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Signing of agreement on construction of a nuclear science and technology center in Zambia

Nuclear Education for Africa's Future

Offering education programs to African students is one of the key areas of cooperation between Rosatom and countries of the continent. The nuclear energy industry, an important component of sustainable development in Africa, needs well educated professionals. In late November, Russia hosted the 1st Russia-Africa Youth Forum on Nuclear Education for Sustainable Development.

The forum was held online due to coronavirus restrictions. It was organized by the Peoples' Friendship University of Russia (RUDN), University of Rwanda and Russian nuclear corporation Rosatom.

The forum was attended by government officials, educationalists, students, postgraduates and junior researchers from Burundi, Gambia, Ghana, Egypt, Zambia, Zimbabwe, Kenya, Nigeria, Rwanda, Senegal, Sudan, Tanzania, Tunisia, South Africa, Madagascar, Mozambique, Namibia, Ethiopia and Uganda.

The goal of the forum is to motivate young people to receive a degree in nuclear engineering, spur interest towards nuclear research and inspire loyalty to the Rosatom brand. Motivation is an important tool in forming a new cohort of professionals who will be able to drive social and technological development in Africa in cooperation with Russian partners.

Vladimir Filippov, President of RUDN and a member of the Russian Academy of Sciences,

addressed the forum, **"This year Rosatom celebrates its 75th anniversary, and 250,000 employees of our nuclear industry have achievements to be proud of. I say 'our industry' because Rosatom is a global technology leader. It is important for us to know that emerging nuclear countries will have highly qualified professionals to hire."** According to statistics, Africa is a continent of young people, with 65% of the population younger than 35 years and 50% younger than 19 years. Africa has great potential for education.

Since 2013, Russia and Rosatom have been offering free education programs to African students. At present, 256 students from Sub-Saharan Africa, including Rwanda, Ghana, Zambia, Kenya, Nigeria, Tanzania, Uganda, Ethiopia and South Africa, study in Russia for nuclear-related majors. As a global technology company, Rosatom offers excellent educational and career growth opportunities for the countries to be proud of their young citizens.

Challenge accepted

The difficult 2020 made some organizations restrict or wind up their activities, but not Rosatom. Here is an example: five students from Ethiopia could not fly to Russia to continue their course at the National Nuclear Research University (MEPhI). The university and Rosatom made necessary arrangements for the students to visit lectures online. The students will join their group at the earliest opportunity.

Rosatom continues to expand cooperation with African universities. This year, the Russian nuclear corporation has signed a foreign student support agreement with

the University of Zululand (UNIZULU). The cooperation will cover the following areas:

- Joint educational programs of UNIZULU and Russian universities associated with Rosatom;
- Internships and training of students, postgraduates and postdocs in Russian universities associated with Rosatom;
- Joint research projects;
- Joint educational event and seminars in South Africa and abroad;
- Joint cultural programs in South Africa and abroad;
- Exchange of information, publications and other documents;
- Grant programs for South African students studying in Russia;
- Student competitions.

Rosatom and the African Commission on Nuclear Energy (AFCONE) signed a memorandum of understanding to lay a foundation for the cooperation in mutual

interest areas, particularly in science, technology and innovations, aimed at improving nuclear safety and promote peaceful uses of nuclear energy in Africa.

This year, Rosatom has built two hydroponic greenhouses at Bokgoni Technical Secondary School in Pretoria (South Africa) to improve the quality of school meals. Rosatom has thus met the school's need for fresh and healthy foods and motivated students to learn more about the new growing technology.

Rosatom launches many initiatives related to sustainable development and young people.

A good example of such initiatives is Atoms for Africa, a Facebook-based video contest for young people. Since 2015, students and young professionals aged 18 to 30 from Sub-Saharan Africa has been creating videos about the advantages of nuclear energy and technology for Africa. The best teams are awarded with technical tours to nuclear facilities in Russia. Over five years, 36 winners have visited Russia. This year, the contest will start in late December. The winners will have an opportunity to visit Russia after the pandemic.

Demand for sustainable, affordable and reliable energy is growing. Nuclear energy boasts each of these properties and is therefore essential for the transition to a low-carbon economy. Rosatom believes that nuclear technology plays a pivotal role in achieving the UN Sustainable Development Goals in Africa. The wide range of available solutions includes large nuclear stations featuring VVER reactors with a capacity of over 1 GW, small modular reactors capable of generating up to 57 MW, and non-energy applications.

Russian expertise

This year, 17 Zambian students studying nuclear energy at MEPhI have taken part in an online discussion with Dr. Roland Msiska, Director General of the Zambia Atomic Energy Agency (ZAMATOM), and experts of Rusatom Service. The students have recently completed their internship at Rosatom.

According to Taonga Chilambo from Zambia, she decided to study nuclear because it was very captivating. Power generation is not the only application of nuclear technology – it is also used in healthcare and food processing. She believes that nuclear energy can help Zambia overcome its energy shortage and boost the national economy.

Education in Russia is a perfect opportunity to both gain knowledge and dispel myths about Russia.

Morris Chema Mungwa is a Zambian student, who studies in Obninsk and travels around Russia. He went out to Karelia to see the beauty of Russian nature for himself. "This experience surpassed my expectations. We set up a camp on a river bank not far from Finland, slept in tents, cooked food in the forest, drank water from the stream and floated down the river. That was a wonderful time – no gadgets. Then we reached rapids, and our boat overturned and threw us into cold water. We had to swim to the bank. The time I spent in the forest in the land of midnight sun was definitely one of the most unforgettable impressions in my life. I am looking forward to the opportunity to return there again," he says.

The nuclear science and technology center (NSTC) is one of the most interesting non-energy solutions offered by Rosatom. The NSTC consists of a research reactor, a multi-purpose irradiation facility, a nuclear medicine center, and several laboratories, including an isotope fabrication laboratory. Isotopes are used in diagnostics and treatment of oncology diseases. According to statistics, around 12% of 804 million Africans older than 75 years are affected with cancer, so nuclear will give an opportunity to improve their health.

The irradiation facility can also be used to treat foodstuffs. About 20% to 45% of produce grown in the world is lost to pests or because of a very short storage life, and Africa is no exception. Irradiation of food products increases their shelf life, reduces spoiled food amounts and helps local producers meet standards of importing countries and mitigate risks of diseases caused by low-quality foods.

The NSTC opens up extensive research and analysis opportunities, such as tests on mineral resources and samples of air, water and soil. Local staff training is another opportunity offered by the NSTC.

Rosatom is already engaged in the construction of a nuclear science and technology center in Zambia. In 2019, an agreement to build an NSTC was also signed between Rosatom and Rwanda on the sidelines of the Russia-Africa Summit in Sochi.

Rosatom ensures safe, sustainable and affordable uses of nuclear technology. Every solution offered by the Russian nuclear corporation has been developed by top-notch professionals. This is why Rosatom involves Africans in its educational and social programs. The first steps on the way towards successful partnerships have already been made. More of them will be made in the coming years.

Bag of Zeolite

Tenex-Japan Co., a subsidiary of TENEX (part of Rosatom) will conduct a proof-of-concept study on safe handling of radioactive zeolites at the Fukushima Daiichi nuclear power plant. The task is to remove zeolites and put them into safe intermediate storage. This is the first contract signed directly between TENEX and Japan's TEPCO, an operator of the plant.

Zeolites are naturally occurring minerals or their artificial analogs easily absorbing water and, thanks to the ion exchange, used as selective adsorbents. Right after the Fukushima Daiichi disaster in 2011, clinoptilolites (natural zeolites of volcanic origin) and activated carbon granules were used to remove radioactivity from water. Zeolites were put into 20 kg bags and

placed onto the floor in the basements of two auxiliary buildings on the Fukushima site. Then the basements were filled with water to cool down the melted reactor cores. They were used as temporary reservoirs for contaminated water.

The zeolites absorbed water containing radioactive particles and dust from the broken-down structures of the nuclear plant. With radioactive particles kept inside the zeolites, water became cleaner but the buildings cannot be used yet.

TEPCO commissioned a proof-of-concept study to remove the source of radioactivity from the buildings. The task is to propose a solution for safe removal of zeolite-filled bags from the basements. Another task is to find a solution for safe container storage of the highly radioactive zeolites.

"Long-term intermediate storage is not an easy task to solve," said Sergei Syomin, a project manager at TENEX. High radioactivity inside the containers will cause radiolytic decomposition of water absorbed by zeolites and generation of hydrogen. If its concentration exceeds 4%, risks of fire and explosion increase. Apart from hydrogen, corrosion processes inside the containers will also pose a serious threat.

Another problem is that most bags are damaged with time or by ionizing radiation – zeolites have spilled and need to be collected and treated somehow.

After the zeolites are removed, they will be put for storage and water will be pumped out of the basement for final treatment. These operations will cause background radiation in the buildings, in the neighboring areas and on the site in general to decline. For now, it is

impossible to remove water because it acts as a radioactive shield. Without it, no one will be able to access the buildings due to high radiation.

"When the study is completed, we will offer the Japanese party a concept for safe handling of radioactive zeolites. It will underlie on-site operations plans," said Elena Artyomova, TENEX Deputy Director for Back End.

TENEX team has already formulated a hypothesis on how the tasks could be solved. It is clear now that bags need to be collected remotely, using robots.

Rosatom has necessary experience in remotely handling contaminated and damaged items. A year ago, the company removed debris of six fuel assemblies from the bottom of the spent fuel pool in the Andreev Bay. TENEX plans to tap into the existing knowledge and expertise.

The proof-of-concept study and proposals regarding the removal and storage of zeolites will be ready by late February 2021. Then TEPCO will select the safest and most cost-effective concepts out of the proposals made

by different companies. The selected concepts will be developed into designs.

TENEX has been participating in the site clean-up and recovery operations in partnerships with different Japanese companies since 2014. Close cooperation with TEPCO started in 2018, but the two companies got to know each other more than 20 year ago thanks to Russian enriched uranium supplies.

The zeolite study is the company's first contract related to the recovery of Fukushima Daiichi and made directly with TEPCO. **"It took us almost five years to prove our sufficient level of expertise in solving complex tasks at this nuclear power plant,"** Sergei Syomin said.

In order to demonstrate its competencies, TENEX invited Japanese colleagues to Russia and showed how similar work had been done before, consulted them, discussed conceptual solutions for different tasks and fulfilled a number of small research contracts. NL

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Rosatom participation in recovery operations at the Fukushima Daiichi NPP

August 2014. The government of Japan selects RosRAO (now Federal Environmental Operator) and Khlopin Radium Institute (both part of Rosatom) as partners to the technology testing project for tritium removal from radioactive water at Fukushima 1. The water treatment unit built by Russian engineers passed tests at one of RosRAO's sites in 2016.

December 2016. The parties sign a memorandum on cooperation in peaceful uses of nuclear energy. The key point is recovery at the Fukushima Daiichi nuclear power plant.

March 2017. The government of Japan selects a consortium of RosRAO and TENEX to develop a compact neutron detector. It will be used to identify and remove damaged fuel assemblies and internal structures from the containment buildings.

January 2018. The consortium of TENEX, RosRAO, Research Institute of Atomic Reactors (RIAR) and Khlopin Radium Institute won a contract for the study of corium properties during the aging process.

April 2019. The consortium of TENEX, RIAR and Mayak (all part of Rosatom) won a contract for the development of a dust collection system to remove radioactive dust produced by nuclear fuel debris at the damaged units of the Fukushima Daiichi nuclear power plant.

June 2019. The consortium of TENEX, RIAR and Khlopin Radium Institute won a contract to continue the study of aging corium properties.

The Year of Nuclear

For 11 months, every issue of our Newsletter has been telling you about Rosatom Group companies. This year's last issue reviews Rosatom's performance in 2020, the year when the Russian nuclear industry celebrated its anniversary.

On December 1, 2007, Russian President Vladimir Putin signed a decree to dissolve the then existing nuclear agency and establish a state-owned nuclear corporation Rosatom. Since then, Rosatom has been a nuclear industry of the Russian Federation in its entirety and complexity. Despite the coronavirus difficulties and restrictions, the industry has seen many important events in 2020.

Nuclear power plants

On May 22, the world's only floating nuclear power plant was put into operation in Pevek (Chukotka, Russia). It is also the first SMR commissioned in the 21st century.

On October 22, Leningrad II NPP Unit 2 with a VVER-1200 reactor was connected to Russia's national power grid. On November 12, 2020, the newly commissioned Leningrad II Unit 2 started supplying heat and hot water to the neighboring town of Sosnovy Bor.

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On November 3, Belarus NPP Unit 1 with a VVER-1200 reactor was connected to the national power grid of Belarus. This is the first Generation III+ reactor unit built abroad to the Russian design.

The nuclear power plants in Russia are expected to generate record-high 214.965 billion kWh of electricity by the end of 2020.

New businesses

Over the last five years, Rosatom has launched 87 new businesses. Nine of them (wind power, composite materials, nuclear medicine, waste management, oil and gas services, digitalization, smart city system, international logistics and additive technology) are strategic programs, two of which – additive technology and international logistics – have been kicked off in 2020. Revenue from new businesses in 2020 is expected to reach RUB 257 billion, up 12.7% year on year.

Wind power

On March 1, the Adygea wind farm was brought online and has been selling power and capacity in the wholesale market since then. With an installed capacity of 150 MW (60 wind turbines with a capacity of 2.5 MW each), the plant is capable of generating more than 350 million kWh per annum, or 20% of power consumption in the Republic of Adygea.

Kochubeevskaya (210 MW), Marchenkovskaya (120 MW), Karmalinovskaya (60 MW) and Bondarevskaya (120 MW) wind farms are currently under construction. The total capacity of Rosatom's wind projects in Russia amounts to 1.2 GW.

In order to increase local content in the wind turbines, the company has launched production facilities manufacturing over 20 sets (turbines and modular steel towers) per month.

Composite materials

Several partnerships have been set up in 2020. In March, Rosatom and Rusnano established Composite Invest to develop pultrusion solutions and composite wires. In July, Rusatom GasTech was established to manufacture, in cooperation with Italian Faber Industrie SpA, high-pressure composite gas tanks and auxiliaries, including solutions for hydrogen economy. In July, Rosatom's composites division Umatex acquired Porcher Advanced Materials, a Russia-based subsidiary of the French company Porcher Industries. The deal aims to increase the output of technical fabrics 1.5 times and acquire expertise, competencies and new technologies required to adapt and upgrade equipment and develop new products.

Northern Sea Route

In January 2020, the Russian government commissioned the construction of the first

nuclear icebreaker in the Leader series. The icebreaker is expected to be put in operation in 2027.

In October 2020, Arktika, the first Project 22220 nuclear icebreaker was officially commissioned. The Project 22220 series will consist of Sibir (to be commissioned in 2021), Ural (2022), Yakutia (2024) and Chukotka (2026) nuclear icebreakers.

In April, Hydrographic Survey Company and Mordraga (a Russia-based dredging subsidiary of Belgian DEME Group) signed an agreement for dredging operations in the Gulf of Ob.

Digitalization

On November 25, Russia established the National Quantum Laboratory. Construction of a data processing center started in the Innopolis Special Economic Zone (Tatarstan). The first data center was put into operation in 2019.

The Smart City system was introduced in 18 cities of Rosatom's operations and the resort town of Zheleznovodsk to assist municipalities in their daily routine. The Smart City based platform was also launched in the Murmansk Region Management Center. Similar systems are planned to be used in Bolshoy Kamen (Primorsky Krai) and Zvezda Shipyard.

Environment protection

Rosatom is working to introduce an end-to-end management system for the most hazardous (class I and II) waste. The Federal Environmental Operator (FEO, part of Rosatom) has developed an information system for waste tracking and is testing it now. Other programs carried out by FEO include a number of waste disposal projects, such as rehabilitation of a dumpsite near Chelyabinsk, waste recycling for lithium-ion batteries, demolition and removal of hazard facilities at UsolyeKhimProm (Irkutsk Region) and hazard class I and II facilities in Leningrad and Kirov Regions. Rosatom also takes part in the construction of waste-to-energy plants (plants burning municipal solid waste to generate electricity).

In cooperation with international partners, Rosatom continues to remove legacy waste from the Arctic region. In 2020, a feasibility study was completed to develop a safe technique for removal of underwater objects. Accumulated radioactivity decreased more than twofold, from 11.1 MCi in 2004 to 5.09 MCi in 2020. In 2020 alone, a total of 758 kCi in radioactive materials was removed from the Arctic.

Nuclear medicine

In October, Rosatom supplied lutetium-177 to a consortium of hospitals and universities in the Italian city of Bari. This was the first shipment of Lu-177 isotope to Europe.

A radiological facility with a positron emission tomography center is under construction in Irkutsk. Rosatom plans to set up a chain of seven radiotherapy facilities across Russia.

In July 2020, work has started to develop a design for a radiopharmaceuticals production facility. Khlopin Radium Institute has manufactured a generator of Ra-223, an isotope for the treatment of cancer metastases.

As for international projects, a CC-30/15 isochronous cyclotron has been delivered to Thailand to be installed at a local radiochemical facility created jointly with local partners.

Logistics

Rosatom plans to develop its own freight forwarding business. Its logistics subsidiary will manage two tasks, freight deliveries to nuclear plant construction sites all over the world and commercial deliveries from Europe to Asia on the Northern Sea Route. This route is shorter, so shipments can be cheaper (exact cost savings depend on the point of departure and point of destination). For this purpose, Rosatom acquired a share in Delo Group operating six container terminals in the Baltic Sea, the Black Sea and the Russian Far East.

International business

Rosatom participates in two joint research programs and conducts in-pile tests of beryllium and lithium ceramics for a proposed DEMO nuclear fusion power station in partnership with Marubeni (Japan) and Karlsruhe Institute of Technology (Germany). The Research Institute of Atomic Reactors and CNEIC (China) are about to sign a large contract for in-pile tests of pilot annular fuel for pressurized water reactors.

Rosatom continues to participate in the International Thermonuclear Experimental Reactor (ITER) project and contributes finance and components for its construction.

Science

Construction of a multi-purpose fast neutron research reactor MBIR was resumed in July. MBIR will be used to conduct radiation tests on structural materials, study effects of high-density neutron flux on such materials, study new fuels and absorbing materials, conduct durability and operation tests on fuel rods and assemblies for innovative reactors with sodium, heavy liquid metal, gaseous and other coolants. MBIR can also be used to conduct tests on new equipment, instruments, reactor control and diagnostics

systems to assess their operability and durability. Another important area of research includes in-pile tests and research into problems of the closed nuclear fuel cycle, disposal of actinides, burning of long-lived fission products, etc.

Rosatom has revamped six of its R&D institutes involved in nuclear research. In general, Rosatom's research and development centers and laboratories carry out about 150 research programs in ten fields, including laser, fusion, plasma, hydrogen and spent fuel management technologies.

Sustainable development

In July, Rosatom approved its Sustainable Development Policy. The document sets out the position of the Russian nuclear corporation on sustainable development, including goals, objectives and principles of environment protection, labor safety, health, social security and corporate governance. In October 2020, Rosatom's application to join the UN Global Compact was approved.

Every company of Rosatom Group has taken measures to prevent the spread of coronavirus and provided support to those who have fallen ill and their families. No less important task is to support hospitals in the cities of Rosatom's operations. Rosatom helps introducing continuous improvement practices aimed at increasing the quality of medical services, reducing waiting lines and cutting redundant reporting. In addition, Rosatom's subsidiary Sterion sterilizes facemasks and kits for the collection of COVID samples.

The Russian nuclear industry celebrates its 75th anniversary in 2020. For three fourths of a century, Rosatom has grown into Russia's major technology company and a global leader in many areas of research. Rosatom develops complex technologies, bringing them from concept to market. The Russian nuclear corporation has accumulated vast knowledge and uses it to make life safer and easier despite any challenges on the national or international scale. NL

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Rosatom CEO Alexey Likhachev at Global Impact Conference

At Sustainable Pace into Future

Having joined the UN Global Compact in October, Rosatom demonstrated the international community its commitment to sustainable development. Rosatom representatives shared their views of the future at two forums held in early December 2020, the Global Impact Conference and the Russia-EU Climate Conference.

Climate change and decarbonization, rapid advancement of technology and no less rapid depreciation of competencies, economic development of nations and companies acting in the interests of all stakeholders were the topics covered by Rosatom top managers in their reports.

Bridging the skill gap

Speaking at the Global Impact Conference, Alexey Likhachev, Director General of Rosatom, focused on the disparity in human resources. **"The imbalance on the labor market continues to grow. The skills that many of us have developed earlier in our careers can become obsolete a few years later... At the same time, there is an increasing need for new professionals,"** Alexey Likhachev stressed.

The skill gap is a global problem. According to the estimates of Rosatom and Boston Consulting Group, it concerns at least 1.5 billion people all over the world. Being human-centric – creating an environment for employees to unlock their potential – helps Rosatom bridge the skill gap.

William Magwood, Director General of the OECD Nuclear Energy Agency, who also

spoke at the Global Impact Conference, shared his belief that nuclear energy was stimulating force in education and social development in general. Nuclear science and technology will be interesting for the new generation of engineers who will create 'a bright and attractive future'.

Gary Bolles, Chair for the Future of Work at Singularity University, suggested picking up PACE to solve problems faced by the labor market. The acronym PACE coined by Bolles stands for problem solving, adaptivity, creativity and entrepreneurial skills (flexibility and empathy). Every successful employee would have those skills in the not-far-away future and would consider them critical, he said. According to the statistics he cited, 20 million Americans lost their jobs in March 2020 at the height of the pandemic. This is more jobs lost than during the Great Depression. Some industries have slumped, some have stayed afloat, and some have even grown. Unless we invest in the skills of the future, there is a risk of lagging behind changes in the labor market.

It should be said, though, that not every country catches up with changing requirements of the community and employers even when there is no crisis in education. João Costa, Deputy Minister for Education of Portugal, described experience of his country. The school curriculum includes such subjects as gender equality, human rights, financial literacy and climate change. Teachers concentrate on the development of critical thinking and problem-solving abilities. These skills are needed, among other things, to know fake from true, be immune to false information and resist manipulation, João Costa believes.

Climate on agenda

According to the latest studies by the World Meteorological Organization, the concentration of CO2 in the atmosphere reached a record high of 410 ppm in December 2020 and continues growing.

No wonder that decarbonization was one of the key topics at the two forums. Decarbonization is important to Rosatom as nuclear power plants prevent greenhouse gas emissions. The Russian nuclear stations prevent 107 million tons of CO2 equivalent from being emitted in Russia annually. This is around 7% of total greenhouse gas emissions in the country.

But Russia is not the only country where Rosatom operates. **"We are a global company building new nuclear generation capacity in 12 countries. We share the global priority of the climate agenda and realize our responsibility for its implementation. We are adamant that nuclear energy is indispensable for the effective achievement of the goals set since today it is virtually the only source that guarantees uninterrupted supply of low-carbon energy regardless of the weather**

or climatic conditions," Kirill Komarov, Rosatom's Deputy Director General for Corporate Development and International Business, reminded the audience when speaking at the Russia-EU Climate Conference.

For now, Russia and the EU differ in their recognition of nuclear energy as clean and sustainable. **"We know that the EU has not yet formed its final opinion on nuclear. We respect its position, whatever it is, but believe that green economy plans should account for local specifics, available natural resources and, ultimately, the historical structure of generation in the country,"** Kirill Komarov stressed.

Speaking about clean and sustainable energy, Rosatom follows the Green Square concept. It comprises four sources of energy – nuclear and hydro generating the base load power while wind and solar ensuring flexibility at peak demands. The concept puts nuclear on a par with renewable energy sources as components of a low-carbon energy mix.

Possible introduction of a carbon tax in the European Union was another important topic discussed at the Russia-EU Climate Conference in the context of decarbonization. Europe is one of the key markets for the Russian nuclear corporation. Rosatom builds two nuclear stations in Finland and in Hungary, supplies equipment and fuel to the European Union and provides services to nuclear companies. **"We understand that the carbon tax, when introduced, will have a more or less pronounced effect on our operations. We are watching closely how the European Union tunes up its taxing mechanism. We expect that consultations for importers will be organized when the basic taxing procedure is established. The dialogue is necessary since Russian laws on climate are yet in the development phase and not every company is ready to meet new, even stricter rules of conduct,"** said Polina Lion, Chief Sustainability Officer at Rosatom. She also noted the importance of Russia-EU dialogue on recognition of the so-called green (low-carbon) certificates. Russia is drafting a new bill that counts nuclear among low-carbon sources of energy. The European law does not. **"We hope that, following the tax tune-up, atom will finally be included in the list of green power sources to be used in carbon footprint reduction programs of Russian exporters. This inclusion is important for us in terms of business and support of Russian exporters to the EU,"** Polina Lion expressed her concerns.

Emin Askerov, CEO of RENERA, offered an unconventional approach to solving climate-related problem. Speaking at the Global Impact Conference, he calculated his personal carbon footprint, which was three times higher than the safe 10,000 tons per annum. To make his footprint safe, Emin Askerov sold his second car and started using carsharing services. He prefers local producers when buying food and chooses expensive brands when buying jackets – high-quality clothes last longer. He also refrains from buying extra

gadgets. Carbon footprint reduction is what the CEO of RENERA does professionally. When in Rosatom, he used to work on wind generation projects. Now he deals with the production of lithium-ion batteries.

Commenting on the possibility of carbon footprint reduction, Michael Harms, CEO of the German Eastern Business Association, reminded that Germany imports about 30% of its energy resources from Russia, its long-standing business partner. Then his words turned more specific, **"We pay much attention to hydrogen economy. We are prepared to work hard in this area together with our Russian partners."** One of the partners is Rosatom, which also promotes hydrogen economy. Michael Harms agreed that nuclear as a low-carbon source of energy will make a sizable contribution to achieving net-zero emissions in the medium and long terms, but the "future belongs to hydrogen".

Michael Harms' compatriot Karsten Sach, Director General of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU), also spoke about hydrogen in the context of cooperation with Russia. **"Russia is the largest supplier of natural resources and, since the focus of demand will be shifting towards hydrogen, it is in the interest of Russia and Germany and the EU in general to create infrastructure and develop measures of support for this segment of the energy industry,"** he said at the Russia-EU Climate Conference.

William Magwood draw the audience's attention to reliability of nuclear energy, an essential property to achieve sustainable development goals. He proved his statement by referring to the recent coronavirus reality: children studied and their parents worked from home thanks to a reliable supply of electric power.

Rapid digitalization

According to Dilip Chenoy, Secretary General of the Federation of Indian Chambers of Commerce and Industry (FICCI), the coronavirus accelerated advancements in the architecture of communications. Relations between students and teachers, customers and manufacturers, employers and employees went digital as work became remote. Communications turn to be a critical skill of the future.

A vivid example of this transformation was A. I. Angel, a virtual moderator who took part in the conference, commented on the speeches and asked speakers questions.

Artificial intelligence is used for the benefit of people all over the world, and Russia is no exception. For instance, the Novovoronezh Nuclear Power Plant (Russia) and Atomenergomash (part of Rosatom Group) use AI-powered analytics to predict equipment failures. The plan is to launch a digital secretary able to recognize speaker voices at meetings, Boris Makevnin, CEO

of Rosatom's subsidiary Cifrum, shared corporate plans.

The participants of the conference also discussed digital inequality and loss of control over artificial intelligence. This is the reason why it is important to develop ethical principles of interaction with AI, which should not discriminate against anyone, be explainable, reliable and so on.

Social responsibility

About 4.3 billion people live on less than 5 dollars a day; 1.6 billion people have no social protection, and more than 500 million live below the poverty line. These figures were cited by Paul Polman, Co-Founder and Chairman of Imagine, in the context of corporate social responsibility: more and more large companies become interested in shaping an economy that 'works for everyone'.

Rosatom is also committed to social responsibility. **"We provide energy and other services to many millions of people in Russia and other parts of the world, and we feel responsible for the communities we operate in. All our businesses, from**

traditional, clean nuclear power generation to our new wind power generation, digital and environment protection products focus on substantial improvement of the quality of life and creation of sustainable cities and communities," Alexey Likhachev assured the audience.

Taking care of people and improving their lives is beneficial for the companies as well. According to Rosatom's Director General, consumers vote with their wallets increasingly more often and steer away from the companies that do not invest in social development and environment protection. NL

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Energy To Illuminate Turkey

Akkuyu Nükleer obtained a construction license for Akkuyu NPP Unit 3 from Turkey's Nuclear Regulatory Authority. The license authorizes the project owner to start construction of the turbine and nuclear islands of Unit 3 and installation of systems and equipment related to nuclear safety. A limited construction permit for Unit 3 was obtained on July 23, 2020.

"A construction license for Akkuyu Unit 3 has been granted. Our energy mix will be more diversified with the new source of energy. The Akkuyu nuclear power plant will light up all Turkey," the Ministry of Energy and National Resources of Turkey said.

The first concrete for Unit 3 might be poured as soon as next spring, said Kirill Komarov, Rosatom's First Deputy Director General for Corporate Development and International Business. He also added that Rosatom expected a construction license for Akkuyu Unit 4 to be issued by the autumn of 2021. **"All the documents were submitted in May 2020. This is the last license we have to obtain. I think it will be granted no later than the autumn of 2021,"** Kirill Komarov stressed.

After all four units of the Akkuyu nuclear power plant with an installed capacity of 4,800 MW are put into operation, the plant will generate around 35 billion kilowatt-hours of electricity every year, covering 10% of the country's total demand for electric power.

On-site construction operations are going full tilt at three reactor units. Russian

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manufactures keep producing nuclear equipment and shipping it to the site. The Volgodonsk-based production facility of AEM Technologies (part of Rosatom) has manufactured a reactor head for Akkuyu Unit 1. The production process took nearly one and a half year. Representatives of Turkey's Nuclear Regulatory Authority (NDK) supervised key production stages. The reactor head is used to seal the pressure vessel and prevent floating of the reactor internals. The reactor pressure vessel and head belong to Class 1 products in terms of earthquake resistance. In December, the same production facility has completed the installation of tubing into the first steam generator for Akkuyu Unit 2. Steam generators are heat exchangers that belong to the nuclear island and are safety Class 1 products.

In mid-November, a delegation of the President's Council for Nuclear Safety of the Republic of Turkey headed by the President of the Council Zafer Demircan visited the Volgodonsk production site of AEM Technologies. The delegation was informed about the progress in the production of core equipment for the Akkuyu nuclear power plant and held a working meeting on the status of the project and equipment supplies to the construction site. The representatives of Turkey toured the production facility manufacturing core equipment for the primary coolant system of nuclear power plants.

As noted by AEM Technologies CEO Igor Kotov, Atommash meets its production program despite the current year's restrictions and without compromising on quality of the products. **"This has become possible thanks to both our hard work and effective cooperation with our Turkish colleagues,"** Igor Kotov stressed.

In his turn, Zafer Demircan thanked everyone for hospitality and mentioned the plant's expertise. **"AEM Technologies has extensive experience in manufacturing equipment for the primary coolant system of nuclear power plants. Today we have seen for ourselves that every piece of equipment is manufactured in strict compliance with technical documents and specifications,"** Zafer Demircan said.

The cooperation between Russia and Turkey goes far beyond construction of the nuclear power plant and includes development of the national nuclear infrastructure, particularly social and educational projects. In November, Rosatom organized the Global Atomic Quiz held online in 11 languages and dedicated to the 2020 World Science Day. More than 12,000 contestants from over 70 countries took part in the quiz. They had to answer 25 questions ranging in complexity and topics. Regardless of the results, each contestant was awarded a certificate and provided a link to a video in which experts analyzed and explained answers to the questions in detail. **"The Global Atomic Quiz has brought together people from all over the world to learn new scientific facts about nuclear**

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energy on the single platform. I am glad that, as an expert in nuclear, I can be a part of the project," Dr. Senem Şentürk Lüle from the Istanbul Technical University said.

In late November, Titan-2 and İçtaş – two companies engaged in the nuclear plant construction project in Gülnar – provided support to the local administration and purchased 17 computers for the middle boarding school in Gülnar. Hüseyin Kadim, Head of National Education in Gülnar, said, **"Since November 23, 2020, children have been learning remotely. With the new 17 computers, we increased the number of points of access to the distant learning system. These computers have saved Gülnar."**

Turkish students studying for nuclear majors make good progress and win recognition from international organizations. In late November, 11 Master's degree students, including six students from Turkey, studying nuclear physics in Russia were awarded Marie Skłodowska-Curie scholarships for women. The winners from Turkey were Seida Merve Değirmenci, Aişe Gök, Yağmur Küçük, Ahsen Özdemir and Zeyneb Nur

Şahin (Thermal Engineering, Peter the Great Saint Petersburg Polytechnic University) and Nurberk Sungur (Design, Operation and Engineering of Nuclear Power Plants, the same university). **"We welcome the award of Marie Skłodowska-Curie scholarships to Russian and foreign students studying nuclear physics at Russian universities. This is a very timely initiative of the IAEA to support education and improve gender balance in the nuclear industry,"** Valery Karezin from Rosatom's HR Department said. NL

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Signing of the Russia-Egypt agreement on collaboration in the construction and operation of a nuclear power plant

See Technology for Yourself

The cooperation between Rosatom and MENA countries did not lose momentum during the pandemic and even reached new heights. Recently, the Rosatom mechanical engineering division has organized a virtual tour around one of Russia's key manufacturers of nuclear equipment.

Atommash, the Volgodonsk-based production facility of AEM Technologies, hosted the first ever virtual tour in the history of the Russian nuclear engineering industry. More than 40 executives and managers of leading Saudi manufacturers, including Zamil Process Equipment, Al Zamil Heavy Industries, Bilfal Heavy Industries, Bemco Steel Industries and others, took part in the tour.

They were demonstrated broad capabilities of the leading Russian manufacturer of nuclear equipment and had a chance to see heavy-duty hot press machines in operation, mechanical processing and welding of key RPV components, thermal treatment, non-destructive radiographic testing, assembly of the reactor pressure vessel and hydraulic tests. The employees of Atommash answered questions of their colleagues and gave necessary explanations. Currently, Atommash is producing equipment for nuclear power plants in Bangladesh (Rooppur), Turkey (Akkuyu), China (Tianwan) and Russia (Kursk).

"Digital technology is an integral part of our daily routine. We started looking into it quite long ago and now we are offering our customers a possibility of accepting their equipment remotely by using augmented reality. Today, we have made a successful attempt at using virtual reality to present

our technology capabilities. I am sure that this was a valuable and helpful experience both for us and for our colleagues from Saudi Arabia," Igor Kotov, CEO of AEM Technologies, said.

The virtual tour is far from being the first event for Saudi Arabia. Rosatom organizes regular seminars dedicated to advanced Russian nuclear technologies. The seminars serve as a venue for local companies to discuss cooperation with Rosatom Group, Evgeny Pakermanov, President of Rusatom Overseas, said. **"In 2018–2019, we held three such seminars in Riyadh, Dammam and Jeddah, key industrial centers of the country. In 2019, Rusatom Overseas opened an office in Riyadh to facilitate cooperation in peaceful uses of nuclear technology with government authorities and private companies in Saudi Arabia. Today, advanced communication technology helps us staying in contact with our partners despite the pandemic and restrictions associated with it."**

Rosatom pays much attention to working with Saudi industrial companies, research centers and educational institutions as Russia sees great potential in involving them in the implementation of the Kingdom's nuclear energy program.

Rosatom has been participating in the bidding process for the construction of Saudi Arabia's first nuclear power plant since October 2017. Russia has passed two stages of selection and is awaiting information about further steps.

In December 2017, Rosatom and the King Abdullah City for Atomic and Renewable Energy (K.A.CARE) signed a roadmap for cooperation in peaceful uses of nuclear energy. The roadmap provides for a series of measures to enable the implementation of a cooperation program signed on 5 October 2017 in Moscow during the history-making visit of King Salman bin Abdulaziz bin Abdulrahman Al Saud to Russia.

While Saudi Arabia is making the first steps in establishing its national nuclear infrastructure, Egypt has many years of experience in this field. The country is preparing for the construction of El Dabaa, Egypt's first nuclear power plant constructed by Rosatom. El Dabaa NPP is designed to international safety standards and will not affect the environment, Karim Al-Adham, the spokesman for the Egyptian Nuclear and Radiological Regulatory Authority (ENRRA), said in an interview to Al Bawaba news. He added that present-day nuclear power plants were extremely safe and quoted a report prepared by the World Health Organization, **"People are always exposed to natural sources of ionizing radiation, including over 60 naturally occurring radioactive substances in soil, water and air. Every day, people breath in and swallow radionuclides contained in air, food and water."**

El Dabaa nuclear power plant will use the latest technology developed by Russian experts and engineers long employed in Russia. The plant will have four reactor units.

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Its generation III+ reactors will feature active and passive safety systems, which will also exclude the possibility of human error.

The cooperation between Rosatom and Egypt goes beyond nuclear construction and includes a number of educational initiatives. In November, Rosatom organized the Global Atomic Quiz held online in 11 languages and dedicated to the 2020 World Science Day. More than 12,000 contestants from over 70 countries took part in the quiz. They had to answer 25 questions ranging in complexity and topics. Regardless of the results, each contestant was awarded a certificate and provided a link to a video in which experts analyzed and explained answers to the questions in detail.

Contestants from Egypt took active part in the global quiz. Asmaa Hanafi, an energy and environment researcher from Alexandria University, represented Egypt as an expert. She said how proud she was for being part of the initiative and stressed that her personal goal was to inform the younger

generation of the importance and benefits of nuclear engineering. According to her, nuclear engineering serves to improve peaceful nuclear technologies used in nuclear reactors and nuclear power plants and she works to eliminate misconceptions about nuclear and show that nuclear power plants are environmentally friendly and produce sustainable energy.

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Nation's Pride

Construction of the country's first nuclear power plant is the largest project for Bangladesh. On-site operations are fully on schedule, while Russian nuclear companies manufacture and ship equipment on time.

The coronavirus pandemic has not affected the construction of Bangladesh's first nuclear power plant, said Shawkat Akbar, Director of the Rooppur Project on the Bangladeshi side. Thousands of engineers and workers are involved in the construction. According to the project schedule, the first 1,200 MW reactor unit will be brought online in 2023. According to Shawkat Akbar, the prime minister and relevant authorities also supervise the construction of Green City, a residential development for employees of the nuclear power plant.

Close and efficient cooperation between Russia and Bangladesh makes it possible to follow the construction schedule strictly. Russian nuclear companies manufacture and ship equipment for Rooppur NPP right on time.

In early December, the Volgodonsk-based production facility of AEM Technologies (part of Rosatom's mechanical engineering division Atomenergomash) shipped steam headers for the first reactor unit of the nuclear power plant. The steam header is a major component of the steam generator. It is more than 11 meters long and weighs over 7 tons. The steam headers were sent by road to the port of Saint Petersburg where

they will be transshipped onto the barge to be delivered to the construction site. The sea route to the port of destination is about 14,000 km long.

In late November, the same production facility finished manufacturing reactor internals for the first unit of Rooppur NPP. These include an 11-meter core barrel, a core baffle and a protective tube unit, all together weighing more than 179 tons. Before being shipped to the customer, the reactor internals were assembled in a standard reactor pressure vessel to test how they fit with other components. In the future, this will reduce the time needed to assemble them at the nuclear plant.

The production facility of AEM Technologies will manufacture two reactors, including reactor internals, RPV heads and eight steam generators, for the Rooppur NPP.

OKB Gidropress, another subsidiary of Atomenergomash, has shipped a set of incremental electromagnetic drives for the I&C system of Rooppur Unit 1. The shipment was preceded by visual inspection and acceptance tests on hot functional testing stands. The products were inspected by representatives of relevant organizations - Zarubezhatomenergostroy (ZAES) and Foreign trade organization Bezopasnost representing the Bangladesh Atomic Energy Regulatory Authority (BAERA).

The Petrozavodsk-based production facility of AEM Technologies completed hydraulic tests on the casings of primary coolant pumps. The tests serve to ensure that the products are strong and tight. Primary coolant pump casings are Class 1 safety products. The pumps circulate coolant between the reactor and steam generators.

Along with building the new power plant, Bangladesh is working hard to create a nuclear infrastructure in the country. This includes, among other things, training of human resources, educational programs, and raising public awareness of nuclear energy.

On November 30, the third anniversary of the first concrete pouring for Rooppur NPP, a Public Information Center (PIC) on Nuclear opened in Ishwardi.

Bangladesh Atomic Energy Commission (BAEC) member Abdus Salam was present to cut the ceremonial ribbon to mark the beginning of the operation of this information center. A number of officials from BAEC were present at the ceremony along with ANO Energy of the Future and Atomstroyexport (ASE) officials. The honorable mayor of Ishwardi municipality, Abul Kalam Azad Mintu, was present with many of municipality counselors.

Abdus Salam was very enthusiastic about the inauguration of the PIC. He said, **“The people of Rooppur has always been very helpful to the cause of Rooppur NPP.”**

Abul Kalam Azad Mintu said that he was born in the very neighborhood that the Rooppur

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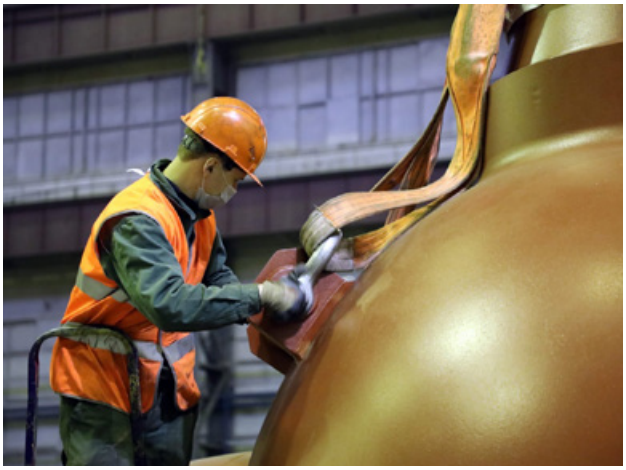

nuclear power plant is growing upon, so the power plant has a warm place in his heart.

The Public Information Center will help to remove information barriers and provide the Greater Pabna residents with an opportunity to get answers to their questions on the use of nuclear energy, operation of the Rooppur NPP, radiation safety, social initiatives and activities such as job opportunities offered by the nuclear plant, and other issues.

The Public Information Center on Nuclear will start its offline activities when this becomes possible and the existing restrictions are lifted. Now, according to the Project Manager Sakif Ahmed, the center plans to continue its activities through online media such as Facebook, YouTube, Zoom, etc.

In addition to nuclear awareness initiatives, the government of Bangladesh is developing and enacting government programs and regulations that are needed to create the national nuclear infrastructure.

In mid-November, the online meeting of the Bangladesh Cabinet of Ministers chaired by Sheikh Hasina Wazed approved the National Nuclear or Radiological Emergency Response Plan. It is designed to set up safety measures for the Rooppur NPP, said Cabinet Secretary Khandker Anwarul Islam at a media briefing organized in the headquarters of the Bangladesh government.

"The IAEA requires us to have guiding principles on protection and safety and response plans in case of emergencies at such power plants, otherwise we will not be allowed to put them into operation. The National Nuclear or Radiological Emergency Response Plan was prepared on the basis of the emergency response and other similar plans already adopted in Bangladesh," Khandker Anwarul Islam said.

Availability of such documents is necessary to meet international standards. However, experts stress that nuclear is a safe, reliable and environmentally friendly source of energy. The Rooppur nuclear power plant will have Generation III+ VVER-1200 reactors. Featuring improved technology and cost efficiency, these innovative reactor units guarantee safe operation and fully meet IAEA safety standards. VVER-1200 is the most powerful Russian-designed reactor boasting three main advantages — high performance, long service life and safety. What makes VVER-1200 reactors different is their unique combination of active and passive safety features ensuring maximum resistance to external and internal impacts, including tornadoes, hurricanes, earthquakes and plane crashes.

It is hard to overemphasize the role of the Rooppur NPP and subsequent nuclear energy projects for the country's economic development for the decades to come. This is the reason why the government of Bangladesh believes it to be a top priority project.

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