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Rosatom: a Breakthrough

Construction of an unparalleled BREST-OD-300 reactor began in Seversk. This is the first Generation IV reactor unit designed in line with the inherent safety principles.

The event is truly of global significance. **"As the construction of BREST began, Rosatom, Russia and the global nuclear industry have made a move forward,"** IAEA Director General Rafael Grossi said via a video link at the first concrete ceremony.

"Each of us is part of a large team sharing the idea of creating here, in Seversk, something that has never been done before in the history of mankind and that the global nuclear community awaits — an operating nuclear reactor of the fourth generation," Director General of Rosatom Alexey Likhachev echoed his colleagues' comments.

BREST is the first of a kind in many aspects.

Safety

"The Proryv (Breakthrough) Project represents a new generation of nuclear fuel cycle technology," TVEL President Natalia Nikipelova said at the ceremony. The reactor will use mixed uranium-plutonium nitride (MUPN) fuel. Unlike MOX (mixed oxide) fuel, it is denser and has a lower operating temperature and a higher thermal conductivity. Thanks to these properties, the coolant absorbs heat faster, preventing the fuel from overheating. It is assumed that MUPN fuel will be fully produced from recycled materials, plutonium and depleted uranium.

Lead coolant does not react chemically with either air or water, which are always present in a nuclear power plant. This is what helped improve the reactor and make it more compact and, consequently, more cost-effective as compared to other reactor designs and clean energy sources. What is more, the high melting/freezing temperature of lead makes a loss of coolant impossible — it will simply freeze. The high temperature of lead coolant enables a more even power distribution in the core and, as a result, a more equal temperature of fuel rods. **"Over the years many, many countries tried to design and propose a lead-cooled fast reactor, but this is the first time that we see the realization of the lead-cooled fast reactor,"** said happily Stefano Monti, Head of the Nuclear Power Technology Development Section at the IAEA, who was present at the ceremony.

The BREST design provides for the integration of the primary loop components into the reactor unit. As for the reactor pressure vessel, it is made of many layers of reinforced concrete and is capable of holding nuclear materials inside even in an accident.

Sustainability

What makes the BREST reactor truly special is that it is part of the Pilot Demonstration Energy Complex (PDEC), comprising also

a fuel fabrication and refabrication unit and a recycling unit. One of the purposes which BREST will serve is to test technologies of the so-called closed nuclear fuel cycle. **"The Proryv Project and BREST as its part embody the dream of our predecessors to 'close' the nuclear fuel cycle. I wish the project good luck. It can really bring us closer to the dawn of a new era. We are open to the bright future when nuclear energy will be used peacefully all over the world,"** Alessandro Alemberti, Nuclear Science Development Manager at Ansaldo Nucleare (Italy), said in congratulation to his industry colleagues.

"Fast reactors can help close the nuclear fuel cycle, optimize the use of natural uranium resources and reduce the amount of radioactive waste. And using lead as coolant simplifies the reactor technology and improves safety," Prof. Toru Obara from the Tokyo Institute of Technology highlighted the benefits of fast neutron reactors.

Can Turgut, Design Engineer at ITER Project from Turkey, put an emphasis on waste reduction, **"Locating fuel production and recycling facilities and a nuclear reactor on one site will reduce storage costs. The problem of ultimate disposal of nuclear wastes will be almost totally solved. The**

TVEL is Rosatom's fuel division and one of the world's largest suppliers of nuclear fuel. TVEL is the monopoly supplier of nuclear fuel to all Russian NPPs, ship and research reactors of Russia. TVEL fuels nuclear power plants in 15 countries, or every sixth power reactor in the world.

repeated use of nuclear fuel will meet long-term energy needs, which will produce a positive effect, both in terms of economy and environment, on the country and the entire world."

Speaking at the ceremony, most representatives of the global nuclear community pointed out that nuclear prevents emissions and neutralizes negative effects on the environment.

Cost effectiveness

The BREST designers will also have to prove that lead-cooled reactors running on nitride fuel are cost-effective alongside being reliable and sustainable.

Rosatom has ambitious plans for lead-cooled reactors. According to Alexey Likhachev, the pilot reactor is a prototype for a large commercial power unit. **"We will scale up the liquid metal fast reactor technology to deploy large commercial power units across the country. We hope the technology will also be exported,"** Alexey Likhachev stressed. By the mid-21st century, he says, the flagship product of the Russian nuclear corporation will be complex power units consisting of thermal neutron reactors, fast neutron reactors, and on-site facilities for the fabrication and refabrication of nuclear fuel.

According to Evgeny Adamov, Science Director of Proryv, the action plan for the project is set for 18 years ahead, and the short-term prospects are clear. By 2023, a fuel fabrication facility will be put in operation. By 2024, construction of an irradiated fuel recycling facility is expected to begin. The BREST-OD-300 reactor is scheduled to be commissioned in 2026.

First One Ready

The first unit of the Belarusian NPP was commissioned on June 10. As this article goes to press, the plant already helps Belarusians heat their homes and cook food using clean energy.

"We have witnessed a historical event. The first unit of the latest Generation III+ constructed by Rosatom abroad has been put into commercial operation. It is a result of arduous work done by the team of top-notch professionals from our two countries," Alexey Likhachev, Rosatom Director General said at the commissioning ceremony.

The Belarusian NPP is the country's first nuclear power plant located in the town of Ostrovets (Astravets). The plant has two power units with VVER-1200 reactors and a total capacity of 2,400 MW. Core equipment of the plant is designed to operate for 60 years, with the possibility of extending its service life for another 20 years.

Before Unit 1 went into commercial operation, Rosatom engineers did much work

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to check and test the systems and equipment and briefed the staff to be sure everything was ready for operation. The power unit already produced nearly 3 billion kilowatt-hours of electricity, from the moment it was brought online till the official acceptance certificate was signed for the plant.

Power for food and heat

The Belarusian NPP is expected to generate around 18.5 billion kWh annually. In the future, electricity generated by the plant will be used to deploy new technology and production facilities. **"We made plans, we knew how electric power from the nuclear plant would be used… Many countries calculate how much electric power per worker they have. This indicator shows electricity available to industrial facilities or households. More electricity per worker means the country uses advanced technologies. What consumes electricity? Robots, sophisticated equipment and electric vehicles do. For this reason, the commissioning of the nuclear power plant opens up ample opportunities for the development of new industries,"** country's First Deputy Economics Minister Yuri Chebotar told the Belarusian media outlet Ctv.by.

For now, clean energy is used for more down-to-earth purposes, though no less important for the Belarusians, such as heating homes, cooking food and supplying hot water.

In response to growing demand, the authorities put effort in creating and upgrading organizational and technological infrastructure. From 2019 until the end of the first quarter of 2021, local offices of the state-owned power grid operator Belenergo received 47,550 applications for the connection of households to the power grid to use electricity for heating and hot water supply. To address all the applications filed, the Belarusian authorities set new tariffs and launched an extensive power grid upgrade program. **"We are currently upgrading nearly 1,700 km of power transmission lines. Next year, we plan to increase the length of upgraded power lines to 2,700 km to respond to as many applications as possible,"** said Mikhail Mikhadyuk, Deputy Minister of Energy. In 2021–2025, the country will allocate about 1.5 billion Belarusian rubles earmarked for retrofitting 0.4–10 kV overhead power lines.

Mikhail Mikhadyuk also gave assurances that Belarus would build over 2 million square meters of residential space in the next five years, with heating, hot water and cooking secured with electricity.

Safety support

On June 14–15, the IAEA organized an online mission to Belarus. Experts from the USA and Argentina reviewed a self-evaluation report on how the Belarus NPP meets recommendations and proposals regarding the Technical Support and Operational Experience aspects covered by the pre-OSART

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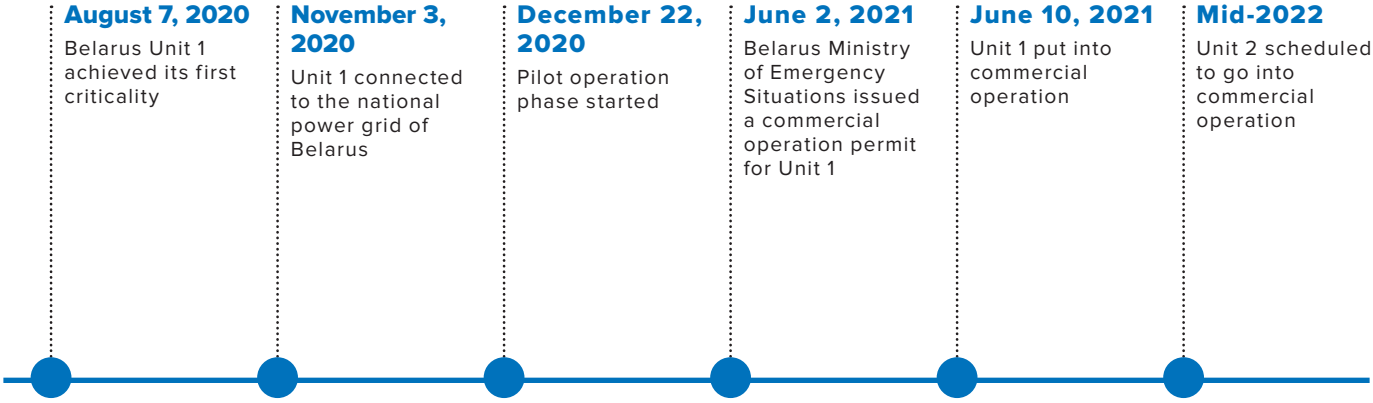

mission. The opinion and recommendations of the IAEA experts will be used to prepare for the repeated pre-OSART mission, which is to visit the country in October 2021.

Belarus also expects an IPPAS (International Physical Protection Advisory Service) mission of the IAEA to arrive in the country this summer. In September, the Belarus NPP will be inspected by experts from the European Nuclear Safety Regulators Group (ENSREG). The previous ENSREG mission visited the plant in February 2021. In the fourth quarter of 2021, Belarus will receive a follow-up IRRS (Integrated Regulatory Review Service) mission that will check the compliance with the recommendations made in 2016. NL

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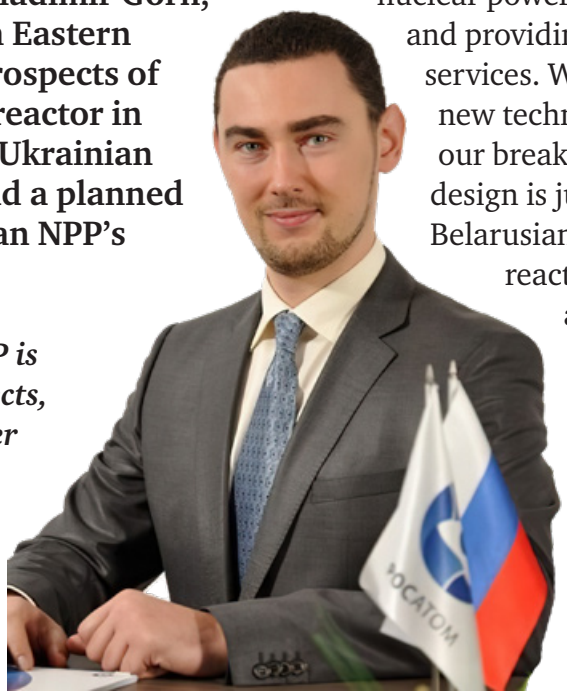
Neighborly Cooperation

This interview is a firsthand account of Rosatom's operations in Belarus, Ukraine, and Armenia. Vladimir Gorn, Deputy Head of Rosatom Eastern Europe, speaks on the prospects of constructing a research reactor in Belarus, fuel supplies to Ukrainian nuclear power plants, and a planned extension of the Armenian NPP's service life.

— Unit 1 of the Belarus NPP is unparalleled in many respects, being the first nuclear power unit in Belarus and the first VVER-1200 reactor built outside Russia. How smooth was your cooperation with Belarus in delivering the project?



— It is no exaggeration to say that we got on well almost immediately. A major factor was that we both were convinced that the nuclear industry is critical for the welfare of Belarus and the entire planet.

Rosatom is the only company constructing nuclear power units in foreign countries and providing a full range of related services. We also keep on developing new technologies in nuclear, and our breakthrough VVER-1200 design is just the case. Our Belarusian partners appreciated the reactor's advantages as early as the stage of technology selection.

— As we know, the second unit of the Belarus NPP is expected to go critical this autumn. Shortly afterwards, the plant will be fully online. How

will this change the power industry and economy of Belarus?

— The commissioning of Unit 1 was actually our primary — but not the only — task in Belarus for 2021. Another priority for the current year is achieving criticality at Unit 2.

This construction project is of national significance and sure to go down in the history of Belarus. The nuclear plant is a source of clean energy, which will now be available to consumers in Belarus. Experts estimate that, following the commissioning of Unit 2, the Belarus NPP will generate 18 billion kWh of electricity per annum, which meets around 40% of the country's power demand. With this input, Belarus will replace much of its energy imports (4.5 billion cubic meters of natural gas per annum) and reduce the share of natural gas in its energy mix.

Bringing the Belarus NPP online will also improve the country's environment by reducing greenhouse gas emissions by more than 7 million tons per annum and enable Belarus to fulfill its obligations under the Paris Agreement.

— Are there plans to jointly maintain the Belarus NPP after it is put into operation?

— Rosatom will continue to collaborate with Belarus after the construction is over. Providing maintenance services for the Belarus NPP is one of our priorities, but I am sure that Belarusian companies, whether state-owned or private, have sufficient competencies to join this work. We have also signed an agreement for the supply of nuclear fuel throughout the plant's service life. During this period (which lasts at least 60 years), Rosatom will provide necessary technical support in any form acceptable to our Belarusian partners.

— The nuclear power industry is not limited to power plants. What are the prospects of nuclear cooperation with Belarus?

— In the future, Russia and Belarus may jointly deliver innovative R&D nuclear projects. Rosatom supports the Belarusian National Academy of Sciences in its plans to build an advanced nuclear research and technology center based on a multi-purpose research reactor. This reactor will help Belarus improve its competencies in nuclear energy applications since it can be used for physical research and material studies. It will also be essential for the training of a highly qualified workforce and development of the country's scientific potential.

— Russia and Belarus have put a lot of effort into training nuclear workforce. Do you plan to engage nuclear experts from Belarus in Rosatom's nuclear construction projects in other countries?

— We are not confining ourselves to Belarus. Now that the Belarus NPP project is at its final stage, Belarusian companies are already taking part in our overseas projects. Earlier this year, Rusatom Service hired several contractors from Belarus for the works at the Armenian NPP.

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— The Belarus NPP has become a landmark project for Rosatom in Eastern Europe. But what is the status of other projects? For instance, do you continue to supply nuclear fuel to Ukrainian power plants?

— We continue nuclear fuel deliveries to Ukrainian nuclear power plants under a contract between Rosatom's fuel division TVEL and the Ukrainian operator Energoatom. Rosatom has never failed to meet any of its contractual obligations. We have repeatedly expressed our commitment to continuing cooperation and remain of the opinion that nuclear should be beyond politics.

— What is the progress in the Armenian NPP upgrade project? What has been and is yet to be done?

— The large-scale life extension program for the Armenian NPP started in 2015. Since then, much work has been done — we have upgraded containment sprays, inspected nearly 5,000 items of equipment, and fully replaced the turbine island machinery. The improvements made by us increased the power output by 10–15%, with the amount of fuel in the core being comparable.

We are now at the final stage of preparing Unit 2 for the service life extension, which will also include safety improvements. All the necessary equipment is already delivered to the site. Rusatom Service will do a major part of the work during the scheduled maintenance, which is already underway and will be finished in October 2021. During this time, we will upgrade the emergency core cooling system and anneal the reactor pressure vessel to restore it to 80–85% of its original condition. These measures will help us make a safety case for the reactor operation after 2026.

— Armenia's Power Industry Development Strategy 2040 provides for another life extension of the Armenian NPP after 2026. What needs to be done for that end?

— After the upgrade, the regulator will carry out all necessary inspections and decide whether to grant an operating license until 2026. We are already certain, however, that the Armenian NPP will get a new life. With improved safety, its operation will be extended until 2026 and then until 2036. A program for the life extension of the Armenian NPP for another 10 years will be prepared by an Armenian-Russian task group set up on Rosatom's initiative. The first step will be to define a set of measures required for the service life extension. Then we will develop an action plan and deal with other important aspects.

In April, our Armenian colleagues visited the Novovoronezh and Kola nuclear power plants to learn from our experience of repeated life extensions. The two stations were chosen on purpose — Novovoronezh delivered an ambitious project for the world's first life re-extension at a VVER-440 reactor unit, while Kola implemented the same measures as those planned to be taken at the Armenian plant.

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— Is it possible to construct a new nuclear power plant in Armenia? Is Rosatom ready to do that?

— The country needs new capacity. This is a matter of energy security given that Armenia has no natural resources such as oil or gas, and nuclear power covers a half of its domestic demand for power.

Rosatom is always ready to construct a safe power unit based on the latest proven technology. Having built a total of 80 reactors across the globe, including 17 over the past 15 years, Russia has extensive expertise in the construction of VVER power units. At the moment, we have 24 units under construction. We offer many different design options, including small modular reactors.

Armenia needs to decide which reactor type and what capacity its new nuclear facility will have. In our turn, we are always ready to help our partners and friends.

— What humanitarian projects are you running in Armenia?

— Since 2017, Rosatom has been organizing regular educational events for the young to raise their awareness of nuclear power and promote nuclear engineering careers. This year, we have conducted another series of entry tests for Armenian students wishing to study in Russia's top technical universities under Rosatom's admission quotas. Four Armenian students succeeded in all the tests. These admission exams are carried out as part of the Russian-Armenian joint initiatives for nuclear workforce training. We organize regular Science Olympiads, nuclear technology days, science festivals, and other educational and entertaining activities.

We have also launched an educational project called 'More for Metsamor' to provide access to modern educational formats for the children and teenagers living in the host town of the Armenian NPP. As part of the project, they had a meeting with Armenian President Armen Sarkisyan who, as a professional physicist, spoke about the role of science in his life and career and about the significance of innovative technologies for Armenia.

This year, the country's nuclear industry celebrates the 55th anniversary of the decision to construct a nuclear plant in the country. To sustain popular interest in nuclear technology, we held the Energy of Life photography contest that attracted both professional and amateur photographers.

— Do you plan to develop cooperation with other Caucasus countries? If yes, in what areas?

— Many countries recognize the need to develop their nuclear power sector. Every country that has decided or still plans to do so comes to an understanding that human resources are key in the nuclear industry and that workforce training requires a continuous investment of time and effort. Rosatom's core

university MEPhI is a major training hub for nuclear professionals. The Russian nuclear corporation has introduced admission quotas for students from various countries, including Azerbaijan that has also announced its plans to develop civil nuclear technology.

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TVEL is Rosatom's fuel division and one of the world's largest suppliers of nuclear fuel. TVEL is the monopoly supplier of nuclear fuel to all Russian NPPs, ship and research reactors of Russia. TVEL fuels nuclear power plants in 15 countries, or every sixth power reactor in the world.

Rusatom Service is a Rosatom company offering comprehensive solutions for lifelong maintenance of nuclear facilities, as well as a wide choice of individual products and services.

Uranium Growth Hormone

In the post-COVID world, metal prices are growing, and so is the global economy. This also lays a pathway for the growth of uranium prices, however, the fundamental factors of supply and demand are weak drivers.

Analysis of the uranium market shows that it barely if at all responds to changes in demand and supply. Over the last forty years or so, no change in supply has affected the price of uranium — neither the three-mine policy, which was introduced in Australia in 1984–1996 to restrict the number of operating uranium mines to three (on the contrary, the price plunged in that period), nor new launches or accidents at mines have had an upward price effect.

The spot market ignored the suspension of Kayelekera Uranium Project in Malawi in November 2013 and two accidents at Rio Tinto's Ranger and Rosing Mines in December 2013, which slashed the company's production by half. Also, the market barely responded to the launch of the Husab Mine, a large uranium project in Namibia, in late 2016. The price of uranium fell by three dollars in May and rose again by the same three dollars in November — and this despite the fact that Cameco mothballed its Rabbit Lake Mine, cut down production at the McArthur River Mine and stopped the development of in-situ leaching (ISL) mining projects in the USA.

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In 2019, the production of U3O8 virtually stopped in the USA. In January 2021, Rio Tinto's Ranger Mine in Australia was mined out, and the production stopped. Kazakhstan took measures to restrict the growth of production over the last few years. Whatever happened, the prices could not pierce the level of USD 30 per pound for four years after March 2016. And, quite likely, they would not if not for the pandemic.

Not until Canada's Cameco suspended production at the largest Cigar Lake Mine and Kazakhstan's Kazatomprom announced staff layoffs and subsequent production cuts during the first wave of coronavirus spread in April 2020, did the prices leap from USD 24.8 in late February 2020 to USD 33.93 per pound in late May. The growth was an impressive 36.8% but… only little more than USD 9 per pound on a modest market of 130–140 million pounds. Then the price went down again, and another suspension at the Cigar Lake Mine in December 2020 went unnoticed by the market.

The laws of supply and demand are so plain and simple that it is hard to understand why they do not apply in the uranium market, which has been undersupplied since the late 1990s. According to NEA and the IAEA estimates, slightly more than 54.2 thousand tons of uranium was produced globally in 2019. Data for 2020 is not available yet, but it is safe to say the figure will be less than in 2019. To put this into perspective, all 444 reactors with a total capacity of 394.2 GW operating as of June 30, 2021 need 59 thousand (Red Book 2020 data projection) to 68.27 thousand (WNA data) tons of uranium.

There are two possible answers to the question of how the shortage in the market

can persist for over 30 years — the market is transparent in terms of demand and non-transparent in terms of supply for several years ahead. First, production data is not available for every country (for example, Uzbekistan) and every year. Second, and more important, it is unknown how much U3O8 energy companies, government reserves, uranium producers, investment companies and others have in stock.

Metals market and economic upturn as possible growth drivers

We can assume that the uranium market is influenced by general economic conditions and growth of metal prices. The correlation between uranium prices and the global economic performance and, even more so, prices of industrial metals could be traced particularly well in the second half of the 2000s and early 2010s.

The pre-crisis peak of 2007, with the price going up as high as USD 136 per pound, was not restricted to the uranium market only. The speculative demand was boosted by an overall growth of metal prices and a global economic growth fueled with an inflating

credit bubble. After the 2007–2009 financial crisis and a 1.67% recession in 2009, the global economy grew 4.3% in 2010. The prices for industrial metals recovered from the 2009 slump and went beyond the level of 2005. The spot price of uranium was also growing through 2010, particularly in the second half of the year. As at January 1, 2011, the spot market price outperformed long-term prices and reached USD 72.63 per pound.

Then a disaster struck at the Fukushima Daiichi NPP, and the correlation between the prices of uranium and other metals started lagging. In 2015, for instance, industrial metals were falling in price, while uranium remained surprisingly stable. The global economy went up 2.87% in that year. But in 2016, as the global GDP growth slowed down to 2.6%, the spot price of uranium plummeted below USD 18 per pound, the lowest since 2004. In 2017, the global economy grew 3.3%; the prices of copper, nickel and aluminum were on the rise; the price of iron ore was also higher than the year before, but the price of uranium went down. In 2018, the prices of ferrous and non-ferrous metals slacked off; the global economy growth slowed down to 2.98%, while the price of uranium increased from that year's low of USD 21 to more than USD 29 per pound.

Post-COVID rise

"The global economy is set to expand 5.6 percent in 2021-its strongest post-recession pace in 80 years. This recovery is uneven and largely reflects sharp rebounds in some major economies," says the June issue of the World Bank's Global Economic Prospects Report.

Expansion of financial assets was one of the consequences the global economy suffered as a result of the coronavirus pandemic. **"Global financial wealth reached an all-time high of USD 250 trillion in 2020 as household savings rose and markets showed unexpected resilience in the face of the protracted COVID-19 pandemic,"** says a new annual report by Boston Consulting Group (BCG). As compared to the previous year, the global wealth soared 8.3%. The report also says that many wealth management clients in 2020 embraced alternative investments in their quest for higher returns. In other words, the world has accumulated lots of money that needs to be invested to avoid depreciation.

What is more, 2021 faces a buoyant demand for industrial metals. In January 2020, iron ore was priced at less than USD 100 per ton. As soon as January 2021, the price was about USD 170 per ton, rising to nearly USD 220 per ton in May. Copper was sold at about USD 2.59 per pound in early 2020, USD 3.1 in early 2021, and as much as USD 4.8 per pound in May. The price of aluminum rallied until recently. In April, it plunged to USD 1,406 per ton and rose to above USD 2,520 per ton in May 2021. Aluminum, iron ore, steel and copper are industrial metals that seem to support uranium.

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How does this work? Not every trade in the metals market is a contract with real consumers — some are speculations. That means financial organizations or, to be more precise, their real employees believe they will earn from reselling metals and derivative instruments. Their interest covers any metals, including uranium. So, it is hardly surprising that more and more people believe that uranium is also an investment asset that deserves attention.

The investment case of uranium is proved by the trends observed in the first half of the current year. Several uranium exploration companies and financial organizations bought a total of almost 10.5 million pounds of U3O8 in the first four months of 2021. The buyers, including uranium prospectors, wrote in their press releases that they used uranium as investment.

More complex financial structures appeared as well. Sprott, one of the oldest Canadian management companies specializing in mining sector investments, established the Sprott Physical Uranium Trust and offered Uranium Participation Corporation (Canada), which focuses on physical uranium (U3O8 and UF6) purchases, to join the trust.

Another market player is Uranium Royalty Corporation. It acquires royalties, or rights to a share of uranium companies' products or profits from selling such products.

Besides, uranium companies successfully raise money to finance their activities. **"By my calculation, since mid-Feb, we've seen around USD 800 million raised by uranium companies in the uranium sector, which hasn't happened for a long time,"** Yellow Cake Uranium CEO Andre Liebenberg said in an interview for Metalsnews.com. Yellow Cake Uranium also plans to increase its physical uranium stock from 9 to 15 million pounds.

This speaks to the fact that the financial market begins to consider uranium a liquid and promising investment instrument.

The investment community expects uranium prices to grow because the nuclear industry is positioned as carbon-free and ideally fits into the current climate and environment agenda. Clean energy is likely to become a major beneficiary of economic growth in the next few decades.

Hopes for a new round of nuclear industry development are so high that they overshadow even the fear of possible accidents. In this regard, it is curious to consider the logic of Simon Chan, an analyst from Bloomberg Intelligence. **"Safety is always a focus for nuclear due to its potential impact. We think the recent issues at Taishan could increase the attention on safety, but the long-term growth outlook should remain intact,"** he told Mining.com.

The combination of factors — global economic growth, accumulation of wealth, and rising prices of industrial metals on

the back of nuclear industry efforts to be included into the list of green and clean energy technologies — might well drive up the price of uranium. To put it simply, if not now, when?

Trying to guess how high it might grow is useless. Stability of the growth will depend on the overall economic conditions — on whether the post-COVID recovery of the global economy, growth of industrial metal prices, and demand for clean energy will be lasting and steady. No less significant is a global political situation, particularly prospects of new construction in China on the back of US sanctions, non-market exclusion from bidding for nuclear construction contracts (as happened to Rosatom in the Czech Republic), and inclusion of nuclear energy in the EU Taxonomy. NL

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In Focus of Attention

Construction work is in full swing on the site of Turkey's first nuclear power plant. However, the Akkuyu NPP is far from being the only area of cooperation between Russia and Turkey. Another one is ship building, with a large contract signed recently between Russian and Turkish companies.

Russian Atomflot (part of Rosatom) and Turkish Kuzey Star Shipyard Denizcilik Sanayi ve Ticaret Anonim Sirketi signed a USD 69 million contract to build a floating dry dock for universal nuclear icebreakers.

As reported by Dünya newspaper, Tuncay İmral, Chairman of the Board at Kuzey Star Shipyard, said, **"We are glad to sign a contract with Atomflot, one of major Russian state-owned companies. It is an honor for a Turkish shipyard to have won a contract for such an ambitious project. Taking part in it means new opportunities and competencies for Kuzey Star. The project will definitely strengthen relations between Turkey and the Russian Federation."**

Having a capacity of 30,000 tons and a 30-man crew, the dock will be capable of operating independently for 7 days.

"The signing of the contract is an important step in the implementation of the coastal infrastructure preparation program for servicing universal Project 22220 nuclear icebreakers. The Turkish shipyard has the necessary competencies and has a decent reputation in the

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shipbuilding market. According to the terms of the contract, construction, including the delivery of the floating dry dock to the port of Murmansk, will take 29 months," said Atomflot CEO Mustafa Kashka.

Meanwhile, construction of the Akkuyu NPP is gaining momentum. The most active work phase is going on at Unit 1. In early June, workers completed the installation of Tier 3 of the internal containment shell — the reactor building reached 28 meters in height. In May, the reactor pressure vessel was installed in its permanent position. Dmitri Romanets, Deputy CEO for Construction, said in an interview for the Turkish channel A Haber, **"We can compare a reactor pressure vessel with a human heart. This piece of equipment will be working throughout the entire life of the nuclear power plant. After the second and third tiers are connected, we will start reinforcing and concreting the reactor containment."**

As the expert explained, they continued building coastal structures. At present, the work is underway to complete foundation pits for pump stations. Construction of the stations, which belong to one of the nuclear plant's safety systems, will begin in the near future.

The work is continuing at Unit 2 as well. In March, a foundation was laid for Unit 3. The foundation for Unit 4 will be laid within a year.

The nuclear power plant will comply with all international safety standards. Chief of the Department of Environmental Protection Merve Demirci Kolukısaoğlu said, **"We carefully monitor certain parameters on the site as required by the international nuclear safety standards. These are seismic, geodynamic and environmental parameters, and we also monitor parameters traced by non-governmental organizations."**

Employee health is another important aspect of the safety culture. A mass vaccination campaign against COVID-19 started at the Akkuyu construction site. Vaccines are administered at a certified medical station. Anyone can be vaccinated as medical staff is present at the station during working hours. This is a second round of the vaccination campaign, says Alexei Frolov, Managing Director for GR and International Cooperation at AKKUYU NUCLEAR. **"We began preparations for the mass vaccination of our employees early this year. We listed everyone who wanted to get vaccinated in advance, ordered the required number of vaccines, and equipped a vaccination station. We were supported by the Turkish authorities, the Ministry of Energy and Natural Resources and the Ministry of Health. With their assistance, the vaccination of Turkish employees is going full tilt."**

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Atomflot is a Rosatom company operating the world's only nuclear icebreaker fleet, which is currently under expansion program.

The construction project, which is unparalleled in Turkey, is in the focus of public attention. Not long ago, the Akkuyu site hosted a group of young people who had won a live quiz organized on Turkey's TV talent show. The winners came to Mersin from all over the country. During the site tour, the children were shown a sea freight terminal receiving materials and oversized equipment for the nuclear power plant, and taken to a storage site for huge pipes, which will be used in the cooling water deep discharge system. They were also brought to a 200m high viewpoint and could watch the construction site from a bird's eye view. After the tour, employees of AKKUYU NUCLEAR communications department told the visitors how nuclear power plants worked and what safety systems they had.

The young people were very much impressed with the site tour. **"I study to be a construction engineer, so seeing such a giant construction site with my own eyes was truly an unmatched experience for me. When we left the site, I made a commitment to myself to devote my professional career to a large project that will be meaningful for Turkey,"** Halil İbrahim Dilik said in an interview for PetroTurk media outlet.

"This project is a clear proof that, in terms of environment protection, nuclear energy is a much better solution to the problem of growing power demand than coal or natural gas. I would like our country to have more nuclear power plants in the future," says Furkan Uzungüngör, who studies civil engineering at Kocaeli University.

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New Milestone for El Dabaa

Egypt's first nuclear power plant El Dabaa made it to a new level as an application was filed to obtain a construction license for two units. The project has reached another important milestone.

The Nuclear Power Plants Authority (NPPA) of Egypt handed over license documents for the construction of El Dabaa Units 1 and 2 to the Egyptian Nuclear and Radiological Regulatory Authority (ENRRA).

The document submission was preceded by joint work between the NPPA and Rosatom's engineering division ASE. Dr. Amged El Wakeel, NPPA Board Chairman, said, **"The event was preceded by joint extensive work of the NPPA and ASE on finalizing the licensing documentation. Today, we are proud to say that the work we have done meets the highest quality standards, local and international requirements."**

Once the license is obtained, the parties will be able to go full tilt into the construction.

"Thanks to the coordinated efforts of the Russian and Egyptian teams, we have promptly accomplished a challenging task of harmonizing the documents, adapting them to specific site conditions and making them meet technical requirements of the EPC Contract," noted Grigory Sosnin, ASE Vice President and Director of El Dabaa Construction Project.

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El Dabaa NPP will comprise four units with Generation III+ VVER-1200 reactors, each having a capacity of 1,200 MW. Apart from building the plant, Rosatom will also supply it with nuclear fuel throughout its lifecycle. The Russian party will also arrange for the training of Egyptian personnel and will assist Egypt in maintaining the nuclear power plant for the first 10 years of operation.

The Russian nuclear corporation also contributes to raising public awareness of nuclear energy. For instance, Rosatom took part in one of the oldest and largest international book fairs held in Cairo from June 30 until July 15 and presented two books about nuclear science and technology, Nuclear ABC and Nuclear Professions.

The Nuclear ABC plainly explains nuclear fundamentals, nuclear energy and how nuclear power plants work.

The Nuclear Professions describes a variety of professions in the nuclear industry and their contribution to social development and environmental conservation. This book informs students exploring their professional futures about in-demand nuclear technology-related career paths in a wide range of areas, from power generation and medicine to agriculture and archeology, amongst others.

Rosatom also donated books to the largest Egyptian libraries and educational centers. The two books are now available in major public libraries and will help increase public awareness of nuclear energy and raise interest in physical sciences among young people. You can get your free copy to read when you visit the outlets of Kotobna publishing house, branches of Al-Shorouk libraries, and Diwan. You can also visit the Russian Cultural Center in Cairo and the Supreme Council of Culture in Cairo.

"It is a great honor for us to partake in the oldest international book fair in the Arab-speaking world, a fair with an established reputation amongst both book lovers and publishing professionals. We hope that our books will help expand local knowledge about the role of nuclear energy in [Egypt's] development and will open new professional horizons for Egyptian schoolchildren and young people in the nuclear industry," Grigory Sosnin said.

The NPP is not only a source of environmentally friendly electricity generation, but also it is the largest infrastructure project that supports the development of various economy sectors and contributes to increasing the state's income. Nuclear energy plays a key role in the country's sustainable development. These topics have been discussed during media roundtable, which was organized by Rosatom together with the NPPA.

"NPP project contributes to at least 6 UN SDGs. It is definitely low-carbon. It provides an affordable and long-term source of electricity. It supports local producers by

bringing USD 3–4 bln of orders to local industries during construction period. It creates about 3,000 of new working places to work at NPP and more than 10,000 indirect jobs as per our estimates," pinpointed Polina Lion, ROSATOM's Chief Sustainability Officer.

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AtomStroyExport (ASE) is Rosatom's engineering division, which is a global leader constructing most of the nuclear power plants abroad and having the world's largest portfolio of nuclear construction contracts. The division is active in Europe, Middle East, North Africa, and Asia Pacific.

Rooppur: Energy of Tomorrow

Bangladesh's first nuclear power plant will open up new opportunities for the country and boost economic development by creating highly qualified jobs in the region. This project is called the Sheikh's Dream, referring to the country's founding father Sheikh Mujibur Rahman.

Bangladesh will load the first batch of nuclear fuel into the reactor of Rooppur Unit 1 in February 2023. This was announced by Rooppur Project Director Shawkat Akbar in an interview for The Financial Express. He said that the fuel loading at Unit 2 would start six months later. Shawkat Akbar stressed this would require a tripartite agreement to be signed between all the stakeholders, namely a fuel supplier, a general contractor from Russia (Rosatom's engineering division ASE), and the Bangladesh Atomic Energy Commission (a body responsible for the delivery of the Rooppur Project).

He also noted that the construction of the country's first nuclear power plant was in full swing. Earlier, the progress in the construction of Rooppur was highlighted by Bangladesh ambassador to Russia Kamrul Ahsan, who also thanked Russia on behalf of his country for its extensive support for the project.

The Rooppur nuclear power plant is constructed to the Russian design. Its reference unit is the Novovoronezh NPP Unit

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6 operating in Russia. This Russian plant has been repeatedly visited by representatives of Bangladesh, and Rosatom employees told them about the current condition of Generation III+ VVER-1200 reactor units and specifics of their operation.

Russian companies continue to manufacture key machinery and equipment for the Rooppur NPP. In late June, the Petrozavodsk branch of AEM Technologies (part of Rosatom's power engineering division AtomEnergoMash) assembled the first primary coolant pump (PCP) casing for the plant's second power unit.

After the welding and assembly operations were completed, the casing was subjected to thermal treatment to relieve residual stress after the welding. During the thermal treatment, the PCP casing is heated to over 600 °C and kept at this temperature for several hours. After each treatment step, all welds are inspected with dye penetrant and ultrasonic techniques.

Primary coolant pump casings are Class 1 safety products. At a nuclear power plant, the primary coolant pump makes the coolant flow from the reactor to steam generators. The pump operates under the pressure of about 160 MPa and temperature of 300 °C.

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AtomEnergoMash (AEM) is Rosatom's power engineering division and one of Russia's largest power machinery producers providing comprehensive solutions in design, manufacture and supply of machinery and equipment for nuclear, thermal, petroleum, shipbuilding and steel-making industries. Its production facilities are located in Russia, the Czech Republic, Hungary and other countries.

Each reactor unit has four primary coolant pumps.

AEM Technologies manufactures key equipment for the nuclear islands of the both power units of the Rooppur NPP. NL

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