CONTENTS

Back to contents

Seeds of Cooperation

This October saw Rosatom's participation in two major events, the Russian Energy Week (REW) in Moscow and the Belarusian Energy and Environment Forum EnergyExpo in Minsk. The two events yielded a number of cooperation agreements encompassing both general frameworks and specific arrangements for the Russian nuclear corporation and its subsidiaries.

More countries have joined the ranks of nuclear countries through Rosatom's efforts. For now, these are Belarus, Turkey, Bangladesh, and Egypt. **"El Dabaa is our flagship nuclear project on the African continent, but our work is not limited to just building the plant. Together with our friends in Egypt, we are creating an entire nuclear power industry in that country from scratch by training personnel and providing maintenance support. In other words, we are helping Egypt to embark on the path of sovereign energy development. This comprehensive, systemic approach is one of Rosatom's main competitive advantages, not to mention its traditionally high standards**

Back to contents

of reactor safety and reliability," Russian President Vladimir Putin said at the Russian Energy Week.

At REW

Viktor Karankevich, Minister of Energy of Belarus, spoke at the REW about the economic improvements achieved by Belarus with the nuclear power plant: **"The Belarus NPP has given a powerful impetus to the development of new and promising sectors — these are energy-intensive industries and construction of apartment buildings and houses with electricity used for heating and hot water supply. Much attention is paid to the development of electric vehicles."** The country expands its charging infrastructure as the number of electric vehicles is growing. The nuclear power plant has saved 5.3 billion cubic meters of natural gas and prevented the emission of over 9 million tonnes of greenhouse gases. With the launch of the second unit in May, the share of nuclear in Belarus' energy mix will approach 25% this year and then grow to 40%.

Minister of Energy and Natural Resources of Turkey Alparslan Bayraktar said that Akkuyu

Unit 1 was scheduled to generate first power in 2024. The Akkuyu NPP will provide 10% of Turkey's energy needs, thus preventing the emission of 30–35 million tonnes of carbon dioxide.

Myanmar is another partner of Rosatom. **"It is necessary to introduce innovations to raise the level of technology. Deploying nuclear power will drive the development of technology and improvements in the quality of products, services and education. Myanmar will deploy nuclear technology with Russia's help,"** said Myanmar's Union Minister for Electric Power U Nyan Tun.

On the same day, Rosatom and the Ministry of Science and Technology of Myanmar signed a memorandum of understanding on the assessment and development of the country's nuclear infrastructure. The parties will identify Myanmar's needs and draw an action plan to build small nuclear power plants. The document also provides for cooperation in training personnel and improving safety culture in the organizations involved in the deployment of nuclear power in Myanmar.

Besides Myanmar, the Russian nuclear corporation signed agreements with two African countries. A memorandum of understanding on peaceful uses of nuclear energy was signed with the Ministry of Mines, Quarries and Energy of Burkina Faso. Being the first nuclear-related document between Russia and Burkina Faso, it paves the way for cooperation in many areas, including approaches to nuclear generation, non-energy applications of nuclear technology in industry, agriculture and medicine, development of nuclear infrastructure, and raising public awareness.

A memorandum of understanding was also signed between Rosatom and the Ministry of

Back to contents

Energy and Water of Mali. It covers such aspects as nuclear infrastructure, public awareness of nuclear technology, fundamental and applied research, nuclear research facilities, application of radioisotopes, nuclear and radiation safety and security, personnel training, and nuclear power.

At EnergyExpo

More specific agreements were signed with companies from Belarus, which has long been cooperating with Russia in nuclear technology. An example of these is a roadmap signed by T-com, a telecom equipment manufacturer and part of Rosatom's fuel division TVEL, and Promsvyaz, part of the Belarusian Ministry of Communications and Informatization. The parties will collaborate in developing, manufacturing and deploying telecommunications equipment at Promsvyaz subsidiaries and training their personnel. As provided for in the roadmap, they will identify what the Belarusian market needs, with necessary equipment certified and supplied. The roadmap covers the period of 2023–2024.

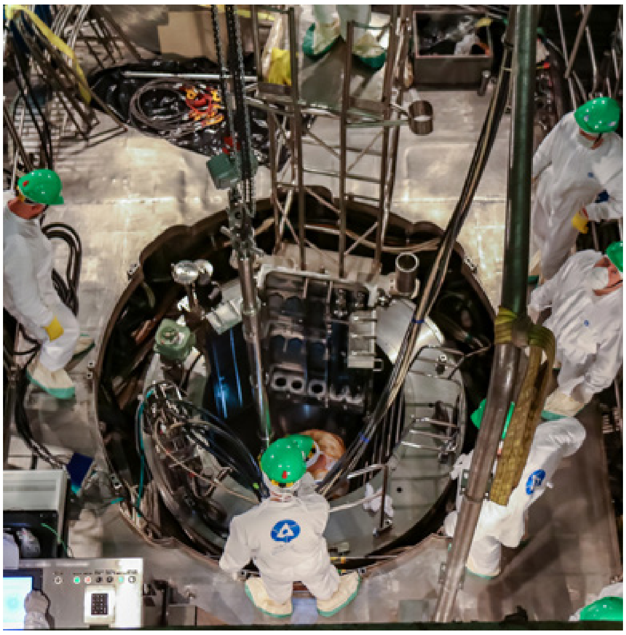
TVEL and the Belarusian Radioactive Waste Management Organization (BelRAO) signed a long-term cooperation agreement to establish and develop the infrastructure for ultimate disposal of radioactive waste in Belarus. The agreement provides for the operation and maintenance of a near-surface repository, monitoring activities, and staff training.

Rosatom and the Ministry of Natural Resources and Environmental Protection of Belarus also signed a memorandum of un-

derstanding that calls for the cooperation on hazardous waste management, recycling and disposal, environmental monitoring action, and legacy management.

Challenges ahead

Speaking at the Russian Energy Week, Rosatom chief Alexey Likhachev outlined strategic plans of the Russian nuclear corporation. One of the most important challenges is to 'close' the nuclear fuel cycle as this will remove commodity-related and environmental constraints that hold back development of the global nuclear power industry. Rosatom plans to begin scaling up its closed fuel cycle technology in 2032–2034 by building fast and thermal reactor complexes. A completely new — thermonuclear — generation technology might emerge after 2050. **"We are still far from commercializing this concept, but we will continue to work, putting more effort and money into the idea,"** Alexey Likhachev stated.



Akademik Lomonosov Refueled

Reactor refueling seems to be a routine procedure. But when it comes to refueling of the world's first floating nuclear power plant, the news becomes interesting for the global nuclear and — more broadly — energy community.

Fuel transportation

The floating nuclear power plant (FNPP) is moored at the town of Pevek in the Chukotka Autonomous Okrug, which lies in its entirety in the Far North. New fuel assemblies were brought to Pevek via the Northern Sea Route. **"Fuel for every Russian nuclear icebreaker and FNPP is manufactured at Rosatom's subsidiary Elemash. After passing the necessary factory tests, the set of fuel assemblies for the first reactor was shipped by train from Elemash to Murmansk, the base of the Russian nuclear fleet. In Murmansk, fresh nuclear fuel and large-size equipment were loaded onto a motor vessel to be transported to Chukotka,"** said Anton Markov, chief expert of the Non-Serial Reactor Operation Department at RosEnergoAtom.

Reactor core specifics

The floating power unit is equipped with two KLT-40S nuclear reactors capable of generating up to 70 MW of electricity and 50 Gcal/h of heat in the nominal operating mode, which is enough to provide the needs of a city with the population of 100,000.

The KLT-40S reactors installed on the FNPP have a specific reactor core: it is of a cartridge type and not of a channel type as it used to be. The cartridge-type core has an increased refueling interval of 3–3.5 years and a 1.5-time smaller share of fuel in the electricity production cost.

The refueling procedure at the FNPP has its specifics, too. It is not some of the fuel assemblies that are replaced once in a year or year and a half as happens at large nuclear reactors, but the entire reactor core. As this refueling operation has been the largest maintenance campaign in terms of scope and duration since the FNPP commissioning, it involves the staff of the FNPP, Rosatom's specialized maintenance provider AtomEnergoRemont, reactor designer OKBM Afrikantov (part of Rosatom's power engineering division), and others.

Refueling procedure

The FNPP reactors are refueled one after another. While one of the reactors is being

Back to contents

refueled, the other continues to generate electricity, so consumers experience no power outages.

The refueling procedure started back in late July. Spent fuel assemblies were removed and placed into storage. Both fresh and spent fuel is stored on board the FNPP in dedicated isolated rooms.

At present, the internals of steam generators are being replaced. When the replacement is completed, the loading of fresh fuel will begin. After the core is loaded with fuel, the reactor will be assembled. This will be followed by the first criticality and first power operations with the fresh core.

In-process safety is ensured with the sensors of the reactor control and automated radiation monitoring systems installed on the FNPP and in Pevek. The sensor readings show no deviation from the norm.

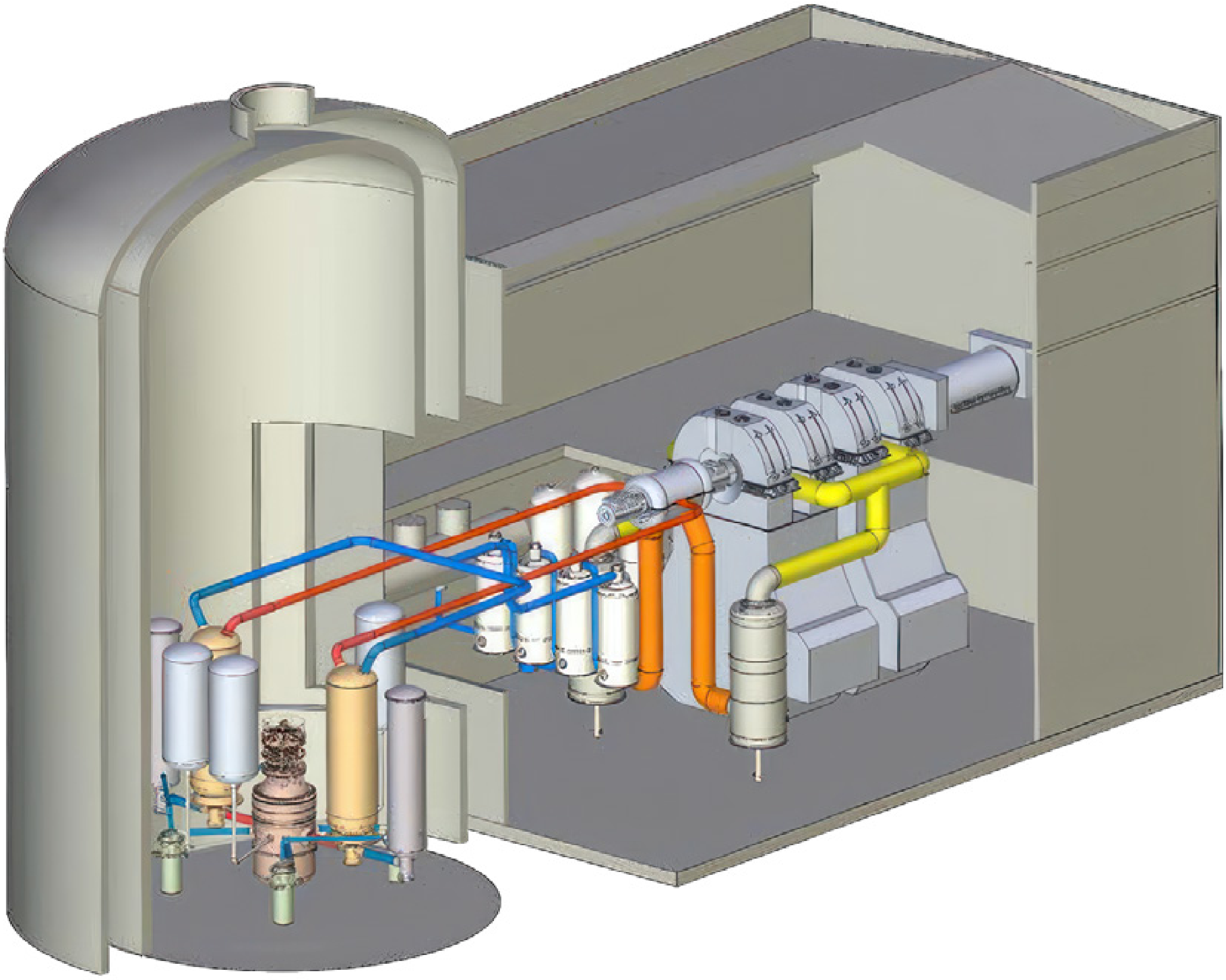
FNPP in Pevek

Our readers remember that the floating nuclear power plant was delivered to Pevek on September 9, 2019. The FNPP fed the first electricity into the isolated power grid of the Chaunsky-Bilibino Industrial Area of the Chukotka Autonomous Okrug in December 2019 to become Russia's northernmost power plant (this title used to be held by the Bilibino Nuclear Power Plant). In May 2020, the FNPP was put into commercial operation.

In September 2023, a 110 kV power line stretching 490 km was commissioned to connect Pevek and Bilibino. The line increased the reliability of power supply for Bilibino consumers and local mining sites (Baimsky GOK is the largest of them) by transmitting electricity from the FNPP.

The maintenance campaign at the first reactor will be completed by the end of the year. The same operations — nuclear fuel delivery from Elektrostal, where Elemash is based, to Pevek, refueling of the second reactor, and replacement of the steam generator internals — are scheduled for 2024.

To the beginning of the section



Fresh Look at Reactor Classics

In October, Rosatom top managers, researchers and engineers gathered at the New Nuclear Energy conference to discuss key reactor technology developments in Russia. One of them is a modification of the time-proven VVER design for large and medium-sized reactors. Here is our account of VVER-S, a water-cooled water-moderated power reactor with spectral shift control.

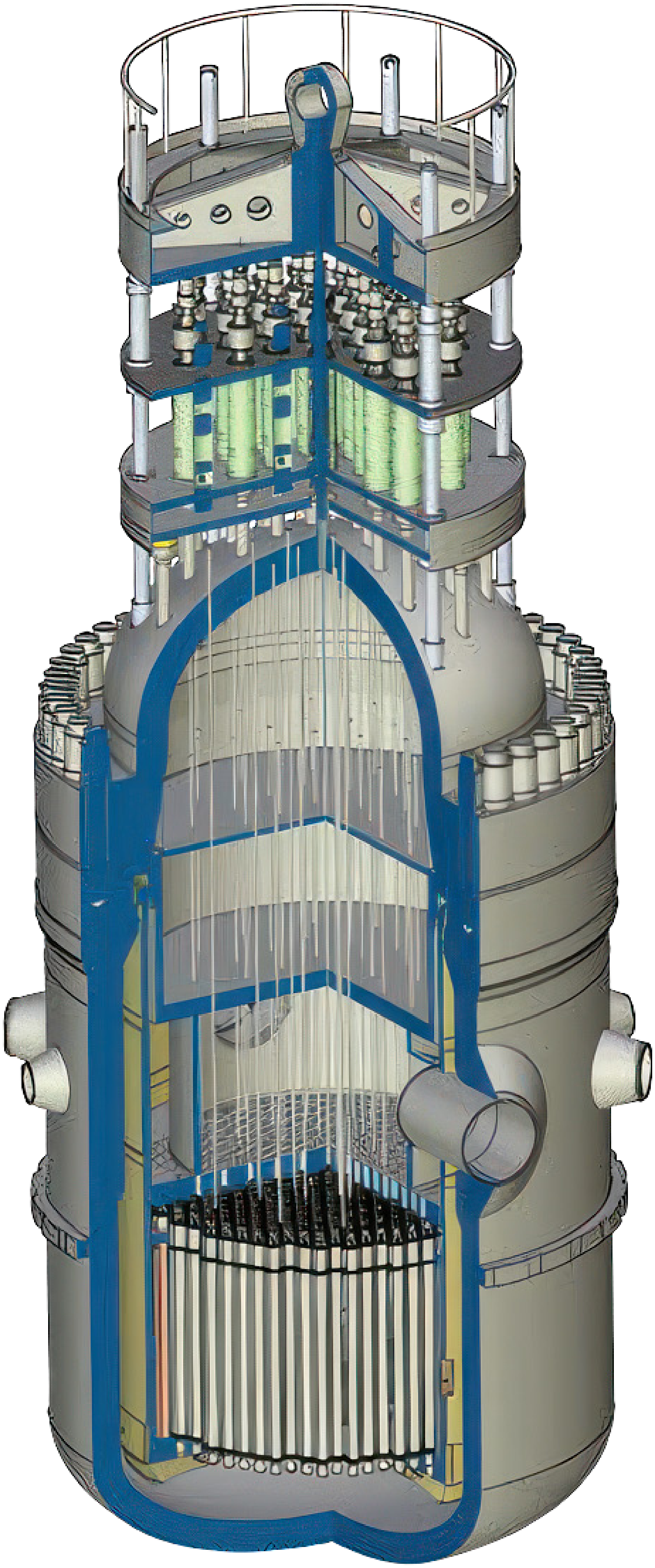
Background

In the 1980s, researchers worldwide considered the concept of reactivity control through the neutron spectrum softening by increasing the moderator volume. The volume could be increased in two ways, either by using displacer rods extracted from the core during the burnup process or by diluting the coolant with heavy water. Spectral shift control was seen as one of the methods of saving fuel through the production of fissile isotopes.

Then the idea was shelved and revived only in 2005. A team under the leadership of

REACTOR TECHNOLOGIES

Back to contents



Vladimir Asmolov (now Advisor to Rosatom Director General) started the work to develop a 'super VVER'. Among other things, they concentrated on the development of a spectral shift control reactor, for which they chose a medium-sized reactor design with a power capacity of 600 MWe. The estimated reproduction factor for VVER-S was 0.7 to 0.8, while conventional VVER reactors have a factor of 0.35 to 0.4. The results obtained during the first R&D phase laid the foundation for the next development run. In 2019–2020, the work on this VVER concept continued. The research conducted by the team proved the possibility of building a cost-efficient nuclear station with a VVER-S reactor.

The current R&D activities in the VVER-S project are aimed at solving five tasks. The first is to reduce the consumption of natural uranium in the open nuclear fuel cycle. The second task is to ensure that the reactor can operate efficiently with a full uranium-plutonium core and a reproduction factor of 0.7 to 0.8 in a closed nuclear fuel cycle. Third, the reactor will be capable of operating in a load following mode in the daily range of 100–40–100%. Fourth, construction time and cost need to be reduced with fundamentally new design solutions. And the fifth task is to reduce the amount of radioactive waste.

The VVER-S concept relies on the experience gained from the operation of conventional VVER reactor units. Although it cannot be claimed that the solutions considered for VVER-S are absolutely novel, the researchers, engineers and designers have studied a wide range of proposals that might improve the reactor performance. With a combination of innovative solutions, the new design can be very promising for the domestic and international markets.

REACTOR TECHNOLOGIES

Back to contents

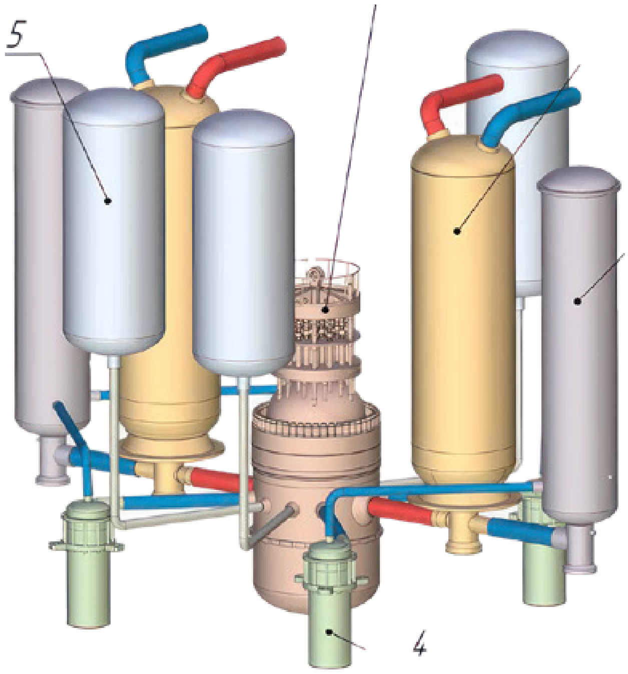
The VVER-S technology is included in Russia's Nuclear Development Strategy 2050 and Prospects 2100 approved by the Rosatom Supervisory Board in 2021.

How it works

"The conventional VVER technology provides for the initial reactivity margin for burnup and absorption control to be compensated by the boron system, that is, by changing the concentration of boric acid in the primary coolant," explains Viktor Mokhov, Head of the VVER-S project management office.

Spectral shift in the VVER-S reactor is controlled by changing the water-uranium ratio during the reactor operation at power. This is achieved by mechanically removing water displacer rods located in special fuel assembly channels in the core. Since the displacers are immersed in the core at the beginning of the fuel cycle, there is less moderator in the reactor and the neutron spectrum is harder. This decreases the fission cross-section of odd fissile isotopes and increases the resonance capture cross-section of the uranium-238 isotope. The both effects reduce breeding in the core and contribute to the accumulation of the fissile plutonium-239, which saves fissile material in the annual fuel load. Another effect of spectrum hardening is a higher fraction of fissions in the uranium-238 isotope. When the displacer rods are removed, the neutron spectrum shifts from hard to thermal and reactivity increases.

The use of displacers to control reactivity in the burnup process makes it possible to abandon the use of boron control during the reactor operation at power. However, it is difficult to fully abandon boron control in VVER-type



reactors as this design requires two independent safety systems based on different physical principles to be used to put and keep the reactor in a subcritical state.

Fuel and equipment specifics

The developers believe VVER-S to be an evolution of the VVER technology facilitating the effective transition from an open to closed nuclear fuel cycle.

Two fuel assembly designs are considered for VVER-S. The first one is of conventional type, but has an increased number of channels for control rods, with some of 'gray' control rods to be used for reactivity control. The second design is evolutionary, with smaller spaces between the fuel rods and displacer channels, which make it possible to change the water-uranium ratio in the fuel assemblies within the range of 1.5 to 2.0.

Time-proven solutions will be used as much as possible for VVER-S fuel rods and main reactor systems. These are the solutions tested and employed in the AES-2006 and VVER-TOI designs. The reactor will have a thermal capacity of 1,600 MW and an electrical capacity of up to 650 MW with an efficiency rate of 38%. It is planned to use a large reactor vessel designed for VVER-1000 to hold the required amount of fuel and displacers.

The entire VVER-S core will be loaded with uranium-plutonium fuel, so the power plants with this reactor design will most effectively fit into the closed nuclear fuel cycle concept.

Kola NPP

The medium power capacity chosen for VVER-S will enable Rosatom to make a competitive offer to those customers who plan to replace the retiring coal-fired power plants or supply power to the regions with underdeveloped grid infrastructure or isolated grids.

The Kola NPP was selected to build the first power unit with a VVER-S reactor because its existing Generation I VVER-440 power units are to be decommissioned soon. The current General Layout for Power Facilities in the Russian Federation provides for a VVER-S unit to be built by 2035 if its technical solutions are justified and the design proves to be competitive with conventional VVER reactors and alternative power sources. VVER-S power units could also be offered to international customers after the technology is tested at the Kola NPP and the efficiency of the new reactor is confirmed.

R&D phases

As the preliminary R&D phase was completed, the project entered a full-scale engineering phase, during which the basic design solutions will be developed for the reactor unit and the power plant. Research is also underway to justify the design solutions adopted for the VVER-S project. A set of documents will be produced by the end of 2024 to enable the assessment of costs, development prospects, etc. Commissioning of the first VVER-S unit at the Kola NPP is scheduled for 2035.

To the beginning of the section

Atomic Outlook

In October, the International Atomic Energy Agency (IAEA), the International Energy Agency (IEA) and the US Energy Information Administration (EIA) each released their energy market outlooks. These organizations acknowledge nuclear power as a low-carbon energy source alongside renewable energy generation. However, predicting the scale of nuclear additions remains a challenging task. All the three outlooks cover the period till 2050, with energy accessibility and carbon neutrality seen as the main challenges. The authors of the three reports also share the idea that electricity generation and consumption will grow and electricity will increase its share in the total energy consumption.

Future Indefinite

Overall, high uncertainty about the future is mentioned in two out of the three outlooks. The authors from the IAEA admit that their projections do not fully capture all the factors affecting reality: **"The low and high estimates reflect contrasting, but not extreme, underlying assumptions about the differ-**

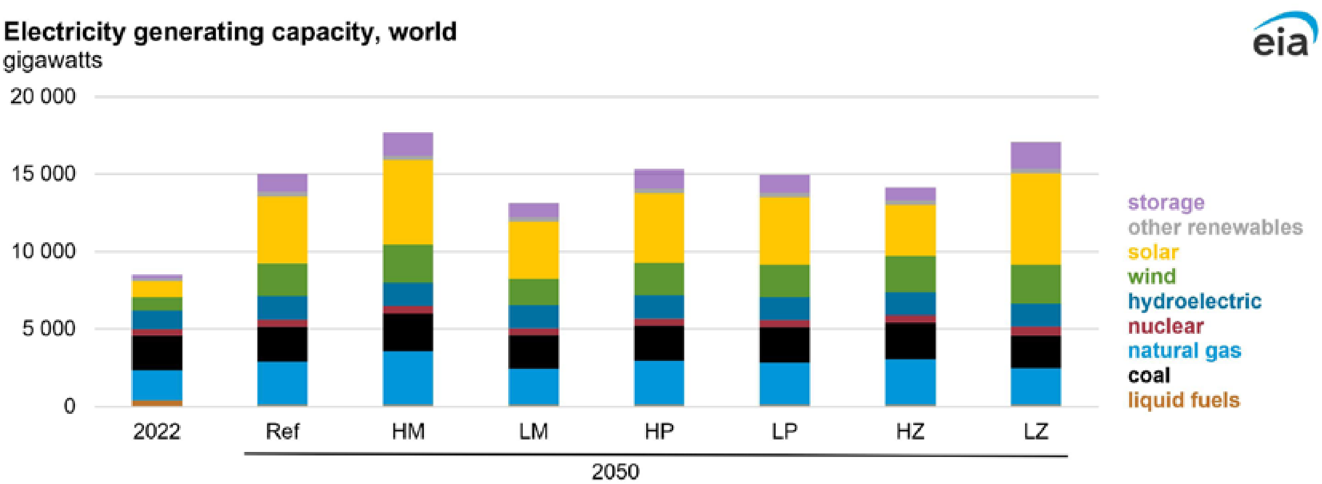
ent driving factors that have an impact on nuclear power deployment. These factors, and the way they might evolve, vary from country to country. The estimates presented provide a plausible range of nuclear capacity development by region and worldwide. They are not intended to be predictive nor to reflect the whole range of possible futures from the lowest to the highest feasible.”

The authors of the EIA outlook give even higher estimates of the uncertainty: **“Unmodeled surprises or breakthroughs that shift the trajectory of the global energy system will almost certainly happen. As Yogi Berra quipped, ‘The future isn’t what it used to be.’ So, our modeled cases should not be interpreted as forecasts. Rather, IEO2023 provides a useful benchmark for decision makers around the world as they continue to shape our collective energy future.”**

The authors of the IEA outlook show more confidence in the future. They developed three scenarios, one of which is believed to come true. Uncertainties are explored: **“Our analysis explores some key uncertainties, notably regarding the pace of China’s economic growth and the possibilities for more rapid solar PV deployment opened by a massive planned expansion in manufacturing capacity (led by China) <…> We examine how any deterioration in geopolitical tensions would undermine both the prospects for energy security and for rapid, affordable transitions.”**

Approaches to data interpretation are also different. The EIA structures data as a probability framework with benchmarks in the middle. **“IEO2023 represents a set of policy-neutral baselines that focus on the current trajectory of the global energy system,”** the document reads. The IAEA traditionally presents two — high-case and low-case — scenarios, while the IEA considers three, the Stated Policies Scenario (STEPS), the Announced Pledges Scenario (APS), and the Net Zero Emissions by 2050 (NZE) Scenario.

The most important difference, perhaps, is that the outlooks by the IAEA and the EIA establish some options of future developments. The outlook by the IEA is a persistent and repeated recommendation for certain



Data source: U.S. Energy Information Administration, *International Energy Outlook 2023* (IEO2023)
Note: Ref=Reference case; HM=High Economic Growth; LM=Low Economic Growth; HP=High Oil Price; LP=Low Oil Price; HZ=High Zero-Carbon Technology Cost; LZ=Low Zero-Carbon Technology Cost.

actions: **“The key to an orderly transition is to scale up investment in all aspects of a clean energy system <…> But the urgent challenge is to increase the pace of new clean energy projects, especially in many emerging and developing economies outside China, where investment in energy transitions needs to rise by more than five times by 2030 to reach the levels required in the NZE Scenario.”** It is unclear, though, why developing economies are obliged to harmonize their energy and, most importantly, financial policies with the targets from the IEA experts.

Nuclear future

Interest in nuclear energy has grown. **“In light of this evolving energy landscape, with strong commitment to climate action and renewed scrutiny of energy supply security, a number of Member States have revised their energy policy towards nuclear, leading to decisions for the long term operation of existing reactors and new construction of Generation III/III+ designs. There has been also an acceleration in the interest and the development of small modular reactors in a growing number of countries targeting both electric and non-electric applications,”** the IAEA projection says.

Specific figures on the installed nuclear capacity differ, however. The outlook by the EIA is the most skeptical: **“Nuclear capacity is stable in most cases except the Low ZTC** (Low Zero-Carbon Technology Cost — RN) **case, where we eased noneconomic constraints (that is, geopolitical considerations) to explore the economic effects on nuclear builds. In this case, nuclear capacity increases by 194 GW in 2050 relative to the 2022 capacity of 400 GW.”**

According to the IAEA, the low case projections indicate that the world nuclear capacity will increase modestly to 458 GWe. In the high case, the world nuclear capacity is expected to more than double to 890 GWe by 2050. As of late 2022, the total nuclear capacity worldwide was 371 GW (370.17 GW as of late October 2023, according to PRIS). Compared to the previous year, the IAEA raised its low-case estimate by 14% and the high-case estimate by 2%.

In the high case, the total nuclear electrical generating capacity is projected to increase globally by about 24% by 2030 and increase by about 140% by 2050 compared to the 2022 capacity. In the low case, nuclear electrical generating capacity is projected to increase by about 9% by 2030 and then increase by about 23% by 2050.

In the low case, the share of nuclear in total electrical generating capacity is projected to decrease by 2050. A reduction of about 1.7 percentage points is expected. In the high case, the share of nuclear in total electrical generating capacity is expected to increase by about one percentage point by 2050.

Different sections of the IEA outlook provide varied estimates. According to one of the estimates (p. 106), **"the share of nuclear power remains broadly stable over time in all scenarios."** According to another (p. 126), **"nuclear power capacity increases from 417 GW in 2022 (sic!) to 620 GW in 2050 in the STEPS."** The authors believe that the reactor life extensions and new additions will increase the installed nuclear capacity to 770 GW by 2050 in the APS and 900 GW in the NZE Scenario. As mentioned in the outlook on page 126, **"nuclear construction reaches new heights."**

Be that as it may, the twofold difference in the outlook is large and also points to high uncertainty.

The EIA and IEA outlooks include nuclear among the low-carbon energy sources, which also comprise renewable energy generation and fossil fuel generation with CO2 capture and disposal. As noted in the IAEA projection (with reference to the IEA data), nuclear generation has prevented the emission of about 70 billion tonnes of carbon dioxide over the past 50 years.

Challenges to implementation

The IEA outlook structures the risks inherent in different energy sectors. As for nuclear power, risks associated with obtaining permits and certificates, lack of qualified personnel and the cost of financing are considered to be high. This is not the largest set of risks as, for example, four risks were named for each of wind power and power grids.

The challenges listed by the IEA overlap with those identified by the IAEA, such as financing, economic difficulties and supply constraints for new construction. **"In recent years, construction cost overruns and delays for first of a kind projects have led to high project risk perception in the Americas and Europe, hampering investment decisions for new projects,"** the IAEA projection says. However, its authors promptly specify that nuclear power units in other regions are built according to the estimates and within the time-frames established. Efforts are also made towards regulatory and industrial harmonization, as well as progress with final disposal of high-level radioactive waste.

Regional aspect

The authors of the IEA and EIA outlooks do not delve into the specifics of the nuclear industry in different regions, so the information presented below is taken from the IAEA projection.

In North America, the high scenario sees the total installed capacity growing by 44% to 156 GW by 2050, while the low scenario provides for a downfall by a third from its current level to 67 GW. In the high scenario, power production at nuclear power plants will grow by about one and a half times from the 2022 level to reach 1,297 TWh by 2050. In the low scenario, the electricity output will fall by a third to 547 TWh. The share of nuclear can rise by 1.5 — or fall by 9 — percentage points (pp.) by mid-century.

In Latin America, where hydropower has always had a strong foothold, nuclear power plants appeared first in the 1970s. Since then, the share of nuclear has quadrupled but remains modest at about as little as 2% of the energy mix. The high scenario sees the installed nuclear capacity growing fivefold to 25 GW by 2050, while roughly doubling

Back to contents

(to 12 GW) in the low scenario. Nuclear generation will grow sixfold to 197 TWh, or 30% to 92 TWh, in the high and low scenarios, respectively. The share of nuclear in the total installed capacity will either grow by 1.6 pp. or remain unchanged; the share of nuclear in electricity generation will triple or grow at a much more modest pace.

In Western, Northern and Southern Europe, the share of nuclear doubled between 1980 and 1990 and then declined to make 19% now. The installed nuclear capacity in the region will be declining until 2030 in the both low-case and high-case scenarios. Then it will grow by a third from the 2022 level to 131 GW in 2050 in the high scenario or fall by 40% to 60 GW. Nuclear generation will either grow by 91% to 1,075 TWh (up 11 pp.) or decline by about 12% (more than 5 pp.) to 493 TWh by 2050.

In Eastern Europe, the share of nuclear has quadrupled since 1980 to 23% as of 2022. The high scenario expects the installed nuclear capacity to almost double from the current levels to reach 102 GW by 2050, while growing by as little as 11% to 59 GW in the low-case scenario. The share of nuclear generation will grow by 6 pp. to 800 TWh or fall by 1.5 pp. to 461 TWh, respectively.

In Africa, nuclear accounted for about 2–3% of the total power output in 1990–2010. Since then, its share has fallen to 1.2% due to an increase in other types of generation, primarily gas and hydropower. Electricity consumption on the continent is expected to quadruple by 2050 vs. 2022. Africa's nuclear generating capacity is projected to grow more than tenfold to 20 GW by 2050 in the high scenario and fivefold to 9 GW in the low scenario. In the high scenario, nuclear power generation is seen to grow more than 14-fold to 144 TWh by 2050, with its share tripling. In the low scenario, it will increase sevenfold to 69 TWh, and its share will grow to 2% of the total power production.

West Asia has traditionally used a lot of oil: fossil fuels have accounted for about 80% of the total energy consumption for more than 40 years. Electricity generation has grown 13 times over the same period. The share of nuclear in the total electricity generation was 1.7% in 2022. The high scenario sees it growing fivefold to 24 GW by 2050. In the low scenario, the share will triple to 14 GW. At the same time, power generation at nuclear power plants will grow more than eightfold (by 5 pp.) to 189 TWh in the high scenario and fivefold (by 2 pp.) to 112 TWh in the low scenario.

In South Asia, nuclear generation accounted for 3% of electricity output in 2022, with coal being the primary source of energy in this region, followed by gas. The electricity generation will more than triple by 2050. The high scenario expects nuclear capacity to grow more than sevenfold to 74 GW by 2050 and the share of nuclear in the total energy mix to reach 2.5%. In the low scenario, nuclear capacity will quadruple to 42 GW, and the share will decrease to 1.4%. Nuclear power generation in the region will increase eightfold (by 5 pp.) to 578 TWh in the high scenario and fivefold (by 1.5 pp.) to 331 TWh in the low scenario.

In Central and East Asia, the share of electric power had more than doubled since 1980 to over a quarter of the total energy consumption in 2022. The share of nuclear in the total electricity production had grown until 2000 and then declined to about 6% in 2022. The high scenario assumes that the installed nuclear capacity in the region will quadruple (grow by 4 pp.) to 345 GW by 2050, while the low scenario assumes its doubling to 192 GW. The share of nuclear in this case will grow from the current 2.8% to 3.6%. Power production in the high scenario will increase 4.5 times (by 11 pp.) to 2,777 TWh by 2050, while in the low scenario it will increase by almost 280% (by 5 pp.) to 1,772 TWh.

In Southeast Asia, electricity generation has quadrupled since 1980. There are no nuclear power plants in the region yet. The main energy sources are coal, gas and hydropower. The region is expected to build 11 GW of nuclear capacity in the high scenario and 3 GW in the low scenario. Nuclear power plants will generate 87 TWh and 24 TWh of electricity in the high and low scenarios, respectively.

Oceania does not yet have nuclear capacity either. Electric power is mostly generated with coal. The high scenario expects 2 GW of nuclear capacity to be built in the region by 2050. There will be no new construction in the low-case scenario. Accordingly, nuclear generation will either reach 14 TWh per year or remain at zero.

For its part, Rosatom makes a huge contribution to the development of nuclear generation around the world. Following 2022, the Russian nuclear corporation remains the largest player in the international market. Rosatom is building 32 power units in seven countries, with a total of 33 units in 11 countries in the pipeline. For 18 years since the foundation, Rosatom has built 18 large power units (excluding the floating nuclear power plant), with nine of them constructed outside Russia. NL

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