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Atoms for Africa

Rosatom's Director General Alexey Likhachev signed a number of agreements at the Russia-Africa Summit to expand the presence of the Russian nuclear corporation across the continent. These agreements give African countries access to nuclear technologies, an opportunity for the youth to get top-quality education and improve well-being of the people.

The agreements show that the continent is an important market where Rosatom works persistently to deliver its projects. Rosatom's network of partnerships cover 16 countries, or almost a third of the states on the African continent. The total number of African countries in the focus of Rosatom's attention reaches 20.

Fighting hunger and diseases with nuclear

The signing of an agreement with Rwanda to construct a nuclear science and technology center (NSTC) was the central event of the summit for Rosatom. The agreement provides for the center to be built around a multipurpose 10 MW pressurized water reactor. The NSTC will feature laboratories and equipment to conduct scientific research, including in radiation biology. It can be used to fabricate radioactive isotopes for diagnosis and treatment of cancer diseases.

The NSTC could also be fitted out with irradiation equipment to treat grain, vegetables and other products. Irradiation kills pathogens and extends shelf life of the product without affecting its properties. Thus, irradiation treatment facilitates export development and domestic consumption.

According to the World Bank, 53% of Rwanda population lives on less than USD 2 per day. Rosatom is developing a similar NSTC project in Zambia.

Forward thinking

Alexey Likhachev also signed an agreement on cooperation between Russia and Ethiopia in the peaceful uses of nuclear energy. On the Ethiopian part, the document was signed by Getahun Mekuria Kuma, Minister of Innovation and Technology of Ethiopia. The agreement sets a legal framework for the two countries to hold a constructive dialogue in the nuclear power sector. It also lays a foundation for the parties to start implementing specific projects.

Supporting development

Speaking at the Contribution of Nuclear Technologies to the Development of Africa plenary session, Likhachev stressed that nuclear helps solving social problems faced by African countries. Availability and reliability of power supply is a prerequisite of sustainable development. The problem is a pressing issue for Africa: less than a half of the population in 24 countries have access to electricity.

According to Alexey Likhachev, nuclear energy is a driver of the national economy as every dollar invested in the infrastructure brings two dollars in contracts with local companies. These are not just words: in Egypt, cooperation with local suppliers and service providers is up and running. In early October, Cairo hosted the second forum for nuclear industry suppliers. The event was attended by around 600 representatives of Egyptian and international companies specializing in construction, mechanical engineering and equipment supplies. Our readers know that Rosatom is going to build Egypt's first nuclear power plant near the town of El Dabaa in the Matrouh Governorate. The plant will have four Generation III+ VVER-type reactors with the power capacity of 1.2 GW each (VVER stands for the Russian water-water power reactor).

"We can make a quantum leap in Africa in terms of nuclear technology development and application within the next few years," Rosatom's Director General said. These words were heard by representatives of Africa's national governments making their first steps in the field of nuclear, including Roland Msiska, Head of the Zambia Atomic Agency, Claver Gatete, Minister of Infrastructure of Rwanda, and Getahun Mekuria Kuma, Minister of Innovation and Technology of Ethiopia.

Educating people

Development nuclear technology is not possible without qualified personnel, which Africa is short of. This fact was stressed by Evgeny Pakermanov, President of Rusatom Overseas. The problem is solvable, though, he said speaking at the summit, **"We are ready to provide comprehensive support to our African partners, look jointly for**

solutions, and contribute to the step-by-step development of national nuclear power programs," he assured.

One of the ways to overcome the shortage of top-quality education was proposed by Rosatom right at the summit. The Russian state nuclear corporation signed a cooperation agreement with the Peoples' Friendship University of Russia (PFUR). Rosatom is interested in making nuclear majors in Russian universities popular among African students. **"Cooperation between Rosatom and the Peoples' Friendship University of Russia promotes academic partnerships with African universities and raises interest in nuclear-related university majors and Russian technologies in Africa,"** Vladimir Filippov, PFUR rector said.

Australian Nickel Production to Benefit from Russian Uranium Technology

Australian Clean TeQ has accepted engineering design documents for a nickel, cobalt and scandium adsorption department of its Sunrise Project from VNIPI (a Rosatom Group company). The first contract with the reputable customer may pave the way for more orders from international companies.

VNIPI is an engineering subsidiary of ARMZ Uranium Holding, Rosatom's mining

division. The company provides design and engineering services for Clean TeQ's nickel, cobalt and scandium leaching process at the Sunrise processing plant.

It was Clean TeQ's initiative to contact VNIPI. Russian engineers working in the Australian company were well aware of VNIPI's capabilities. They knew that VNIPI has long been providing design services for mining projects across former Soviet Union. Some of the projects involved the resin-in-pulp process that was of particular interest for the Australian company.

Resin in pulp

The ion exchange technology, which the resin-in-pulp process belongs to, has long been used for the extraction of uranium and precious metals (mostly gold) in former Soviet republics, primarily in Russia and Kazakhstan.

The essence of the resin-in-pulp technology is for the pulp and resin being fed into a series of reactors in a counter current manner. The pulp reacts chemically with the metal and absorbs it. Two processes – leaching and sorption – run in parallel, thus improving

the recovery rate. After that, the barren pulp ("tailings") goes to the waste dam, and the loaded resin goes to desorption. The metal is recovered, and the desorbed resin returns into the sorption circuit.

There is a specific resin grade and a set of reactors for each metal. Each set of reactors extracts one metal only. A similar project with two sets of reactors – for uranium and molybdenum respectively – is developed at VNIPI for another subsidiary of Rosatom's ARMZ Uranium Holding.

A distinctive feature of the Russian technology is that resin interacts directly with pulp. In other mining countries including Australia, pulp is first divided into liquids and solids, so that the sorption process uses pure solutions only. This technology is more expensive as it employs filtration and clarification equipment, which is costly and needs extra space at the processing plant. Additional expenses for electric power and repairs are also unavoidable.

Nickel is almost never recovered using the ion exchange technology. Examples are few. In 2002, a patent to use the resin-in-pulp process for cobalt and nickel extraction was obtained by BHP, the largest Anglo-Australian mining company. Another example is

Anglovaal Mining from South Africa (now part of African Rainbow Minerals) that is piloting the resin-in-pulp technology to extract nickel, cobalt and copper. The technology for Anglovaal Mining was developed by local research company Mintek.

Experts are able to understand each other

The first step was to study the technology in detail. Australian engineers analyzed chemical and physical parameters of the process and specifications of the equipment. They wanted to calculate the exact parameters, such as the amount of feedstock supplied and concentrates obtained, recovery rate, process losses, operating parameters of the equipment, consumables and, finally, economics of the entire process, including production costs and labor productivity. Calculations were made separately for each metal.

Those difficulties arose because Russian and Australian engineers were using different data processing software programs. VNIPI experts managed to convince their Australian colleagues that their calculations were accurate. **"Experts will always understand each other because it is a matter of mathematics,"** Roman Kovalyov from VNIPI explained.

At present, engineers are discussing the shape of reactors for the resin-in-pulp process. Clean TeQ plans to install U-shaped columns, while Russian engineers propose using ordinary Pachuca tanks since they make the process more cost-efficient. The Pachuca tank is a barrel-like vessel with a cone-shaped bottom. It was named after an engineer who developed it.

Russian engineers were surprised by the meticulousness on the customer's part. **"When they come to Russia, we spend no less than a week discussing all the details. They are interested in equipment specifications, components, workmanship, column types, and so on. We have discussed mesh sizes and composition of the solutions,"** Alexey Shemetov, CEO of VNIPI, says.

Last September, VNIPI submitted the first package of design documents for the leaching section of the plant. The customer accepted the documents and signed a contract for the next phase, which involves conducting a pre-feasibility study. This phase is planned to be completed by the end of 2020.

Sunrise in numbers

Plant capacity	2.5 million tons of ore per annum
Expected mine life	25 years
Project CAPEX	USD 1.49 billion
Average production cost, incl. income from by-products	USD 1.46 per pound (key product is nickel)
Average production cost, excl. income from by-products	USD 4.68 per pound (key product is nickel)
Nickel sulfate output	89,270 tons per annum
Cobalt sulfate output	21,260 tons per annum
Scandium output	250 tons over 25 years
Average recovery rate (nickel)	92.6%
Average recovery rate (cobalt)	91.2%

According to the definitive feasibility study of the Sunrise Project (as of 25 June 2018), the plant is expected to process 2.5 million tons of ore per annum for 25 years. The expected annual output of nickel sulfate will be 89,270 tons. The output of cobalt sulfate will be 21,260 tons per annum.

Clean TeQ is VNIPI's first – and hopefully not the last – customer outside of the former Soviet Union. VNIPI plans to sign more contracts with external customers that do not belong to Rosatom Group. According to Alexey Shemetov, their share will grow to 70% of the order portfolio.

Clean TeQ, which is listed on the Australian Securities Exchange, is a reputable customer. Its shareholders include Robert Friedland, one of the most successful mining industry investors, and Chinese Pengxin International Group Limited (USD 1.3bn market cap). Success of the project will be the best recommendation of VNIPI for international customers and raise interest in the services of the Russian engineering company. NL

Sorting Out Priorities

Rosatom's international public forum AtomEco-2019 wrapped up in Hungary. It proved once again that nuclear energy was the key to solving modern global problems.

More than 300 top-rank officials, executives, environmentalists and scientists, who discussed safe uses of nuclear energy, innovative technologies, prospects of their

application, and present-day standards of public acceptance, attended the forum.

At the session on new technologies, speakers told the audience about the latest developments in the nuclear power industry of Russia and Hungary. For instance, Rosatom continues developing new fuel for nuclear reactors, improving VVER reactor technology and developing fast reactors (Russia is now the only country operating commercial fast neutron reactors – RN). Work is continuing on the Breakthrough Project that aims at 'closing' the nuclear fuel cycle, i.e. making nuclear fuel fully recyclable. The floating nuclear power plant (FNPP) intended to supply power to Russia's northernmost city of Pevek was another point of interest.

Another lively session was devoted to nuclear decommissioning and safe management of nuclear waste and spent nuclear fuel. These matters are very important for Rosatom: by 2040, there will be 25 shutdown nuclear reactors in Russia. As many as 21 more will be in the process of decommissioning. **"The basic strategy we have defined provides for immediate dismantling of all reactors. This approach reduces total costs and removes the burden of responsibility from future**

generations. Robotic automation also makes a great contribution to the overall cost reduction," Natalia Safonova from the Decommissioning Management Division of Rosenergoatom (Rosatom's subsidiary) explained. She added that the costs of a pilot segmenting project at the Novovoronezh Nuclear Power Plant were reduced 2.5-fold, while the radiation dose absorbed by the staff decreased more than 10-fold.

Since Paks NPP Unit 1 is envisaged to be shut down in 2032–2037, Hungary is already considering a decommissioning strategy. According to the Hungarian officials, dismantling will begin after the so-called protection period is over. Postponed dismantling is seen as the primary option, but immediate dismantling is also being considered.

Participants of the session were united in the opinion that spent nuclear fuel is a valuable product that can be reprocessed and used in the nuclear and other industries. **"Spent nuclear fuel is a real treasure as its two thirds are elements that are in demand from high-tech industries,"** Albert Vasiliev, Chief Researcher at Dollezhal Research and

Development Institute of Power Engineering (Rosatom's subsidiary) and Director of the International Environmental Safety Center said.

The session devoted to public acceptance of nuclear power brought together those, who wanted to discuss stakeholder communication technologies and information disclosure requirements forming a new environmental transparency standard that will become obligatory for every nuclear organization. Today, the primary goal of a communications policy is to create a single information space enabling everyone to obtain accurate information about activities of nuclear companies and organizations. **"The principles of reliability, accuracy, transparency and accessibility of information have largely improved public confidence in nuclear power,"** the Memorandum summarizing the discussions held at the Forum read.

Public acceptance, maximum safety and ongoing development of nuclear technology are the three pillars of the nuclear power industry. This was repeatedly stressed by both Russian and Hungarian speakers. These principles let nuclear energy play a key role in meeting the greatest challenges of today, such as environmental pollution, global climate change and depletion of natural resources.

"The annual average emissions of carbon dioxide in our country is 6.6 tons per capita, which is below the EU requirement of 8 tons per person. It is the nuclear power plant that helps us achieving environmental goals. Nuclear energy has a positive effect on the nation's competitiveness and well being," Andrea Beatrix Kadar, Deputy State Secretary for Energy Affairs at the Ministry of National Development of Hungary, said in her speech.

Both Hungarian and Russian top-rank officials were repeatedly praising many years

Many years of partnership

Hungary's only nuclear power plant Paks produces nearly 40% of electricity consumed in the country. It is Russian-designed and was built in the late 1980s. Nuclear fuel for the Paks NPP is supplied by TVEL (a Rosatom Group company). According to the current contract, TVEL will be shipping fuel for all the four reactors of Paks NPP until the end of their service life.

Last year, Paks nuclear power plant won the Quality Innovation Award, which is held under the auspices of the European organization for quality (EOQ), in the Business Innovations (Large Companies) category with its project of extending the fuel cycle from 12 to 15 months.

In order to switch four VVER-440 reactors to a 15-month fuel cycle, Paks hired TVEL to upgrade nuclear fuel, have it licensed and improve the fuel cycle. The extended nuclear fuel cycle increased utilization of the plant's power capacity while meeting all safety requirements.

In November 2017, TVEL and MVM Paks NPP Ltd. signed a contract to develop and introduce a modified version of Generation II fuel assemblies with a higher uranium density and an optimized water uranium ratio. The use of the modified assemblies will make Paks more cost efficient even if the fuel cycle remains unchanged.

In late 2014, Russia and Hungary signed a package of agreements to build new reactor units Paks 5 and Paks 6 with VVER-1200 reactors. New build will double electricity production.

of fruitful cooperation in the field of nuclear energy between the two countries.

Before the Forum, Rosatom's Director General Alexey Likhachev had a meeting with János Süli, a minister without portfolio responsible for the Paks II project. According to Alexey Likhachev, field-proven innovative solutions used at Novovoronezh II and appreciated by the international experts will also be used at Paks II. For the time being, Rosatom has obtained 400 licenses from Hungarian regulatory authorities, including an environmental license and a site license. Likhachev said that the Russian state nuclear corporation plans to provide Hungary with a set of documents to be submitted for a license already in the summer of 2020. **"With this in mind, we expect the license to be obtained in the second half of 2021,"** Alexey Likhachev stressed.

"We employ international experts to make new Paks II units the most advanced and reliable in the world. All engineers and consultants involved confirm that the units meet all the requirements of Hungary and the European Union," János Süli said. NL

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Rosatom: Bringing Better Education To Africa

Africa is the most promising market for utility companies. While population on the continent is growing rapidly, less than 50% of households in about a half of the African countries have access to electricity. Poverty and poor education are paradoxical situation: no effective demand means no electricity and no development. Rosatom tries to solve the conundrum by unlocking the potential of African youth and improving the quality of life in local communities.

According to World Energy Outlook 2019 published by the International Energy Agency (IEA) in mid-November, Africa's urban population will grow by over 500 million people by 2040. These figures are even more impressive than the growth of urban population in China in 1990–2010. The IEA estimates that nearly 20 million people will need air conditioners and other cooling systems because of hot weather by 2040.

Despite a dramatic increase in power output from 193 GW in 2016 to 229 GW in 2018, electric energy remains in shortage in Africa. According to the Energy, Electricity and Nuclear Power Estimates for the Period up to 2050 prepared by the International Atomic Energy Agency (IAEA), the total output of electric power in 2018 reached 820 TWh. For comparison, Eastern Europe alone generates twice as much power as Africa (1,634 TWh). In 2018, electricity accounted for only 10% of total energy consumption. By contrast, biomass, including charcoal, made 52%.

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Demand for electric power in Africa will grow. **"Electricity consumption is expected to grow at a faster rate — about 4.5% per year during the entire period. It is expected to increase from 2.4 EJ in 2018 to 4.0 EJ and 9.8 EJ by 2030 and 2050, respectively,"** the forecast reads.

Demand, however, does not necessarily mean the ability to pay. According to the World Bank's data for 2018, the largest African countries in terms of GDP are Nigeria (USD 469.4 bn), South Africa (USD 429.9 bn) and Egypt (USD 286.1 bn). However, many countries on the continent are very poor. According to the World Bank, over 30% of population in 26 African countries lives on less than USD 2 per day.

There is a need for resources in order to create effective demand for electric power. Broadly speaking, such primary resources are only two. The first one is our planet that has land to grow crops and minerals to mine. The other one is humanity, its knowledge and skills.

One of the problems is that the global market brings losses rather than income to African countries. In general, the continent is a net importer. According to the International Trade Center (ITC), exports from 54 African countries made USD 497.2 billion in 2018, while imports reached USD 573.4 billion.

The second problem is the sorry state of education in Africa. According to a report published on Worldpopulationreview.com (this website publishes statistics about global population) on November 7, 2019, sub-Saharan Africa is one of the least literate regions in the world. Niger is a country with the lowest literacy rate with less than 19% of adults able to read and write. **"Sudan is another nation with a very low literacy rate of just 26.8%... Guinea also has a low literacy rate of just 30.4%,"** the study reads. Among ten least literate countries in the world are nine African countries: Burkina-Faso (36%), Central African Republic (36.8%), Benin (38.4%), Mali (38.7%), Chad (40.2%), Côte d'Ivoire (43.1%), Liberia (47.6%), Sierra Leone (48.1%) and Ethiopia (49.1%).

Although Rosatom's nuclear projects in Africa are yet in the preparatory phase, the Russian state nuclear corporation is already helping Africa solve at least one of its most pressing problems - access to quality education.

Atom 101

Rosatom invests money and efforts in educating people in its countries of presence. Education is, of course, nuclear-related. One of Rosatom's major goals is to dispel myths surrounding the field and explain the advantages of nuclear power generation. Such public awareness campaigns have been launched in Ghana, Zambia, Kenya, Nigeria, Rwanda, South Africa and North African countries. The campaigns include production

and distribution of printed and audiovisual materials about nuclear technology, tours to Russian nuclear facilities for students, journalists and experts, lectures and presentations at conferences, information stands, films and consultations for local authorities.

For example, a fishing tournament was organized in the Gulf of Finland near Russia's largest Leningrad Nuclear Power Plant to dispel a myth that nuclear power plants affect sea life. It was a purely sporting event with the catch returned back into water. A team from Egypt won the tournament. **"We were fishing near Leningrad NPP and there were a lot of fish there. This made it clear that NPPs do not affect ecology,"** Ghanem Hamed, one of the tournament winners, noted.

Focusing on knowledge for the future

Would-be students from Africa are one of Rosatom's target audiences on the continent. The logic is clear. When they come to Russia, they meet Russian people, make friends, gain knowledge and study Russian. If necessary, this background will enable them one day to be employed at a nuclear facility, act as consultants or even disseminate knowledge themselves.

For five years, Rosatom has been offering state-sponsored scholarships to those African students who want to major in nuclear technology and engineering in leading Russian universities. They annually allocate quotas to African students at Rosatom's request. Russian universities train students from Algeria, Ghana, Egypt, Zambia, Kenya, Nigeria, Tanzania, Uganda, Ethiopia and South Africa.

Rosatom is stepping up the pace of cooperation. At the Russia-Africa Summit held in November, the Russian nuclear corporation signed a cooperation agreement with the Peoples' Friendship University of Russia.

Students begin getting acquainted with Russian universities in schools where Rosatom presents its opportunities.

Rosatom also cooperates with local universities. It organizes awareness building lectures and career days in seven universities of Ghana, Zambia, Kenya and South Africa.

Investing in children

There is also a specific set of programs for schoolchildren. For example, Rosatom's representative office in South Africa funded a school in a poor neighborhood in South Africa and purchased study materials for it for three years (2015–2017). It also equipped a computer lab and classrooms for chemistry and physics lessons. **"Our employees repaired the school with their own hands. You just cannot forget such a help,"** representatives of from Rosatom

International Network's press service shared their impressions.

The same approach is used by Rosatom Group's Uranium One operating the Mkuju River mine in Tanzania. Its local subsidiary Mantra Tanzania sponsors a local hospital and has organized a library (including a digital one) for several schools in the Namtumbo District.

Supporting schoolchildren, especially those from poor communities, is very important because they get in the social lifts early in life. If children receive good school education, they have more chances, even if born in a poor family, to continue education, find a well-paid job and give quality education to children of their own.

Meet Russia

Even leisure and entertainment events organized by Rosatom place an emphasis on the need to acquire new knowledge. For instance, Rosatom has been holding an online video contest for school and university students for five years. The prize is an opportunity to visit a nuclear power plant or university offering nuclear-related majors. Last year, contest winner Veronica Gouws, who has a bachelor's degree in nuclear physics, visited the Tomsk Polytechnic University (TPU) and Tomsk Radiology Center. Veronica was so impressed with what she saw that she decided to take a postgraduate program at TPU and is currently majoring in nuclear medicine.

Another regular event is the International Smart Holidays. This is the simplest way for kids to learn more about Russia by being engaged in activities related to Russian traditions. They paint matryoshkas, cook pelmeni and play snowballs. This year's International Smart Holidays welcomed 20 children from Egypt and 11 more from Zambia.

Educating adults

Finally, to the main point. Rosatom trains professionals for its nuclear projects in the power generation and other industries. The latest example is Egypt. Rosatom plans to train around 2,000 people. Training programs will focus on two fields, operation and maintenance. Training courses for the operating staff will begin in 2020. Maintenance personnel will be trained starting from 2024. In addition, Rosatom holds seminars for potential suppliers. This is where Egyptian companies can learn more about the specifics of Rosatom's tendering procedures.

As our readers might remember, the EL Dabaa Nuclear Power Plant in Egypt will have four Generation III+ VVER-1200 reactors.

Social and business projects delivered by Rosatom improve the quality of life in African

communities. For example, Egypt's El Dabaa will, along with dozens of years of reliable power supply, produce clean drinking water. For Egypt where life concentrates in the Nile delta and along the Red Sea shore, El Dabaa offers new opportunities for urban planning and agriculture development. Nuclear science and technology centers, in their turn, offer opportunities for food protection and hunger reduction, development of medical technology, and scientific research resulting in new knowledge. NL

Cooperation between Rosatom and African countries: current status

1. Algeria: 2017 – a memorandum of cooperation in staff training
2. Egypt: 2019 – onshore engineering surveys completed at El Dabaa, additional site surveys underway, documents submitted for offshore survey permit, construction license under consideration by the regulator
3. Tunisia: 2016 – an intergovernmental agreement
4. Morocco: 2017 – a memorandum of understanding and cooperation in peaceful uses of nuclear power
5. Sudan: 2017 – an agreement to develop a nuclear power plant project in Sudan 2018 – agreement to develop a floating nuclear power plant project in Sudan; staff training memorandum
6. Zambia: 2018 – a framework agreement for the construction of a nuclear science and technology center
7. Ghana: 2015 – an intergovernmental agreement on peaceful uses of nuclear power
8. Kenya: 2016 – a memorandum of understanding and cooperation in peaceful uses of nuclear power
9. Republic of the Congo: 2019 – a roadmap for Russian-Congolese cooperation in peaceful uses of nuclear power; an intergovernmental agreement on cooperation in peaceful uses of nuclear power
10. Nigeria: 2017 – an agreement to develop nuclear power plant and multi-purpose research reactor construction and operation projects in Nigeria
11. Rwanda: 2019 – an agreement for construction of a nuclear science and technology center in Rwanda
12. Uganda: 2019 – an intergovernmental agreement on cooperation in peaceful uses of nuclear power
13. Ethiopia: 2019 – a roadmap for cooperation in developing nuclear power plant and nuclear science and technology center construction projects; an intergovernmental agreement
14. South Africa: 2018 – a cooperation agreement on the use of nuclear non-power technologies
15. Namibia: uranium mining projects
16. Tanzania: uranium mining projects

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