank. The authors conclude that Russia will take a leading position in the SMR market.

Subject of assessment

One of the sections of the report is dedicated to assessing and comparing the economic parameters of large and small nuclear power plants. This projection is founded on "baseline assumptions and the model put forward by the UK government in the Small Modular Reactor Techno-Economic Assessment". NNWI evaluates some "generic SMR" technology from aggregated project materials submitted by anonymous vendors to the UK government to obtain public support. The 2010 average in British pounds was then adjusted to 2023 in US dollars. In particular, the cost of constructing 1 kW of nuclear power plant was estimated at USD 7,500/kW.

The authors of the report sought to find out under which conditions the cost of building 1 kW of small-scale nuclear generation would be comparable to that of a large nuclear power plant. They took USD 7,500/kW for an SMR and USD 5,500/kW for a large NPP as a baseline.

However, the 2020 edition of the Projected Costs of Generating Electricity joint report by the International Energy Agency (IEA) and the Nuclear Energy Agency (NEA) says the overnight costs ranged from USD 2,157/kW in South Korea to USD 6,920/kW in Slovakia. The overnight costs for the US were USD 6,041/kW, according to the IEA 2020 report. Considering that more or less known data for different large scale projects differ by more than three times, it must be taken into account that the report data is averaged and cannot be directly used to estimate the cost of a particular project. This is especially important for assessing projects with RITM reactors of various modifications, because their specifications were not used to determine average characteristics.

The authors of the report, comparing different types of nuclear power plants, come to the conclusion that the cost of constructing an SMR will be equal to that of a large nuclear power plant in the best case after the construction of 20 units, in the basic and worst case — after 70–90.

Perhaps, we can say that Russia has already completed part of this journey (half in the best-case scenario): Rosatom enterprises have already manufactured 10 RITM-200 reactors for Atomflot.

The Market Share

The executive summary at the beginning of the report reads: “The Russian RITM reactor family, capitalizing on government support and an integrated ‘plant-as-a-service’ business model, including spent fuel and waste management, is set to dominate the off-grid segment of the global SMR market, becoming the most common installation worldwide. The Chinese ACP100 or Linglong One is projected to follow, capturing about 15% of the global SMR fleet by installed capacity». NuScale’s VOYGR is likely to secure 5–10% of the world’s installed SMR capacity in 2050. Amongst advanced reactors, which are set to be deployed in series around 2040s, the US XE-100 appears to have the highest chances to capture the largest market share of 7% of global installed capacity.”

Since other projects are not named in the report and Russian reactor technologies are the only ones whose share is not explicitly stated, the comparison of names and figures seems to suggest that small-scale nuclear power plants with RITM reactors will account for at least 68% of the small-scale nuclear generation market.

Since other projects are not named in the report, and Russian reactor technologies are the only ones whose share is not directly stated, one would like to think that the share of SMR NPPs with RITM reactors will account for at least 68% of the market. However, the text below suggests that in 2030 Russia will account for 20–25%. At the same time, the shares of China and the United States will be approximately the same.

Regardless of the UK study, it should be noted that Rosatom is currently an indisputable leader of the global SMR market. Akademik Lomonosov is still the world's only floating nuclear power plant. Project 22220 icebreakers are equipped with RITM-200 reactors. Three such icebreakers are already in operation on the Northern Sea Route, and another three are under construction.

Rosatom Group companies are developing ten advanced designs of small and micro reactors. For instance, equipment is being manufactured for new floating power units that will supply electricity to the Baimsky GOK mining site. Production of components for an onshore SMR to be built in Yakutia has also begun. Those floating power units and the onshore SMR will be equipped with different modifications of the RITM-200 design.

RITM-400 reactor will be installed on the world's most powerful icebreaker Rossiya (Leader project). Russian mining giant Nornickel and Rosatom are discussing the construction of an onshore SMR with the same reactor design.

Construction of RITM-based offshore and onshore small-scale nuclear power plants of various capacity and modifications is also being discussed with potential foreign customers.

A pilot power production facility with BREST-OD-300 reactor is being built apace (for more details see our article "BREST Gets Based"). A decision was made to build an SMR with SHELF-M micro reactor to supply power to the Sovinoye deposit in Chukotka. Its technical design is expected to be ready later this year, with on-site preparations to begin next.

Three lead-bismuth designs (SVET-M, SVGT-1 and SVBR-100), a pressurized water VVER-I reactor, a HTGR-based nuclear power plant, and a thermoelectric conversion reactor Elena-AM are at an earlier stage of development.

In addition, Rosatom is working on two research reactor projects (according to the IAEA, they cannot be classified as SMRs). One of them is MBIR, a fast neutron research reactor, which is already under construction. The other, a molten salt research reactor, is at the concept design stage. Its technical design is expected to be completed in 2025. The two reactors will be used to conduct research to develop solutions for closing the nuclear fuel cycle.

Returning to the report: unfortunately, an error was made: “By 2025, Russia is likely to have about 1 GWe of SMR capacity operating in the closed nuclear fuel cycle. However, it is unclear whether the SMR concept will be central to Russia’s fuel cycle closing strategy.” Apparently, there was a typo and the year 2035 was meant, but even in this case it is not entirely clear which SMRs are meant.

Fragmentation

The authors of the report note an important trend emerging in the global nuclear market — division into spheres of influence. One of the sections of the report highlights two blocks. The first is the Sapporo 5 (named after the place where the United States, Canada, France, the United Kingdom and Japan agreed to cooperate in the manufacturing of nuclear fuel), their allies from the OECD countries and other countries. The second is the BRICS countries and countries inclined to cooperate with Russia and China, the key players in the SMR segment. The authors of the report note that Russian and Chinese SMRs are unlikely to be subject to sanctions risks, since they will not contain components subject to sanctions risks. All while such projects can be financed outside the dollar and euro systems.

The authors of the report note that the Rosatom SMR export offer is beneficial for potential clients thanks to the service for exporting spent nuclear fuel back to Russia for reprocessing. Rosatom views spent nuclear fuel not as a waste, but as a valuable source of fissile materials suitable for reuse. This concept allows clients to save money on creating their own processing facilities. And, we note, it increases the public acceptance of nuclear projects with the participation of Rosatom.

Overall, Rosatom is doing a lot of work to promote its reactor technologies on the Russian and the global markets in various ways in order to reduce risks and make SMR projects implementable at specific sites.

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