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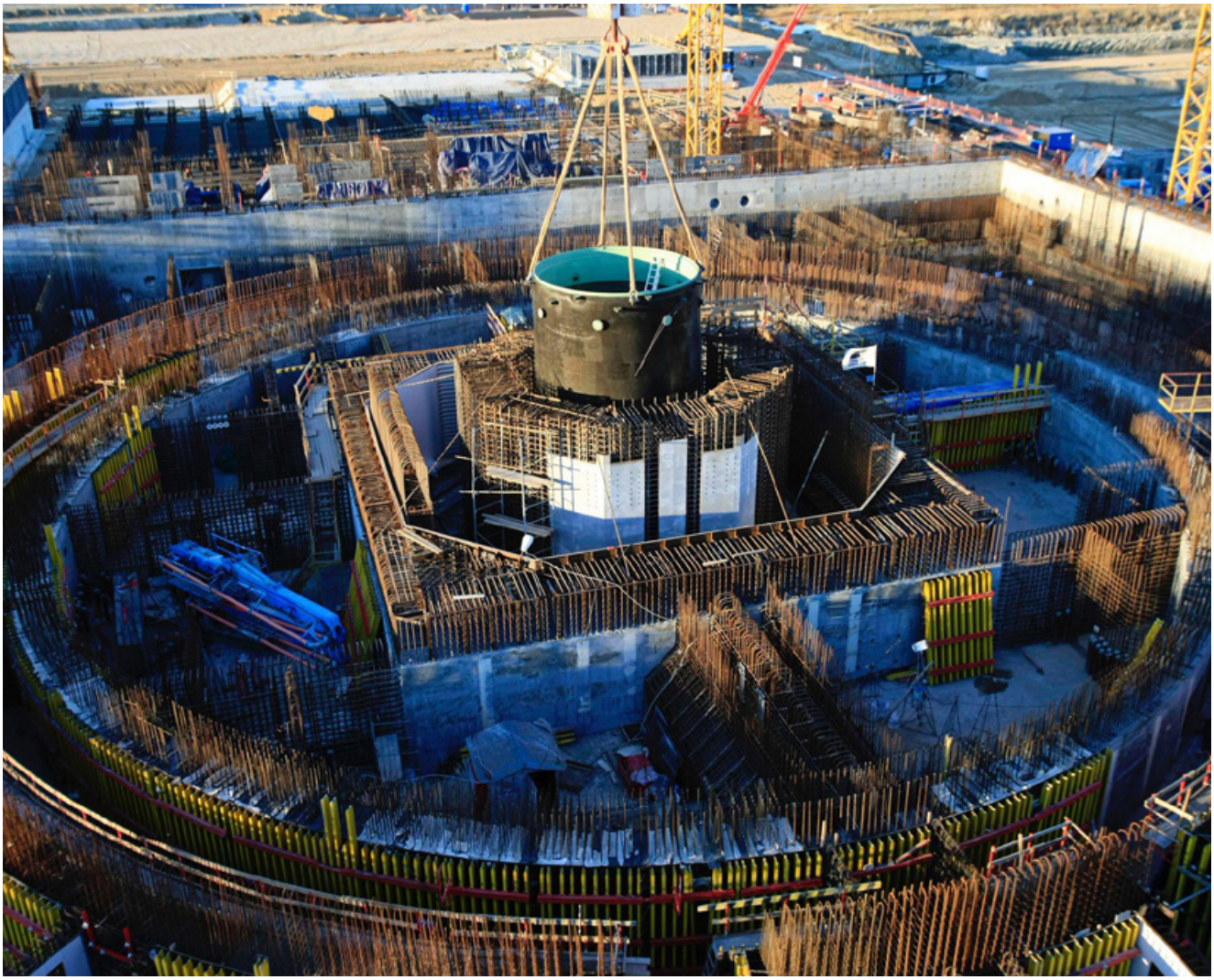

Core Catcher in Place

Molten core catcher installation began at Kursk-II Unit 1 three weeks ahead of schedule. The plan is to complete the job by the end of the year.

On November 13, the 168-tonne core catcher body was installed in its permanent position under the reactor pit of Kursk-II Unit 1. This is the first heavyweight component installed there. The entire catcher weighs more than 800 tonnes and, apart from the body, includes

For reference:

The high reliability of Generation III+ nuclear power plants with VVER-1200 reactors is attributable to a unique combination of passive and active safety systems. Unlike active safety systems that need a source of power, passive safety devices operate on natural forces, such as gravitation or convection, require no human intervention and exclude the possibility of error in accident management. Apart from core catchers, passive safety systems include containment pre-stressing, passive heat removal, double containment, etc.

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assemblies filled with nonmetallic sacrificial materials, a service deck, a cantilever girder and a lower plate. The project's general designer and contractor is ASE, Rosatom's engineering division.

The core catcher is a unique passive safety barrier developed by Russian nuclear engineers. The catcher can hold corium (lava-like fuel-containing mass) for an unlimited period of time, preventing the release of nuclear materials in the unlikely case of a beyond-design basis accident resulting in a nuclear meltdown. **"The catcher can sustain earthquakes, floods and external mechanical impacts,"** says Alexey Deriy, ASE Director for the Kursk II project.

The molten core catcher for Kursk-II was produced by Energotex (a Russian mechanical engineering company) and delivered to the site in two days instead of a week. A 110-ton lower guide plate and a 209-ton 9.5-meter cantilever support arrived at the site on October 15; the catcher body was delivered the following day.

Two innovative power units with VVER-TOI reactors are under construction at Kursk-II. The 1,255 MW units are planned to go online simultaneously with the decommissioning of the now operational Units 1 and 2 with RBMK-1000 reactors. At present, Kursk NPP is a Top-4 nuclear plant in Russia in terms of capacity. It supplies power to 19 regions of Russia's Central Federal District.

The world's first ever core catcher was installed at the Russian-designed Tianwan NPP in China. Similar catchers are also installed at Kudankulam, Leningrad-II, Novovoronezh-II and Belarus NPP and will be used at Akkuyu, Rooppur and other nuclear plants built by Rosatom. NL

On the Northern Sea Route

Two RITM-200 reactors were loaded onboard the nuclear icebreaker Ural.

The employees of the Baltic Shipyard and Spetstyazhavtotrans, a Russian carrier of oversized cargo, performed the loading of the reactors onto the second Project 22220 nuclear icebreaker Ural. It was the first time slipways were used to load reactors onto a ship. Before that, both loading and installation were performed afloat at the fitting-out quay with the help of a crane vessel.

Prior to the loading, Baltic Shipyard engineers designed special fixtures and accessories to synchronize the loading process and maintain the required slope angle to within a distance below 1 mm. A modular gantry crane was used to lift and lower heavyweight and oversized equipment. This approach allows for easier, faster and more cost-efficient loading, installation and fitting out.

RITM-200 is an innovative reactor developed by OKBM Afrikantov (Rosatom's mechanical engineering division subsidiary) specifically for icebreakers. The Ural icebreaker will be equipped with two reactors of this type, each with the capacity of 175 MW. RITM-200 is

unparalleled for its compact size and cost effectiveness. Its energy-efficient integrated design allows for core equipment to be placed inside the steam generator shell.

The same reactors are installed on Arktika and Sibir (Siberia), both of them already afloat. Together with the Ural, the three icebreakers will replace Soviet-era nuclear powered vessels Yamal, Taymyr and Vaygach.

Arktika, Sibir and Ural icebreakers will become the world's largest and most powerful nuclear icebreakers. When they are put into operation, Atomflot (Russia's nuclear icebreaker fleet owner and operator) will be able to arrange for year-round navigation along the entire Northern Sea Route. Thanks to unparalleled technical specifications, the icebreakers will be capable of breaking three-meter-thick ice and able to operate in the Arctic Ocean and estuaries of Siberian rivers.

Not long ago, Atomflot's acting Director General Mustafa Kashka announced at the 7th Murmansk International Business Week that the decision to build the fourth and fifth nuclear icebreakers would be made before the end of the year.

Ready for the Journey

One of the two reactors on board the world's first floating nuclear power unit Akademik Lomonosov entered first criticality procedures.

The KLT-40S reactor on the starboard side of Akademik Lomonosov floating nuclear power unit (FNPU) went live in early November, sustaining a controlled reaction for the first time. After the necessary setup, it was brought to minimum controlled power level. The next step is to start up the vessel's second reactor. Then the two nuclear reactors will undergo harbor acceptance tests to be followed by the power ascension process. All work on the FNPU is planned to be completed by March 2019.

Akademic Lomonosov is currently the only FNPP of its kind. **"All that we do on the FNPU is done for the first time, so we do it with great care and attention. We have extended the setup phase and will perform multiple checks on every operation. Test results will be verified by experts of the Baltic Shipyard's QA department, representatives of Rosenergoatom (on the customer's part), employees of OKBM Afrikantov (FNPU designer), and representatives of Kurchatov Institute,"** said Vitaly Trutnev, Rosenergoatom's Director for floating nuclear power plants (FNPPs). The FNPU features five protection levels, isolating nuclear reactors from the environment. The vessel has a double hull capable of withstanding a direct collision with ships and icebergs, as well as extreme weather impacts, such as tsunami.

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Akademik Lomonosov is the first-ever towable small-scale nuclear power unit designed to operate as part of an FNPP. The vessel is now anchored off Atomflot's (Russian nuclear ice-breaker fleet owner and operator) base in Murmansk. After all tests are carried out, the FNPU will be towed to Pevek (Chukotka Peninsula). Hydraulic structures for the FNPP will be completed in July; construction of on-shore facilities will be finished in August. Since Pevek must be ready to harbor the FNPU by that moment, Akademic Lomonosov's transportation from Murmansk is scheduled for the fall of 2019.

Akademik Lomonosov is designed to replace the retiring capacity of the Bilibino nuclear power plant and the Chaunskaya coal power plant. Two KLT-40S reactors are capable of generating up to 70 MW of electricity and 50 Gcal/h of heat in nominal operating conditions. That is enough to provide heat and light to a city with the population of up to 100,000 residents. Akademik Lomonosov will supply heat and power to several remote areas in Russia's Far North and Far East, including remote industrial facilities and the port of Pevek, which is strategically important for the development of the Northern Sea Route.

Southeast Asia and Middle East have already displayed interest in the project. FNPPs can be high in demand in island countries since they can also function as desalination plants.

At present, Rosatom is working to create the second generation of floating nuclear power plants (optimized FNPU, or OFPU) that will be smaller than the current version. **"The OFPU will be equipped with two RITM-200 reactors, each with a capacity of 50 MW. The new design will not provide for a spent nuclear fuel storage compartment and thus consume a quarter less of steel. RITM-200 reactors will be refueled at intervals of 10 to 12 years. The decision to build the new FNPU will be based on the results of the current FNPP project,"** Vitaly Trutnev said.

Conductors for the Future

Chepetsk Mechanical Plant, a subsidiary of Rosatom's TVEL Fuel Company, will manufacture four prototypes of superconducting strands for the Future Circular Collider.

The Chepetsk Mechanical Plant (CMP) is set to manufacture niobium-tin superconducting strands (bundles of superconducting fibers 2-6 micron thick) to be used in the world's largest particle accelerator, the Future Circular Collider (FCC). The superconductors are manufactured and supplied under an R&D contract between TVEL and the European Organization for Nuclear Research (CERN). By the end of 2018, CMP will develop four prototypes to undergo qualification tests afterwards.

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"Working with CERN is not new to us – we supplied superconductors for the modernization of the Large Hadron Collider. The new contract also provides for the shipment of superconductors, but we first need to meet certain requirements. These superconductors are manufactured at the Chepetsk Mechanical Plant. The production technology was developed by the Russian Research Institute of Inorganic Materials," says Andrei Andrianov, TVEL vice president for the development of general purpose industry business. Apart from niobium-tin strands for the electromagnet system, a key component of the FCC, TVEL is ready to manufacture niobium-titanium wires for its magnet system.

In 2014 CERN announced plans to construct the Future Circular Collider with a tremendous circumference of 100 km. The FCC should replace the current Large Hadron Collider by the end of the 2030s. Its technical parameters will bring fundamental research in particle physics to a new level and take the scientific community one step closer to revealing the state of the universe at the early stages of its existence.

The high speed of particle collisions in the collider sets stringent requirements for the quality of niobium-tin wire. Besides, it will be needed in large amounts – no less than 6,000 tons. **"Today we are working on a niobium-tin wire grade which will be ideal physically and will be globally unparalleled. This is a serious challenge for the Chepetsk Mechanical Plant. If qualification tests are successful, the plant will be able to produce around 100 tonnes of superconducting strands annually,"** said Andrey Eseneev, superconductor project manager at CMP.

Producing a large amount of strands for the FCC requires multilateral cooperation. The technology is under development in Europe, USA, South Korea, Japan and China. It is important for Russia to be among the leaders. **"We want a share in the order,"** says Maxim Alekseev, Head of the Bochvar Institute laboratory working on the superconductor manufacturing technology from intermetallic and oxide compounds. **"Superconductors for the FCC are made on the verge of possibility for these materials. They also have prospects of being used in fusion reactors and high-resolution emission spectroscopes. This is why it is extremely important for us not to be late and join an elite club of superconductor suppliers for research megaprojects."**

Wild Edens Comes to Turkey

The programme is brought to you by Rosatom and will be broadcast by National Geographic this winter.

The premiere of a new documentary "Wild Edens: Turkey," the second in a series that highlights the issue of climate change, took place in Ankara, Turkey. Focusing on the flora and fauna in the one-of-a-kind natural habitats of Turkey, the programme highlights the unique and delicate habitat of the Kars Wetland, the Caucasus, and the Mediterranean Sea. Brought to you by Rosatom, it will be broadcast by National Geographic starting this December.

Rosatom State Atomic Energy Corporation, the world's leading producer of safe and clean

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energy, is deeply concerned with the threats associated with global climate change.

"Firstly, we want to draw attention of the international community to the nature's rich beauty. Secondly, we want to remind that this environment may fall victim to the destructive consequences of human activities. Our film demonstrates the fragility of the ecosystem, as well as the importance of participation of each of us in saving our planet," Kirill Komarov, Rosatom State Atomic Energy Corporation First Deputy Director General, said at the event.

In her video message Freida Pinto, the project's ambassador, says: **"I believe that the project is very important for a multitude of reasons. It is important because it shows all of us the beauty of a natural world that has been hidden from the human eyes for so many years. It is also important because Wild Edens takes the chance to highlight the risks that we all face if climate change is not something we pay attention to."**

Andrew Zikking, series producer of the documentary, Off the Fence, said: **"Although this film is part of the Wild Edens campaign highlighting the issue of climate change, it did not set out just to film habitat destruction, or environmental damage. We wanted to capture and celebrate Turkey's staggering array of wildlife, but also set out the very real context of what could be lost. We wanted to tell the story of these fragile ecosystems through some of Turkey's most endangered species at intimate, important moments in their life cycle, be that mating, hunting or just surviving."**

Filmed over 3 months, the documentary, an Off the Fence production, will air across multiple markets in Turkey, Africa and Europe. NL

For reference:

The Wild Edens project's main goal is to attract the attention of the international community to climate change and the need for a global transition to clean and carbon-free energy. The filming and broadcasting on National Geographic Channel of unique documentaries about wilderness areas with animals and plants in danger of extinction due to global climate change will be the culmination of the project. The locations for filming have been chosen to show the extraordinary beauty of landscapes, and at the same time to emphasize that these unique places and their inhabitants, rare species of animals, birds, the unique natural environment, forest, water bodies and plants, are in danger of extinction. Off the Fence, an independent production company, produced Wild Edens documentary series. Executive producers are Ellen Windemouth and Allison Bean. Producer and Director is Andrew Zikking.

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TRENDS

Composite Materials: A Russian Perspective

ALEXANDER TYUNIN
CEO of UMATEX GROUP (Composite Materials Division of Rosatom)

Over the recent years, annual growth of the composite market averaged 11%. It is one of the fastest expanding industries worldwide. To compare, the steel industry experiences only a 2% annual growth. The composite materials scope of application has also expanded immensely. Just 30–40 years ago, they were used strictly in the space industry. The aircraft industry developed interest for these materials 20–25 years ago. And now, dozens of new composite materials are finding their way into households every year.

The world consumes 141 thousand tonnes of carbon-based composites annually. In monetary terms, this accounts for nearly USD 21 billion. According to experts, the market will grow more than twofold by 2025 and reach 335 thousand tonnes, or USD 48 billion.

Russia comprises less than 1% of the global market, with annual composite material consumption at 800 tonnes (approx. USD 200 million). We anticipate the Russian market will reach 6 thousand tonnes, or more than USD 1 billion, by 2025. This means that Russia is expected to outperform the global market in terms of annual growth rates. Five key industries will drive the market: aircraft engineering, pressure vessel manufacturing, wind power engineering, construction, and sporting goods.

TRENDS

THE GLOBAL MARKET

We can outline several global trends by industry:

1) Aircraft manufacturing. Major global players Airbus and Boeing use more than 50% of composite materials in their flagship aircraft. The aviation composites market is estimated to be USD 12.8 billion per annum. More importantly, it is expected to double by 2025 given extensive fleet renewal.

In Russia, the prospects are excellent as well. The flagship MC-21 airliner, which is currently being tested, contains 30% of carbon-based composite materials. In addition, Russia and China are jointly developing the CR929 wide-body airliner.

2) Wind power engineering is one of the fastest developing industries in the world, with China as its current leader. Composite materials are widely used in wind turbine construction. A recent trend in wind engineering is the focus on boosting wind turbine capacity by increasing the mast height and blade size.

The highest and most powerful wind turbine thus far was built in Scotland and commissioned in 2018. With a capacity of 8.8 megawatts, it has a blade spread of 160 meters (80 meters for each blade) and is 191 meters high. Its blades are 100% made of composite materials. Most of them are fiberglass composites (90%), while the carbon-based composite stiffener makes for the remaining 10%. The stiffener enables the blade to be longer, lighter and therefore more efficient.

3) Automobile manufacturers have become major consumers of carbon-based composite materials, with a steady use growth attributed to the last 6–7 years. This segment is led by premium-class cars, but mass-market cars are catching up as well. Carbon-based composites are used as interior trim materials and, primarily, to construct load-carrying structures. The market of car composites totals nearly USD 2.8 billion annually.

Major car manufacturers, such as Ford, KIA and Hyundai, study composite materials and are preparing to use them serial production.

4) The sports industry is another key consumer, which is important for us. Hockey sticks, skis, snowboards and fishing rods are all made of composite materials, and the industry is growing at a rapid pace. The size of this market segment is USD 1.8 billion.

RUSSIAN SPECIFICS

The industries mentioned above are inconceivable without composite materials. What other segments can be drivers of the composites market?

In Russia, the gas-powered vehicle development program presents a lucrative opportunity. On a global scale, the trend is towards electric cars, but Russia also pays significant attention to gas. The gas-powered vehicle development program provides for the use of composite high-pressure vessels that allow for a large reduction of logistics and fuel expenses and a longer driving range.

Construction is another market driver. This industry is fundamental for the development of composite materials. Russian companies have engineered a broad range of composite products for the construction industry,

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including construction rebars, construction profiles, and prefab road surface blocks that can be repeatedly assembled and disassembled (dozens of cycles). Another area of application is external reinforcement systems allowing for cheaper and faster capital repairs of bridges, beams, foundations and other structures as opposed to conventional approaches. In addition, using composites in repair work extends the service life of buildings and structures by 30–50 years. When calculating costs, we should take the full lifecycle into account. At first, composite materials look more expensive, but they do not dilapidate, serve for up to 100 years and make buildings and structures cheaper in maintenance. As a result, we can save up to 20–30% over the full lifecycle.

We see shipbuilding as the third most promising industry. We are now developing composite barge covers. They are 2–2.5 times more expensive than steel covers, but they are corrosion-resistant and much lighter – which means that barges can carry more cargo. This solution pays off, and businesses are interested in it. Russian composite materials are shipped to Italy, where they are used in yacht building. Russian companies also produce vessels that are 100% made of composite materials. These products enjoy high demand globally and, in particular, are exported to Asian countries.

For reference:

Composite materials are materials made from two or more constituent materials that, when combined, produce a material with properties different from those of the individual components.

The oldest composite materials are plywood and concrete. When mentioned in this text, “composite materials” means “polymer composites”.

Medicine is our fourth point of focus. Two local companies, Motorika and Nanotechmed, produce high-tech composite implants and prostheses.

Although the Russian market seems to be small, I am sure that its future is bright. Russian-produced composites can play a major role on the global market.

We are still behind market leaders, but they are not far away, and we can bridge that gap. I am sure that we will be among industry leaders in 5–6 years and will be able to set industry trends. What matters is thinking outside the box. NL

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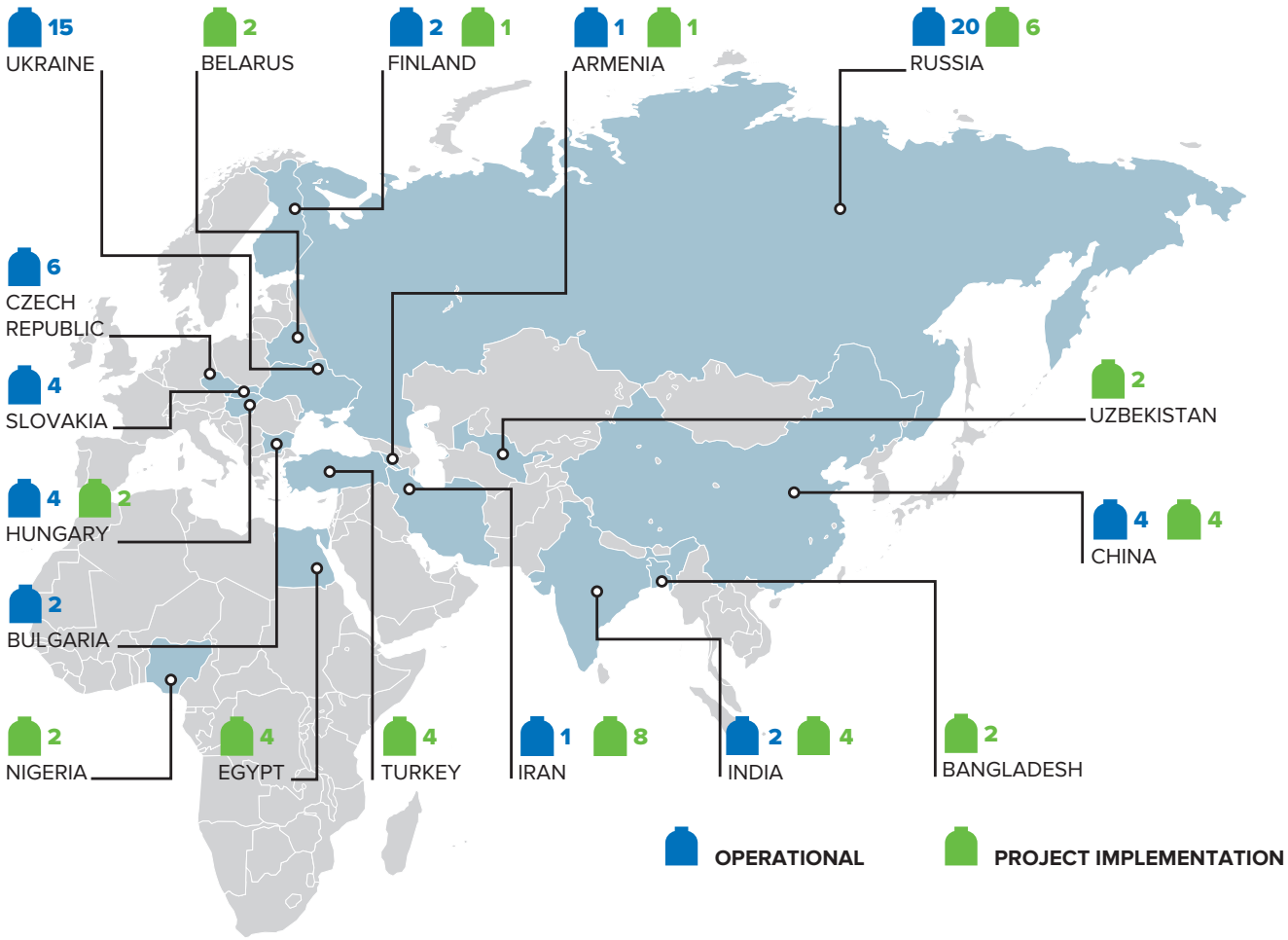
INFOGRAPHICS

GLOBAL VVER FLEET



A BRIEF HISTORY OF THE VVER

The first VVER unit was commissioned in 1964, at the Novovoronezh NPP in Russia. It was called the V-210, its successor – the V-365 (the numbers were initially corresponding to electrical output).

Successful commissioning and operation of these units provided the basis for subsequent development of more powerful reactors. Implemented first at the same site, the VVER-440 was the first of the VVERs to be constructed on a serial basis.

The VVER-1000 was a milestone not only in terms of generating capacity, but also because of the many safety innovations it incorporated.

The VVER-1200 is an evolutionary Generation III+ design. It is in operation at Novovoronezh phase II and Leningrad phase II in Russia. Today, Rosatom continues the commitment to a proven approach – to export only the technology which has been thoroughly tested at home.