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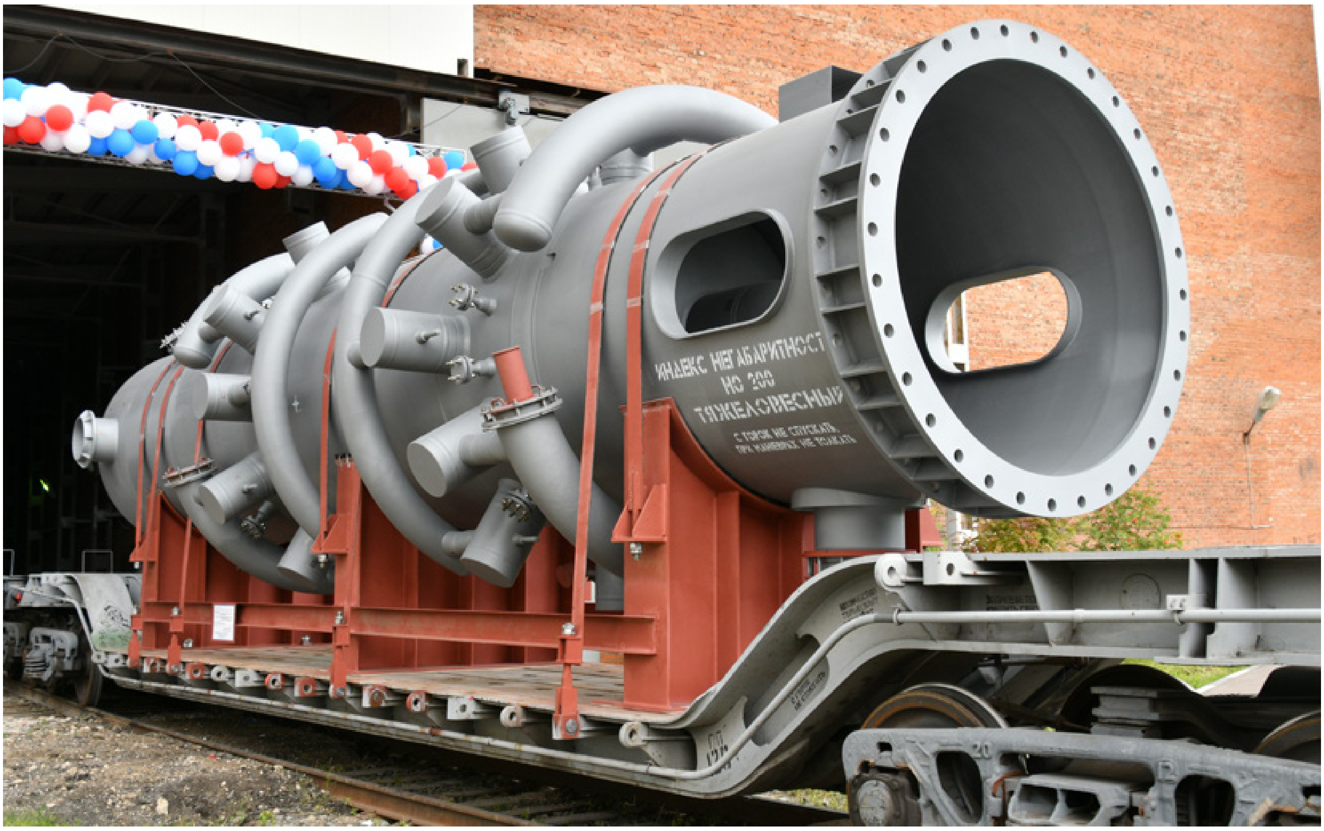

Ambitions for Gas Projects

Rosatom is strengthening its position on the LNG equipment market. On July 10, Rosatom's mechanical engineering division AtomEnergoMash (AEM) and Russian gas major NOVATEK signed a partnership agreement for LNG projects. AEM's subsidiary ZiO-Podolsk manufactured the first Russian heat exchanger – an ethane evaporator – for the Yamal LNG project.

The agreement between AEM and NOVATEK is premised on achievements in the production of coil heat exchangers and medium capacity cryopumps. It sets out obligations of the parties to develop, manufacture and test high capacity cryogenic pumps. The document confirms the parties' intention to develop domestic production of pumps, heat exchangers and other equipment for NOVATEK's LNG projects.

The first cooperation agreement between NOVATEK and AEM was signed two years ago when LNG equipment was an absolutely new area for the company. Today, AEM is deeply involved in LNG projects. **"Core equipment units at an LNG plant are coil heat exchangers that cool and liquefy gas. We have made a number of pilot contracts for the supply of almost the entire range of key units for the fourth production line at Yamal LNG's medium capacity plant. These are coil heat exchangers, pumps, and new steel grades,"** Andrey Nikipelov, CEO of AEM said.

The company also signed an agreement with Cryostar (France), a subsidiary of Linde, to

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set up production of turbo expanders and high performance LNG pumps in Russia. **“Our products are made of new steel grades developed at the Central Research Institute for Machine Building Technology. AEM’s subsidiary Atommash was certified as a manufacturer and a potential supplier of high capacity heat exchangers,”** Andrey Nikipelov explained. Another AEM’s subsidiary OKBM Afrikantov contracted Saint Petersburg-based Research and Development Institute for Electrical and Physical Equipment to develop the first Russian test bench for cryogenic equipment to be used at LPG plants. AEM plans to expand the range of domestically manufactured machinery for large-capacity LNG plants, LNG-powered icebreakers and LNG carriers.

The ethane evaporator made at ZiO-Podolsk will be installed at the LNG plant in Sabetta, a Russian town beyond the Arctic Circle.

The plant will have a capacity of one million tons of LNG per annum and will use Arctic Cascade, the first Russian technology for medium capacity LNG production. The technology will be first used at the fourth production line at NOVATEK’s operating Yamal LNG plant. The first three production lines with a capacity of 16.5 million tons were constructed under a foreign license. After the new line is commissioned and production at the other three is optimized, the total annual capacity of the Yamal LNG Project will increase from the current 16.5 million to 18.5 million tons.

The total set of equipment to be produced by the company for Yamal LNG will include six units, five ethane evaporators and a flash evaporation tank. The ethane evaporator is a 15-meter high and 2.6-meter wide cylinder weighing 61 to 86 metric tons. Inside there are 3,800 heat exchanging tubes with a total length of 70 kilometers. The evaporators operating at temperatures below -170C are directly involved in the natural gas liquefying process. The design and engineering documents will be developed at ZiO-Podolsk.

In August 2018, the Russian Government approved a roadmap setting up domestic production of critical equipment for low- and medium-capacity LNG plants and LNG carriers. The roadmap covers a time period until the mid-2020s. The document provides for establishing a domestic production of the entire range of core LNG equipment, constructing test sites, drafting industry standards and regulations, and developing domestic technology for medium-capacity (less than 1 million tons per annum) and high-capacity (more than 1 million tons per annum) LNG plants. The new equipment will be used at three production lines of the Arctic LNG II project to be launched in 2023–2025.

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According to forecasts, the LNG market will grow. **"Its current share in global gas exports is around 40%, with 60% of gas supplied via pipelines. Many analysts from large reputable agencies believe, though, that LNG will soon play a leading role. Global LNG demand will increase by 17% to reach 384 million tons by 2020 and continue adding 4% every 12 months until 2030. By 2040, the share of LNG in the gas market will reach 60%, leaving only 40% to pipe gas,"** Andrey Nikipelov said.

Transportation of LNG from Yamal LNG and Arctic LNG II will account for a considerable portion of freight traffic on the Northern Sea Route (where Rosatom is now an infrastructure operator). Speaking at the International Arctic Forum held in April 2019, Rosatom's Director General Alexey Likhachev said that freight traffic on the Northern Sea Route would reach 92.6 million tons by 2024, including 41 million tons of gas from Yamal LNG and Arctic LNG II.

NPP Overlooking Danube

Construction of auxiliary facilities started in June on the site of Paks II NPP in Hungary. Assembly shops, warehouses and offices – a total of 80 facilities – will be the first to build.

Speaking at the ceremony dedicated to the start of construction, Paks II Minister János Süli stressed that Hungary was deeply interested in cheap and environmentally friendly electric power to make the national economy competitive in the long run.

The governmental environmental policy provides for both the nuclear capacity to be maintained and the share of solar generation to grow. At present, a third of the country's demand is satisfied with electricity from coal-fired power stations in neighboring countries. Paks II is therefore crucial for Hungary's future as the plant is capable of mitigating environmental impact and reducing dependence on imported energy.

"According to the latest report by MEKH (Hungarian Energy and Utilities Regulatory Agency – RN), energy tariffs in our country are the second lowest in the European Union after Bulgaria. In order to keep this place in the ranking, we need to maintain the present share of nuclear in the national energy mix. And for this reason, it is essential to have the new reactors built," János Süli said.

Alexander Khazin, Senior Vice President at ASE (Rosatom engineering division) and Paks II Project Director, assured the audience that preparations for the construction would run smoothly. Safe and reliable generation III+ units featuring VVER-1200 reactors have 60 years' service life, which could be extended, and will provide Hungary with cheap, carbon-free electric power.

István Lenkei, CEO of Paks II, noted that the construction of auxiliary buildings and structures went alongwith the preparation of over 300,000 pages of engineering documents in close cooperation with the general contractor ASE. These documents are necessary to confirm that the new reactor units meet the strictest international, European and national safety standards.

Paks Background

The Paks nuclear power plant has four operating VVER-440 reactor units. In 2009, the Hungarian Parliament approved construction of two more units with VVER-1200 reactors. In December 2014, Rosatom and MVM Hungarian Electrical Works Private Limited Company (MVM) signed a general contract, followed by a loan agreement to finance the construction of Units 5 and 6. Engineering, procurement and construction contract (the EPC contract) came into effect on 29 April 2017.

Rosatom's subsidiary Atomproekt is preparing an engineering design of the nuclear station to be submitted to the regulator by the year-end. The regulator's approval will allow filing for a construction license next year. Most of the long-lead machinery and equipment has been ordered from manufacturers.

The European Union finally gave its approval to the construction of the nuclear power plant; all formal procedures were completed. **"It is not a question for us whether to build the nuclear station or not, whether to implement the agreement or not. I will not deny that we are behind schedule. But being behind schedule does not mean abandoning our agreements. It only means that the power plant will be commissioned later than planned. The delays were mostly caused by long-drawn formal procedures established in the EU – they took much more time than they should. Definitely much more than we expected. They are finally over now, and the EU gave a green light,"** Péter Szijjártó, Hungary's Foreign Minister said.

At present, 50.6% of electric power consumed in Hungary comes from nuclear sources. This share will increase after the second nuclear station is brought online.

World's First Nuclear Power Plant Celebrates 65th Anniversary

In late June, Rosatom and its guests from all over the world celebrated the 65th anniversary of the Obninsk Nuclear Power Plant, an important event both for Russia and the entire world. Obninsk NPP was the first to prove the

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feasibility of using nuclear power for peaceful purposes such as heat and electricity generation for industry and communities.

The celebration of the Obninsk NPP's anniversary lasted several days. On June 25, Russian Prime Minister Dmitry Medvedev congratulated former and current employees of the nuclear power plant. On the next day, the Obninsk NPP hosted a scientific and technical conference entitled Nuclear Industry's History, Traditions, Experience, Knowledge and Employees as Sources of Development in the 21st Century. The event brought together top managers of Russian and international nuclear power organizations and agencies. Mikhail Chudakov, IAEA Deputy Director General, Tom Mitchell, Chairman of the World Association of Nuclear Operators, and Fernando Naredo, Secretary General of the European Nuclear Society were among the guests.

"Back in 1949 when the entire world viewed nuclear technology only as a military one, Russian scientists were the first to suggest a peaceful use of nuclear power … The first nuclear power plant

operated for 48 years, which is 18 years longer than initially planned. There was no single accident throughout its operation time, and this is truly remarkable for the technology that had never been used before," Alexey Likhachev said when speaking at the conference.

Timeline

In February 1950, scientists suggested constructing an experimental reactor in the Moscow Region to generate 30,000 kW of heat and 5,000 kW of electric power. The USSR Council of Ministers approved the project in May 1950; the construction began in July 1951. Igor Kurchatov was appointed Research Director of the project. Nikolay Dollezhal became Chief Designer as his design of an uranium-graphite reactor was selected for the yet to be constructed nuclear power plant.

The first concrete was poured in March 1952. Pipes, channels and cables laid inside the thick cast-in-situ reactor walls allowed for potential changes in the design. Changes were thought to be inevitable since designers were facing complicated calculations. In order to take missing measurements and make adjustments, a test reactor assembly was constructed and brought critical in early March 1954. Tests (achieving a self-sustained chain reaction) were held on March 3, 1954 proving that the initial calculations were essentially correct, but continued to be adjusted and verified until the reactor reached criticality.

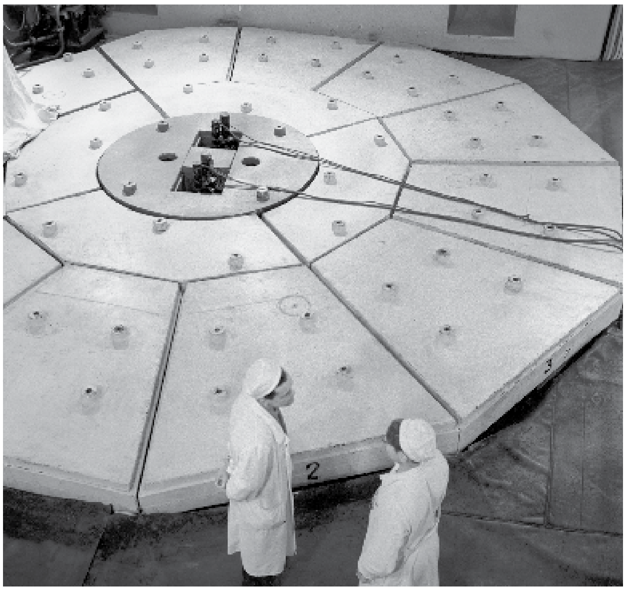
The most important task was to develop fuel rods capable of remaining operational throughout long refueling cycles. After several failures, a team led by Vladimir

Malykh created an acceptable prototype. Uranium and molybdenum grits were encased in a stainless steel tube and separated by a magnesium layer. Pouring magnesium into fuel rods turned out to be a difficult process that required designing and manufacturing a dedicated machine.

The reactor went critical on May 9, 1954. After all 61 fuel rods were loaded into the reactor, the self-sustaining chain reaction of uranium fission started at 7:40 pm. **"The reactor's power was steadily growing. And finally, we saw a jet of steam coming out of the valve with a loud hiss somewhere near the thermal power plant to which the reactor steam was supplied. A little white cloud of ordinary steam, which was not even hot enough to run the turbine, seemed a miracle because it was the first steam ever generated by nuclear power,"** Dmitry Blokhintsev, who was in charge of the criticality phase, wrote in his memoirs. Research Director Igor Kurchatov congratulated his colleagues.

Despite difficulties with the equipment, the first nuclear power plant was connected to the Moscow regional grid as early as June 1954 and reached the rated capacity in October same year.

The role of Obninsk NPP in promoting peaceful uses of nuclear power is not limited to power generation alone. It became a platform for training nuclear submarine crews, experimenting with new reactor designs, studying neutron flux and fuel elements, and fabricating isotopes. Although the Soviet nuclear industry could hardly be called open to foreigners, Obninsk NPP welcomed visitors from the abroad since the very first year of its operation. The trust in nuclear technology was growing.



The Obninsk NPP was shut down in April 2002, but potential uses of nuclear technology are still studied in Obninsk. **"The role of nuclear for mankind is a centerpiece of discussions today. It is not just power generation, but also the use of nuclear technology in medicine, agriculture and manufacturing. Obninsk will be a place where future employees will be taught to use nuclear in different industries. Young people will have great educational prospects and opportunities for getting an interesting, well-paid job,"** Russian MP Gennady Sklyar said in his speech at the anniversary conference.

In the interview to the Energy Expert Center (EEC), Luis Echavarri, former OECD NEA Director General invited to the conference, expressed his confidence that civil nuclear technology could provide the planet's growing population with access to green power, **"Taking into account that fighting the climate change is the priority now in the energy sector, I think the nuclear has a future because it can contribute to it. I think the future of electricity in the world for some years to come will be**

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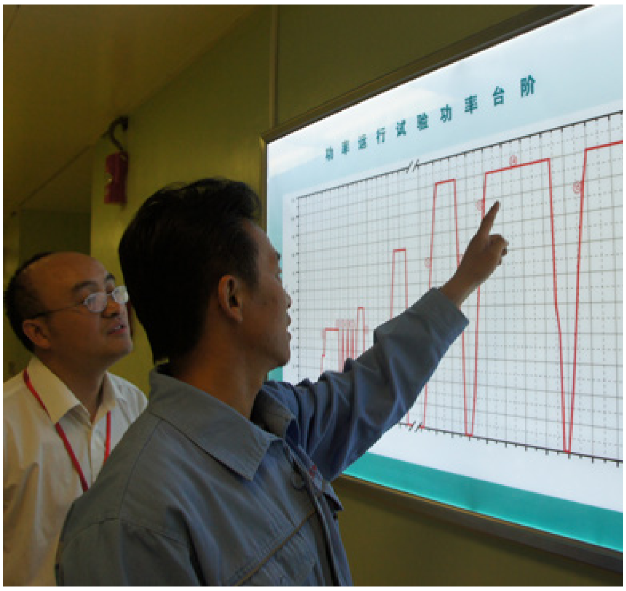
fundamentally a combination of nuclear power for baseload electricity and renewables for peak hours. This is going to be more and more important in the future, because all the societies including emerging countries have aspiration to having a better quality of life. And I think nuclear power can contribute significantly to that”.



Fuel for China

Rosatom’s TVEL Fuel Company supplied fuel for the China Experimental Fast Reactor.

TVEL supplied a batch of nuclear fuel for the China Experimental Fast Reactor (CEFR). Fuel assemblies were manufactured at Elemash (Moscow Region), the world’s only producer of uranium fuel for fast neutron power reactors. These deliveries are a part of the Russian-Chinese umbrella program for cooperation in the fast reactor technology development.

“TVEL considers cooperation with its Chinese partners to be strategic and large-scale. We supply fuel for VVER-1000 reactors at Tianwan. We have also organized local production of nuclear fuel for VVER-1000 reactors at Yibin Plant and export Russian components there. At the same time, we are also working on fuel supply contracts for VVER-1200 reactors to be built by Rosatom in China. Cooperation in the fast reactor technology, including fuel management, is of strategic importance as it focuses on the development of a two-component (combining thermal neutron and fast neutron reactors – RN) nuclear power industry of the future,” Oleg Grigoriev, Senior Vice President for Commerce and International Business at TVEL commented.

CEFR

China launched its fast reactor research and development program in 1964, with Russia’s support. The first 65MW China Experimental Fast Reactor (CEFR) was brought online in 2011. The reactor was manufactured at OKBM Afrikantov in cooperation with OKB Gidropress, Dollezhal Research and Development Institute of Power Engineering (both of Rosatom Group companies), and Kurchatov Institute. The CEFR design is based on the Russian-designed BN-600 fast reactor.

While the engineering design of China’s first fast reactor was developed in Russia, China designed buildings and manufactured general-purpose equipment. Although CEFR is used as a research reactor, it is also connected to a 20 MW power unit and supplies power to the grid. For this reason, it is considered by the IAEA to be the only fast power reactor operating outside Russia.

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CFR-600

CFR-600 is China's new 600 MW fast reactor under construction in Xiapu County, Fujian Province. It is a Generation IV demonstration project launched by China National Nuclear Corporation (CNNC) in December 2017. The new reactor is a logical continuation of the CEFR Project. In early 2019, a contract for the supply of fuel for CFR-600 between TVEL and CNLY (a CNNC subsidiary) came into effect. Fuel for CFR-600 will also be manufactured at Elemash where a new production line will be installed. CFR-600 will first use mixed oxide (MOX) fuel and later migrate to metallic fuel with a higher reproduction factor. Both the operating CEFR and the under-construction CFR-600 are designed to use MOX fuel that is not produced in China.

The development of fast reactor technology speeds up the transition to a closed nuclear fuel cycle and supports more efficient consumption of uranium reserves. This is a crucial matter for China's fast developing economy as the country faces a growing demand for electric power.

BN-600

BN-600 is a Russian-designed sodium-cooled fast power reactor operating at Unit 3 of the Beloyarsk Nuclear Power Plant (Sverdlovsk Region, central Russia). The reactor was commissioned in April 1980 and is capable of generating 600 MW of electric power. From the shutdown of the Phoenix reactor in France in 2009 until the startup of BN-800 (mid-2014), BN-600 was the world's only fast power reactor in operation.

BN-800 is a Russian-designed sodium-cooled fast neutron reactor designed to refine the MOX-based fast breeder technology. The first and only reactor of this type operates at Unit 4 of the Beloyarsk NPP. The reactor went critical on December 10, 2015 and was brought online on November 1, 2016. Its electric power capacity is 880 MW.

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S&P Confirms AtomEnergoProm's Global Competitive Advantage

In a report published in June, S&P Global, one of the largest financial analytic companies in the world, revised its credit rating for AtomEnergoProm (AEP) upwards. The agency recognized AEP as a large and globally competitive nuclear industry leader and upgraded its rating to BBB- on a par with Russia's sovereign foreign currency rating. The key reason behind the upgrade was strong government support for the nuclear industry and major nuclear projects.

The report on AtomEnergoProm dubbed What Makes Russia's Nuclear Sector Competitive answers the question. First, it is a supportive government policy in a stark contrast to tighter restrictions in the European countries. Second, construction costs are relatively low as compared to those abroad. Finally, the AEP is a financially stable, low-leveraged company.

Evaluating the domestic market, the S&P experts do not expect any significant increase of the installed power capacity. However, the company still has room for growth in building advanced reactor units to replace retiring ones.

> AEP is a vertically integrated company that consolidates Russian civil nuclear assets across all industry segments, from uranium mining to construction of new power reactors and electricity generation. Russian state-owned nuclear corporation Rosatom holds 100% of the company's voting shares.

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The S&P report calls Russia "a large global nuclear player" and refers to the AEP's share in different sectors of the nuclear power market. AEP maintains its leadership in uranium enrichment (36% of the global market in 2018). With its 14% share in global uranium production, the company is second only to Kazatomprom. AEP is the world's third largest supplier of nuclear fuel (17%) after Westinghouse (25%) and Framatome (23%). The share of nuclear power in Russia's energy mix reaches 19%.

Race for Replacement

According to S&P analysts, state support and nuclear-supportive regulatory framework are the key reasons for AEP's competitive advantages. For example, Russia has no special taxes on electric power generated by nuclear power plants, while some European countries, particularly Sweden, do have such charges.

By contrast, Russian nuclear companies enjoy state benefits and offer predictable payback on capital making it attractive for the investors. **"Capacity supply agreements for the nuclear sector support payback of CAPEX in 25 years and a basic return on investment at a solid 10.5% (although down from 14% in 2011)... Capacity payments therefore provide a solid boost to AEP's EBITDA. Nuclear capacity payments totaled RUB 116 billion in 2017 (over one-third of AEP's consolidated EBITDA) and are projected to be about RUB 221 billion by 2021, if the company sticks to its current construction plans."**

According to the Russian Energy Ministry, AEP features higher capacity utilization (78%) due to its priority access to the market and has less unprofitable contracts than small generation companies thanks to its large nuclear power plants.

Besides, AEP is also a primary employer in over 20 Russian company towns where it efficiently cooperates with local companies and regional authorities.

Finally, the government is interested in the company's projects and provides necessary financial support. **"At RUB 13.6 billion in 2018 (RUB 22.7 billion in 2017), equity infusions are not essential for the company's financial metrics, but still positive. Also, we understand that the government plans equity contributions for AEP's and Rosatom's new strategic initiatives outside of their core business but linked to national priorities... This enables the company to raise its visibility, standing vis-à-vis the government, and its social profile while avoiding an increase in debt."**

Along with construction of new power plants, these strategic initiatives include development of the Russian nuclear icebreaker fleet and nuclear medicine. Another example is radioactive waste management. According to the law dating back to 2011, the federal and regional governments finance this activity. **"Even if technically, AEP is the only Russian entity that can store and process nuclear waste, financial liability remains with the government,"** the S&P analysts conclude.

For AEP, developing new capacities in Russia is a race for replacement. The power market here is not expected to grow much in the near future because electricity demand in Russia is satisfied. RosEnergoAtom (a subsidiary of AEP) builds new power reactors only to replace the retiring capacity and test new reactor designs. A good example is the world's first floating nuclear power plant Akademik Lomonosov that went critical in 2018 having moored in the port of Russia'a northernmost city of Pevek, Lomonosov will replace the retiring on-shore Bilibino Nuclear Power Plant. The year of 2018 was also marked by the commissioning of Rostov Unit 4 and Leningrad-II Unit 1 (the second Generation III+ unit). Novovoronezh-II Unit 2 (the third Generation III+ unit) was brought online in May 2019.

Construction costs excluding financing costs (S&P estimates based on the data of the International Energy Agency and the World Nuclear Association)

Country/project	Estimated construction costs (USD'000 per kW)
Russia (recently completed units)	2
Akkuyu, Turkey	4
Paks, Hungary	5.5
Europe	5.5
China	3.5
USA	5

In Economically Stable Ruble Zone

The second reason behind AEP's competitiveness is its financial stability. Its vertically integrated structure mitigates the risks related to coordination of its activities. However, the key component of the company's financial stability is lower production costs as compared to other countries. According to the S&P analysts, this it is attributable to a two-fold devaluation of the Russian ruble over the past five years (RUB 32.73 per USD in late 2013 vs. RUB 69.71 per USD in late 2018). The price of the Russian-made equipment for the international projects has also dropped due to the decrease in total production costs.

Revenue of the company grew from RUB 747.5 billion in 2017 to RUB 769.5 billion in 2018. Accordingly, profit rose from RUB 116.1 billion to RUB 207.7 billion.

In a table included in the report, AEP is compared to its peers in terms of financial performance. The table shows that AEP has the best financial indicators (EBITDA margin, EBITDA interest coverage, Debt/EBITDA, Free Operational Cash Flow/Debt, etc.) and one of the best returns on capital.

50 Shades of Risk

International nuclear projects, particularly those partially owned by AEP (96% stake in Turkish Akkuyu NPP and 36% stake in Finnish Hanhikivi NPP), are considered by S&P analysts to be the company's key risk that may render its cash flow negative. Amidst the current problems with the

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Unit 3 of the Olkiluoto Nuclear Power Plant constructed in Finland by the Areva-Siemens conglomerate, the S&P considers the delay in granting the regulatory permit deserving attention. **"We understand that the delay will not expose AEP to any financial penalties, but rather the company will postpone large CAPEX, which were pre-funded with a RUB 57.5 billion equity contribution from the Russian Government in 2015 and that we have treated as restricted cash. Also, we believe that because the project is delayed and not canceled, AEP will not be required to return this equity contribution to the Government."**

As for Akkuyu NPP, S&P analysts also draw attention both to the risk itself and to the existing ways of mitigating it. **"We understand that AEP, with the Russian Government's political backing, is looking for a local partner for up to a 49% stake in Akkuyu which, if successful, could help to share the massive construction costs, while a fixed electricity off-take contract with the Turkish company Tetas at a very attractive price (12.35 cents/KWh) should support the project's economics."**

When asked by Rosatom's Newsletter to what extent the risks could be mitigated, Elena Anankina from S&P noted, **"The future is inherently unpredictable and multicolored, so we are trying to grade risks from light gray to dark gray instead of seeing things black and white."**

According to Ms. Anankina, a lot of new nuclear projects across the globe (e.g. Flamanville or Olkiluoto III) are facing delays, rising costs and reputation risks. All these problems are caused by technical and organizational reasons, as well as regulatory changes in a number of countries. This is why performance risks are typical of all large and complex projects, not only those in the nuclear power generation industry. For instance, Kazakhstan's Kashagan oil and gas project was delivered with a delay of many years and at almost double its initial cost.

"Our rating of AEP takes both positives and negatives of Hanhikivi and Akkuyu into account. The company would hardly ever take part in an unprofitable project. I believe the economics of the both projects would have been greatly different but for the government finance and the power

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supply contract. We also think that AEP is not fully safe from the risks posed by multiple international projects of its sister company ASE. AEP is also involved in them, so the long-term prospects of fuel supplies will depend on how successfully these projects are delivered," the analyst explained.

On the whole, S&P experts believe that the company's large liquidity reserve and financial robustness enable it to handle large projects. However, AEP's ambitious international project strategy is one of the reasons why the company's own credit rating (i.e. without government support) does not exceed its current level (BB+).

With government support included, it equals Russia's sovereign rating (BBB-). **"In our view, AtomEneroProm is one of Russia's major corporate borrowers, given its profitable vertically integrated business, currently low debt, and our expectations of continuing government support. A number of other Russian corporate borrowers that have recently placed eurobonds (such as Russian Railways, Rushydro and others) have the same credit rating,"** Anankina said.

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