PAY MORE WITH NUCLEAR
RUSSIAN NUCLEAR INDUSTRY OVERVIEW

PAY MORE FOR NUCLEAR: Report 4

The PAY MORE WITH NUCLEAR series of research reports examines the enormous costs involved in building and operating nuclear power plants. The warning signs against this dangerous source of energy can flash no brighter after the devastation of Fukushima, Japan. Yet, the South African government is tendering a nuclear build programme estimated to cost R1-trillion. What are the full costs of the nuclear build programme? We had better know now before it is too late. The stakes can be no higher.

Also in this series:
• What does it take to finance new nuclear power plants?
• Nuclear technology options for South Africa
• Funding nuclear decommissioning: Lessons for South Africa

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Introduction: Plans for Russian/South African rapid nuclear development

On September 22, 2014 Russia and South Africa signed an intergovernmental agreement on strategic nuclear partnership. According to Russian sources, this may lead to the construction of up to eight new nuclear reactors of VVER design by 2030, with the first reactor coming online as soon as 2023. Sergey Kiriyenko, head of the Russian State Atomic Energy Corporation, Rosatom, estimated the program’s total cost at $40-50-billion. He also promised “preferential” funding coming from the Russian state budget and up to $10-billion in contracts for local companies. Other sources suggested the total cost may be up to $90-billion, which, they said, would be “unaffordable.”

Although the agreement was not made available to the public in Russia or South Africa, the Russian media reported that it also included the construction of a “multifunctional” research reactor and, possibly, a number of other facilities that would produce various components for new nuclear power plants. Russia also promised to provide training to nuclear professionals and, at a later stage, partner up with South Africa to promote construction of new nuclear reactors in other countries. Although South Africa signed nuclear agreements with several other countries in 2014 (including, among others, France, China and South Korea), the Russian proposal appears to be the most ambitious, as it is backed by state funding and high-level political support. Moreover, Rosatom reported it was already covering around 45% of South African uranium needs under the agreement until 2020.

Earlier, Rosatom also promised that a nuclear fuel assembly facility will be built in South Africa in case the country decides to go for ambitious nuclear program development with Russia.

In November 2014, Russian nuclear engineers from Gidropress, a company owned by Rosatom, presented their new reactor design VVER-TOI at the Vendor parade workshop in South Africa. French and British companies may also be involved in the construction (see chapter on the Generation III+ design for details).

This paper reviews the current state of the Russian nuclear industry, the GenIII+ design proposed for South Africa, as well as the Russian nuclear sector’s safety, corruption, and public participation record.
The Russian nuclear industry: current situation

In 2014, the Russian nuclear sector generated about 17% of electricity with its ten nuclear power plants in operation. In 2013, domestic reactors produced 162 TWh of electricity.

Russia operates seventeen units of the VVER type, eleven units of the RBMK type, four units of the EGP-6 model and one fast breeder, the BN-600. Originally, all Russian reactors were designed to remain in operation for 30 years. Old reactors have been getting 15-year extensions on their operational life. This practice has been widely criticized by experts, especially in the case of the RBMK units — reactors that are, save for certain modifications, of the same type that exploded in Chernobyl in 1986. The experts’ concerns proved to be well-founded when, during a planned maintenance check in 2012, swelling and cracks were found in the graphite stack of the No.1 reactor at Leningrad Nuclear Power Plant (LNPP). The unit was shut down in order to avert coolant cutoffs and uncontrolled chain reactions. The reactor, much to environmentalists’ dismay, was nonetheless brought back online after prolonged repairs.

According to the Russian nuclear regulator Rosstekhnadzor, 39 incidents occurred at Russian nuclear power plants in 2013. The main reasons cited by Rosstekhnadzor were “mishandling, defects in equipment and design errors.”

Aging reactors and decommissioning

One of the very important issues for the Russian nuclear industry has been the management of its aging reactors. In Russia, 19 units have been operating beyond their engineered life spans of 30 years. Of these 19, four have remained online for over 40 years. The No.1 RBMK unit at Leningrad Nuclear Power Plant is scheduled to be shut down around 2018. The other three units will be taken offline in 2020, 2024, and 2025. It is expected that the EGP-6 reactors at the Bilibino station in the region of Yakutia will be shut down before 2020. More reactors will follow within the next decade, an effort that will require significant expenses.

Although Russia has a nuclear power plant construction program, it does not have a program detailing the decommissioning of its old reactors. The industry has very little experience in this field. At the same time, the lack of timely planning of the decommissioning process may increase costs by up to 30%. Some experts predict Russia will in the foreseeable future face “a serious socio-economic crisis in those regions where the [expiring] NPPs are operated”.

There are various estimates on the cost of decommissioning. In the case of the Russian RBMK reactors, over $3-billion per reactor may be required (this is the cost of the decommissioning program under implementation at the Soviet-designed RBMKs in Lithuania). Up to $12-billion may be required to decommission reactors scheduled to be taken offline by 2025.

Russia has four nuclear reactors that were shut down a long time ago. Two reactors of an early VVER design at Novovoronezh NPP were taken out of operation over 20 years ago. But the decommissioning activities (equipment dismantlement, decontamination of the area, etc.) have been postponed indefinitely for lack of funding and a comprehensive decommissioning concept. The other two reactors, at Beloyarsk NPP, are in a similar situation. The first two reactors at BNPP operated for 17 and 21 years respectively, and were stopped owing to “non-compensable deviations from safety regulations” in 1981 and 1989.

Although Rosatom maintains a special fund for decommissioning projects, the amount of financing it has accumulated to date is far from sufficient for this work.

New reactors

In 2008, the Russian government approved the “General Layout Plan for Siting Power Generation Facilities for the period until 2020.” It included construction of 13.2 GW in new reactor capacities within the next five years. By March 2010, this goal had been downscaled to just 5.2 GW. After auditing the Ministry of Energy in March 2010, the Russian Audit Chamber announced it would not be possible to achieve the target outlined in the plan. As a result, only about 40% of planned reactors were expected to come online by 2015.

In July 2012, Russia’s overall nuclear power development target for 2020 – 44 GW – was again reduced, to 30.5 GW. The new target remains a pie-in-the-sky figure because the Russian industry is unable to produce more than one reactor per year, according to the industry’s top officials.

As of today, Rosenergoatom – Rosatom’s reactor-operating branch – lists ten new reactors as under construction: eight VVER units, one fast breeder that is approaching the 30-year anniversary of its construction, and a small floating nuclear plant.

At least two of the VVER projects on this list have seen no progress since mid-2013 – the two units of a planned Baltic NPP in Kaliningrad Region. A variety of reasons caused the construction to freeze indefinitely, including the limited market for the future electricity and harsh criticism by environmental movements on the project’s safety and financing issues. Rosatom sought funding for this project in European Union countries, in hopes to involve foreign investors and energy companies in building the plant and exporting its energy to Europe. These negotiations took three years and proved unsuccessful. Russia’s neighbor and EU member, Lithuania, also repeatedly criticized Rosatom over the project’s safety and lack of transparency. Environmental groups from both Russia and Europe successfully campaigned against this project by pushing European banks and companies to stay away. In 2013, the German Hypovereinsbank and the French BNP Paribas announced in written form that they would not join the project. Earlier,
the Italian energy giant ENEL had stated that it was doing its assessment and looking into the possibility of investing in the Kaliningrad project. That led to heavy criticism by Russian and Italian environmental groups in 2011-2012. The company never announced its decision. The French bank Société Générale was under heavy pressure from Russian and French campaigners in 2013 over its possible involvement in the Kaliningrad project. Société Générale’s managers said in the beginning of 2013 that the bank planned to assess the possibility of joining the project in Kaliningrad by providing the funds for turbine manufacturing by the French firm Alstom. No decision was announced before the Russian government put the project on hold in June 2013.

Two more VVER-1200 reactors are currently under construction at the Leningrad nuclear plant; construction started in 2008 and 2010, respectively. The units were slated for grid connection by 2013 and 2016. Both projects, however, hit delays with grid connection dates pushed back to 2016 and 2018, partly on account of a major accident that occurred at the construction site on July 17, 2011. A 600-800-ton reinforcement cage of the containment building fell on its concrete frame. The weight of the cage caused the concrete frame to crack and the entire structure had to be replaced, leading to massive additional costs.14

Another two units on Rosenergoatom’s current construction list are so-called “floating reactors” (Akademik Lomonosov 1, 2), 32 MW each. Rosatom began this project in 2007 with plans to complete it by 2010. As of 2014, the completion date had been revised to 2019.15 Among the major concerns with the project are the high risk of accidents, vulnerability to piracy and terrorism threats, and the increased risk of proliferation of nuclear materials, if the project is taken to serial production and floating nuclear power plants are deployed on a wide international scale.16

However, two units each at the Novovoronezh plant, Novovoronezh-2 (VVER-1200, under construction since 2007, delayed for 2-3 years), and Rostov (VVER-1000, under construction since 1983) are close to completion. Russian media repeatedly reported on corruption and safety concerns related to the Novovoronezh-2 construction, but there was no investigation of these claims by Rosatom.17

Another unit that is nearly completed is the fourth unit at Beloyarsk. This is a fast breeder of the BN-800 design; construction started back in 1986. So far, the only commercial breeder reactor in operation in the world is the highly problematic Beloyarsk-3, of the BN-600 design. It was passing its 30-years-in-operation mark back in 2013 and got its license extended for another 15 years.

Fast breeders

The nuclear industry started to promote the so-called closed nuclear fuel cycle with fast breeder reactors some 50 years ago. The idea was to develop a technological cycle that would involve reprocessing spent nuclear fuel, extracting plutonium from it, and then “breeding” this nuclear material in commercial reactors in order to provide the nuclear power industry with a virtually inexhaustible source of fuel while also eliminating the problem of managing the highly toxic nuclear waste. No country in the world, however, has since been able to introduce a closed fuel cycle successfully. All breeders that were brought online in Western countries that attempted to close the nuclear cycle stopped their commercial operation long before their designed lifetime periods expired, for economic, safety, and technical reasons. As of 2014, Russia remains the only country with a fast breeder reactor in commercial operation, a BN-600 operating at Beloyarsk Nuclear Power Plant.

The Beloyarsk station is near Russia’s third largest city of Yekaterinburg, in the Ural region, some 2,000 km east of Moscow. Thirty various accidents occurred at the BN-600 during its 30 years of operation, some convolving radioactive releases. A larger-capacity breeder reactor, of the BN-800 design, may enter commercial operation as early as 2015 at the same plant. Russia is further planning to export this technology, in particular to China.

In the 1980s, the Russian nuclear industry planned to build another breeder reactor, at the South-Ural nuclear plant in the region of Chelyabinsk, but in a referendum held in 1990, local citizens voted against the construction. In 2008, the Russian government again included the South-Ural NPP into its nuclear power development program. In August 2011, however, it was announced that plans for this nuclear plant were postponed indefinitely.
Fast breeders are designed to breed plutonium – i.e. produce more plutonium than they consume – while generating electricity. Russian proponents of the use of plutonium for electricity generation continue to argue that reactor-grade plutonium cannot be used in nuclear weapons because of "pre-initial ignition," and that the plutonium programs should not be considered contrary to nuclear non-proliferation goals. But this is nothing more than adspew refuted by facts recognized in the international scientific community. The 1994 U.S. National Academy of Sciences report on disposal of nuclear weapons materials, for instance, states that "plutonium of virtually any isotopic composition can be used in nuclear weapons".18

In Russia, plutonium fuel is not yet used on an industrial scale, but Rosatom is developing plans to introduce mixed uranium-plutonium oxide (MOX) fuel at certain nuclear power plants. In particular, new power units of the VVER-1200 type are capable of using MOX instead of conventional uranium fuel. In addition, the newly built fast breeder of the BN-800 design at Beloyarsk will likely use MOX fuel as well.

Plutonium is one of the most dangerous radioactive substances for human beings. When released into the biosphere, it interacts with natural biochemical cycles. The radiation hazard of plutonium is due to its alpha activity, the specific value of which is approximately 200,000 times greater than that of another alpha emitter, uranium-238. Plutonium has a half-life of 24,000 years. Once inside the human body, plutonium remains there forever, destroying the surrounding tissue with strong ionizing radiation. Even an insignificant amount of plutonium can cause severe, even fatal, damage to the body. Alpha particles have low penetration depth: they are stopped by clothes and the skin. However, plutonium can enter the body via the respiratory or digestive tracts.

All nuclear power plants, even in the course of regular, accident-free operation, emit radioactive waste in gaseous, liquid or solid form. Introducing MOX fuel into the nuclear power cycle will inevitably lead to radioactive releases containing additional particles of plutonium, which may spread into the environment. And should an accident occur at a MOX-fueled nuclear power plant, the risk of plutonium contamination will be greater compared to an accident at a reactor running on uranium fuel.

Beloyarsk NPP started to use MOX fuel in 1988, but to a very limited extent. Over the next twelve years, until 2000, 34 fuel assemblies with mixed fuel were altogether loaded into the BN-600 (annual consumption of uranium assemblies is 246).

Sodium is used in the BN-600 as a coolant in the primary and secondary circuits, and the third circuit is water/steam with intermediate (sodium) overheating of steam. Sodium burns when in contact with the air or other oxidizing environments. Burning sodium produces smoke that can cause damage to equipment. The problem becomes more complicated if the smoke is radioactive. When in contact with concrete, hot sodium can react with the concrete’s components and evolve hydrogen, which, in turn, is explosive. Sodium is very likely to react with water and organic materials as well. This is especially important for the design of a steam generator, as leakage from the water circuit to a sodium one leads to a rapid increase in pressure. In addition, the "hollow effect" of positive sodium in the BN reactor core is very likely to occur, which can lead to a thermal explosion.

Over the 30 years of its operational history, 27 sodium leaks occurred at the BN-600, five of them in systems with radioactive sodium; fourteen were accompanied by burning of sodium, and five were caused by improper maintenance or repair operations or by the unit input/output operations.19

One of the accidents at the BN-600 occurred on January 21, 1987: As a result of the operating temperature in the reactor core exceeding permissible levels, fuel claddings suffered massive loss of seal. This led to a radioactive release with a total activity of about 100 thousand Ci. In all its characteristics, the incident was a Level 4 accident if assessed on the International Nuclear Event Scale.

In August 1992, an expedition of the State Chernobyl Committee of Russia to the Beloyarsk NPP area found anomalous concentrations of cesium-137 and cobalt-60. Maximum radiation levels were registered at about 1200 mcR/h and were attributed mainly to the radiation emitted by cobalt-60 particles.

On September 9, 2000, personnel errors caused an accident in the Sverdlovenergo power grid, which supplies the Beloyarsk plant with electricity. As a result, the Beloyarsk station was disconnected from power supply. Three seconds later the BN-600 reactor was shut down by its automatic emergency system. The plant’s power output dropped to zero. The station remained in blackout for nine minutes. Emergency situations of this kind are not described in the operating instructions. The BNPP was only a few minutes away from a Chernobyl-type disaster.

In 2010, Rosatom secured $200-million in government funding to develop a new breeder design, the BN-1200.20 Three BN-1200s were planned to be under construction in Russia for completion by 2030, Rosatom head Kiriyenko said.21

Waste and spent nuclear fuel reprocessing

According to governmental sources, about 500 million tons of radioactive waste is accumulated at various facilities across Russia. There is no clear plan as to how the waste problem should be solved. Rosatom has pushed through the Russian Parliament the “Law on the Radioactive Waste treatment,” a first of its kind in Russian history. The adoption of the law was protested in a dozen of regions across Russia because it effectively excludes local population from the decision-making process over establishing new sites to store and dump radioactive wastes. Judging by the supplementary documents given to the parliamentarians in 2009 along with the proposed draft of the law, the radioactive waste management plan outlined by Rosatom would affect no more than 30% of all accumulated wastes until 2030. It is unclear when and how the majority of the Russian radioactive waste will undergo proper management or treatment. Some of the storage facilities across Russia are in poor condition and require urgent measures to avoid radiation leaks.22

The overall amount of spent nuclear fuel accumulated at Russian nuclear sites is estimated at over 22,000 tons. Fuel from seven commercial reactors (six VVER-440s and the BN-600) is transported for reprocessing at the Mayak nuclear facility in Chelyabinsk Region – a place of a devastating nuclear accident of 1957, which caused widespread radioactive contamination and led to the resettlement of about 20,000 of local residents in the subsequent decades.

Spent nuclear fuel reprocessing does not help to solve the problem of nuclear waste. Rather, it makes the problem that much bigger. Between 100 to 200 tons of radioactive waste of various compositions and activity levels is generated during reprocessing per just 1 ton of spent fuel reprocessed. As a result of the reprocessing activities at Mayak, large amounts of radioactive waste have been accumulated and, over the years, partly dumped into the local river, Techa, causing ever wider radioactive contamination. In 2005, Mayak’s former director, Vitaly
Sadovnikov was taken to court and charged with illegal dumping of radioactive waste into the Techa. Although he was found guilty by the court, Sadovnikov was immediately released under an amnesty granted by the Russian government. Nevertheless, the court’s decision concluded that radioactivity levels in the river water were so high in some parts of the Techa that the water could well be qualified as liquid radioactive waste.

Although environmental groups successfully pushed the nuclear industry to resettle Muslyumovo – the most contaminated village in the region – several thousands of local residents still live in the radioactively contaminated area on the banks of the Techa. The Russian government and the nuclear industry refuse to provide resettlement funding for the local residents while many of them continue to suffer from radiation-caused illnesses, including conditions related to genetic damage.

In 2011, about twenty families of local villagers along with two environmental groups (Ecodefense, Planet of Hope) filed a class action against the nuclear industry and several government ministries over the lack of radiation protection in the contaminated area.

Spent fuel from the VVER-1000s and RBMKs is only stored in Russia, as the country does not possess a facility for reprocessing such fuel. While reprocessing of spent RBMK fuel was never seriously planned, a plan to build a facility to reprocess spent fuel from the VVER-1000 reactors, to be sited in Krasnoyarsk, Siberia, has existed since the 1980s. After it was approved by the Soviet government, the plan was stopped by mass protests around 1990. It is unclear if Rosatom will ever bring it to implementation.

One of the issues under discussion in the nuclear industry is the future plans for the management of spent nuclear fuel. Rosatom may either go for reprocessing and extraction of plutonium – especially if the development program for breeder reactors and the concept of using plutonium as fuel gets political approval – or for final disposal of spent fuel in a repository in a deep geological formation near Krasnoyarsk. Presently, the option of long-term storage there is approved with a new storage site partly completed in that area. It is projected that the storage site will hold close to 40,000 tons of spent fuel in the future. As of today, spent fuel is mostly stored at nuclear power plants around the country, and the old storage facilities are overfull or nearing capacity; Rosatom is planning to move 22,000 tons of this fuel to Krasnoyarsk by 2025. But any final solution for the highly radioactive spent fuel must include efficient barriers to prevent the radiation from escaping into the surrounding environment during the next million years. Such a solution obviously does not exist.

International activities

Despite continuous media reports about new deals that Rosatom has signed with yet another foreign customer, any current reactor construction is only proceeding in Russia, China, India and Belarus. Notably, Rosatom is not only proposing to build reactors in various countries, but it also offers Russian state funding to support the construction loans, as well as fuel cycle services (such as supplying fresh fuel and taking back spent nuclear fuel). Given the limited capacity in reactor manufacturing, it is unclear how many nuclear plants of Russian design will actually be built across the world and in what time frames. Moreover, the quality of the nuclear power plant components produced by Rosatom enterprises has been called into question after numerous complaints from CNNC, the corporation’s partner company in China, in the process of building the Tianwan nuclear plant.
While the import of radioactive waste to Russia is forbidden, spent nuclear fuel is not treated as waste under the Russian law and can be imported for reprocessing. At the same time, radioactive waste resulting from the reprocessing in Russia can be sent back to the country the spent fuel came from.

One of the most controversial deals signed by Rosatom in recent years is the Turkish Akkuyu NPP. Under the “Build, Own, Operate” (BOO) scheme, a Russian consortium will own and operate the plant. Fuel services are included. Turkey agreed to guarantee the future price of energy for 15 years. The total cost of Akkuyu is expected to be around $20-billion for four reactors. The agreement on the nuclear plant construction was signed in 2010, with the start of construction expected one year later. However, construction works at the site are unlikely to start before 2016. So far, this is the only current BOO deal signed by Rosatom. In 2011 to 2013, about $1.5-billion in state budget funds was obtained by Rosatom for this project.

In Belarus, construction work started at the site in Ostroves, near the Lithuanian border, officially in late 2013. Rosatom is planning to build two VVER-1200 (AES-2006 or NPP-2006 design) units in Ostroves, with commissioning dates set for 2018 and 2020. The Russian government provided $10-billion credit to Belarus for this project.

Two deals were signed with EU member countries in 2014. In Finland, Rosatom signed a contract to build the Hanhikivi nuclear plant. And in Hungary, the agreement envisions Rosatom building two VVER-1200 reactors at the old Paks NPP. In both cases, Russian funding is directly involved. In Finland, Rosatom paid €36-million for a 34% stake in the company, Fennovoima, which will own the reactor. In 2014, Rosatom asked the Russian government for additional funding of over €1-billion for this project. The Finnish parliament is expected to make its decision on the Hanhikivi NPP before the end of 2014. In Hungary, a €10-billion loan for the construction at Paks was approved by Russia. This loan will cover up to 80% of costs, while the rest is to be covered by the Hungarian national government. It was reported that the reactors will be completed by 2025. Hungary will start repaying the loan after the reactors are commissioned but not later than 2026. Some of the construction orders may be given to the Hungarian company Ganz EEM, which is controlled by Rosatom. Construction has not started yet.

Rosatom’s previous experience negotiating deals in the EU had not been good. A BOO contract was signed with Bulgaria in 2008 with a value of €4-billion. The project of Belene NPP included the construction of two VVER-1000s (the AES-92 or NPP-92 design). The situation changed after the Bulgarian Socialist Party, then in power, lost the elections and a new, opposition-led government came to power. In 2011 to 2013, Rosatom paid €36-million for a 34% stake in the company, Fennovoima, which will own the reactor. In 2014, Rosatom asked the Russian government for additional funding of over €1-billion for this project. The Finnish parliament is expected to make its decision on the Hanhikivi NPP before the end of 2014. In Hungary, a €10-billion loan for the construction at Paks was approved by Russia. This loan will cover up to 80% of costs, while the rest is to be covered by the Hungarian national government. It was reported that the reactors will be completed by 2025. Hungary will start repaying the loan after the reactors are commissioned but not later than 2026. Some of the construction orders may be given to the Hungarian company Ganz EEM, which is controlled by Rosatom. Construction has not started yet.

In 2013, it was reported that Rosatom may build a VVER-1000 reactor at the Rooppur side in Bangladesh. And in 2010, Vietnam announced it intended to order two reactors from Rosatom for its Ninh Tuan site. In both cases, reports said the reactors may be commissioned as soon as 2020. As of 2014, construction has not started at either site. Significant delays are expected for these projects.

In 2014, Russia and Kazakhstan signed an intergovernmental agreement on building a new nuclear power plant in that former Soviet state. The project is far from implementation as many important details such as the choice of design, the number of reactors, or the future location in Kazakhstan are yet to be confirmed. Various reports on negotiations for new reactors were also coming from Iran, India and China in 2014.

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**Gen III+ (VVER-TOI, VVER 1300/510, AES-2010)**

A VVER-TOI nuclear power plant, also referred to as AES-2010 (or NPP-2010), is a two-unit nuclear power plant with VVER-1300/510 water pressurized reactors. The plant’s operation life is 60 years and power output is 1255 MW per reactor. No plant of this design has yet been put into operation in Russia or abroad. This means that no operational experience or independent safety assessments exist for the project.

The Generation III+ design is advertised as one that offers improved safety systems, taking into account lessons from previous nuclear accidents, and has better economic performance.

The joint stock company Atomenergoproekt (which is a Rosatom enterprise) is the general designer for VVER-TOI. The company, as its information page says, performs the full complex of engineering services on the project ordered, including engineering research, construction, delivery, and commissioning. Additionally, safety-critical instrumentation and control systems may be provided by the British-French Rolls-Royce corporation, and turbines by the French Alstom.

The company says that the VVER-TOI project “was developed on the basis of the design documents worked out for AES-2006.” Atomenergoproekt was the general contractor on the construction of Novovoronezh NPP-2 (where the first nuclear plant based on the AES-2006 design is being implemented in Russia; it includes two VVER-1200 reactors).

Atomenergoproekt claims construction time, from first concreting until physical startup, will be 48 months for the first unit and 40 months for the second unit of the VVER-TOI plant. But Novovoronezh NPP-2 has to date been under construction 84 months. There is no clear evidence that Atomenergoproekt can build faster.
Although Rosatom often claims that domestic VVER-1200 projects cost around $5-billion, it is hard to obtain independent evidence for this figure. The only independent cost estimate on this reactor was published in Finland in June 2014, when it was reported that the expected construction cost of one VVER-1200 at the Hanhikivi site would be about €7.68-billion. This is close to the price estimate reported for the French EPR, which puts in doubt the claim that Russian reactors are cheaper than Western ones.33

It is not unusual for Russian nuclear construction projects to fall behind schedule by at least two years, which increases initial costs by 10-25%.34 Even though Rosatom claims a VVER-TOI project would be 20% cheaper compared to a VVER-1200 design, the usual delays will likely eliminate this saving.

Another point of concern is that the Russian nuclear industry has never operated reactors designed to remain in service for more than 60 years. At present, Rosatom is obtaining 15-year license extensions for old Soviet reactors which were originally designed to operate for 30 years. Extending the service life of an old reactor may lead to serious consequences for its safety, as in the case of the LNPP’s RBMK reactor, which was shut down forever for research and expensive repair work after cracks were found in the unit’s graphite stack.

The designers of the VVER-TOI project claim it includes a combination of passive and active safety systems which makes the nuclear plant safer compared to previous designs. However, according to the former Russian deputy Minister of Atomic Energy, Bulat Nigmatulin, passive safety systems are not fully passive and still require automatic system response. With concern then over their effectiveness, improvement in this field would make both construction and operation more expensive.35

The accident control facility of the VVER-TOI project includes a corium trap Atomenergoexport’s information says. It is expected that this trap will capture the molten core material (corium) of the reactor in case of a nuclear meltdown. But Nigmatulin points to an ongoing discussion among reactor experts concerning the risk of the trap itself melting if the corium reacts with the material the trap is made of, and hydrogen being released.

In general, the question of safety of the VVER technology is still open. The latest experience with the newly-built Kalinin-4 unit (VVER-1000) puts its declared high level of safety in doubt. The reactor went critical in October 2011. According to the regulatory body Rostekhnadzor, a hydrogen explosion occurred at the reactor on November 26, 2011.36 This accident prompted serious public concern about possible radioactive leaks. Within just two months following the reactor launch, eleven incidents were reported, including emergency shutdowns and primary circulation pipe failures.

Corruption in the Russian nuclear industry

Corruption risks have been historically high in the Russian nuclear industry. One of the most glaring examples occurred back in 2000. The environmental group Ecodefense managed to foil a Rosatom deal which envisioned building a nuclear waste repository on Simushir, an uninhabited island near the Kuril Islands in the Far East. The repository was to hold nuclear waste imported from Taiwan and Japan, and the deal involved the participation of certain high-ranking officials both from the nuclear industry and the Russian parliament, the State Duma. According to documents pertaining to that deal, the Russian participants promised, in return for a remuneration, to lobby a change in legislation that would allow the importation of radioactive waste into Russia. The document confirming this secret deal was published on the front page of a national newspaper, and this was followed by a special meeting in the Duma which effectively stopped the deal. No criminal charges were ever filed against any of the alleged participants, and neither officials in the industry nor the parliamentarians involved were prosecuted.

Corruption in the Russian nuclear industry was not researched much until 2010. The first major attempt to analyze the situation was carried out by two non-governmental groups – Transparency International (Russian branch) and Ecodefense. Their joint study, published in November 2010, took a look at some 300 orders placed by Rosatom and posted on the corporation’s official website; after an initial screening, 200 of these were chosen for a detailed analysis.

A monitoring study of the selected sample of 200 purchasing agreements made by Rosatom revealed numerous violations of what is called the industry procurement standard. In particular:

- violations when choosing the method of placing a particular order;
- failure to provide cost estimate documentation when ordering construction or renovation works for buildings and infrastructure (such documentation was only found in one case);
- imposing requirements containing mentions of specific means of individualization (this legal category is used to describe the means of identifying discrete goods, services, enterprises, organizations and other economic entities –such as trademarks, domain names, company names, or other such identifiers).

Violations of the Russian procurement standard were found in 83 purchasing contracts, or 41% of the 200 contracts selected for in-depth analysis.

Furthermore, the study found, purchasing activities of Rosatom companies fall under no external control. Where purchasing deals are concluded in most state-governed structures, such control is the purview of the Federal Antimonopoly Service, but this agency’s mandate is limited when it comes to oversight of state corporations. The Central Arbitration Committee set up by Rosatom to supervise the placement of orders by its companies is a body of internal control and its authority is incommensurable with that of the Federal Antimonopoly Service. As a supervisory structure, the Committee has a passive function, only conducting its audits on the basis of complaints it receives – whereas the state’s Antimonopoly Service is entitled to carry out its audits when and where it sees fit. The glaring gap between the levels of transparency and openness in the operations of these two bodies is just as obvious: In contrast to the Federal Antimonopoly Service, Rosatom’s Central Arbitration Committee does not publish its decisions, but only general statistics on the complaints filed for its consideration.
Ecodefense and Transparency International Russia's study demonstrated that the order-placing activities of Rosatom companies are exposed to high corruption risks. These activities are regulated by the Industry Standard, whose guidelines are not on par with those of the corresponding federal law. Moreover, the contracts studied show that even these weaker regulations are often ignored by the purchasing parties. There is no outside control present to oversee the agreements, while Rosatom's internal oversight structure, the Central Arbitration Committee, has a passive role and does not provide a due level of information disclosure. All of these factors add up to produce a closed-circuit system in which a contracting party will only allow certain select companies into the purchasing contracts, while the purchasing itself is done at overcharged prices with violations of the Industry Standard.

When the state corporation Rosatom was created out of a former government agency in 2008, it became something of a cross between a state organization and a private-owned company, a legal entity fitting no standard definition and charged with undertaking commercial activities on behalf of its owner, the government. This metamorphosis meant, effectively, that on top of the resources that the agency received from the state, it would also enjoy another source of income: borrowing money from private investors. Rosatom converted most of the enterprises of the atomic industry into joint stock companies, which, nonetheless, still remain under state control. All of these developments were considered opportune for attracting more funds.

The current legal format that determines the operations of the state nuclear corporation is thus nothing short of a breeding ground for abusive practices, and a concept Russia would be better off abandoning. Rosatom is, in essence, a “state within the state,” functioning under no one’s control but its own.

A wave of corruption scandals swamped Rosatom after the report was published. The work that Ecodefense and Transparency International Russia had conducted to expose the high corruption risks in the corporation led to important consequences. Rosatom became more mindful of its public image and started various programs aimed at improving its image. Several years after the study was published more than 270 Rosatom employees were fired over corruption allegations. Several cases involved top officials, one as high-ranking as a deputy director.

In July 2011, Rosatom’s former deputy general director, Yevgeny Yevstratov, was arrested on suspicion of embezzling 50-million roubles ($1.7-million). The charges were related to a series of incidents of large-scale fraud that investigators said took place at Rosatom and its nuclear fleet subsidiary, Atomflot, under Yevstratov’s supervision. Prosecutors said in court that Yevstratov was suspected of two cases of embezzling budget funds allocated for the planning and construction of facilities. Later investigators found that Yevstratov and another high-level Rosatom executive, Mustafa Kashka, the deputy director general of Atomflot, may have embezzled an additional 60-million roubles (around €1.5-million) intended for reprocessing of nuclear waste.

In February 2012 it became known that the ZiO-Podolsk machine building plant’s procurement director, Sergei Shutov, had been arrested for allegedly buying low-quality raw materials on the cheap and pocketing the difference. It is not clear how many reactors have been impacted by the alleged crime, but reactors built by Russia in India, Bulgaria, Iran, and China, as well as several reactor construction and repair projects in Russia itself, may have been affected by sub-standard equipment, given the timeframes of works completed and the scope of the investigation as revealed by authorities. The charges leveled against ZiO-Podolsk, which is Russia’s only manufacturer of steam generators for nuclear plants built by Rosatom domestically, and internationally, were a staggering blow to Rosatom’s credibility, probably the biggest one in its history. Founded in 1919, ZiO-Podolsk produced the boiler for the first electricity-producing nuclear reactor at Obninsk in 1952, and has produced the boilers for every Russian reactor built ever since. ZiO-Podolsk is a subsidiary organization of Atomenergomash, founded in 2006. Atomenergomash was acquired by Atomenergoprom, which is 100%-state-owned, in 2007. Atomenergoprom is a part of Rosatom.

Rosatom says it has been working hard to deal with corruption, but judging by the most recent news media reports, the corporation has not solved the problem.

In October 2014, it was reported that another high-level corruption case was under investigation at Rosatom’s Siberian Chemical Combine (SCC). Historically, the SCC used to produce plutonium as part of the Soviet nuclear weapon program, and was also involved in storing radioactive uranium wastes from Europe. Two months ago, the top-management of SCC was accused of bribery related to procurements. Russian media also questioned the case of the 23-year-old son of Rosatom head, Sergei Kiriyenko, Vladimir, who obtained a large number of shares in the bank connected to Rosatom.

In November 2014, US authorities arrested the director of Rosatom’s fuel supply arm, Vadim Mikerin, during an FBI sting operation. Mikerin is alleged to have accepted bribes of around $1.7-million from three American businessmen in exchange for tenders.

It appears that corruption has deeply penetrated various branches of Rosatom. And so far the corporation’s management has not been able to present any kind of plan that would convince the public of its ability to solve the problem.
Conclusion

Rosatom remains one of the largest nuclear energy producers and reactor suppliers in the world. Its willingness – attested to by deals signed with developing countries for dozens of reactor contracts in recent years – to enter unstable markets, and to offer state funding and fuel services as part of the package, ensures the corporation a leading position on the international market.

However, taking into account its limited reactor manufacturing capacity and the current domestic development plans in Russia, it is unlikely that Rosatom will be able to build new reactors in other countries as scheduled. Cost overruns and significant delays must be expected. So far, active construction is only underway in Russia itself, China and Belarus. Furthermore, with cost overruns only growing with additional reactor projects planned for construction, it is unclear how many deals can actually be funded from the Russian state budget. While Rosatom estimates the cost of its new 1200 MW reactor between $5-billlion and $5-billion in various cases, independent assessments suggest it could be as much as €7.7-billion, which is close to the cost of France’s EPR.

Very serious concerns exist with regard to Russia’s aging reactors, which have been given 15-year license extensions when their original operating life expires. Some of the old reactors do not have a secondary containment, which is unacceptable under modern safety requirements. With the current policy of extending the operation of old reactors, the risk of new nuclear accidents is growing. Moreover, Russia still does not have a detailed plan for decommissioning its old reactors, and the experience it can rely on in this field is very limited.

As for its new projects, Rosatom is promoting its new reactor design, the VVER-TOL, to international customers even though this design has never been tested in practical operation in Russia. No assessments of this design have been done by independent experts, either. It remains unclear if safety has been improved in the new design, as Rosatom claims. But even industry experts put Rosatom’s claims of increased safety in doubt and argue over the effectiveness of new safety systems.

Existing Russian reactors, likewise, do not demonstrate a high level of safety. Over a dozen incidents and failures have already occurred at the newly built VVER at Kalinin NPP, including one involving a hydrogen explosion. The Russian fast breeder reactor – the only commercial unit of this type in the world – has in its over 30 years of operation experienced almost as many various accidents, including fires involving radioactive substances and coolant leaks. Further development of the breeder technology planned by Rosatom in Russia includes experiments with plutonium fuel. VVER-1200s are also designed to operate with plutonium fuel. Introducing variations on the Chernobyl design – still remain in operation in Russia.

Rosatom continues to reprocess spent nuclear fuel at the disastrous Mayak facility. Not only is the stockpile of extracted plutonium growing, but there is also a constant significant increase in volumes of radioactive waste resulting from reprocessing. Russia has no realistic and viable plan for the disposal of radioactive waste. The risk of radioactive leaks from the aging radioactive waste storage facilities is increasing. Rosatom’s attempts to build new disposal sites for radioactive waste in several regions of Russia have been met by harsh opposition from local populations and environmental groups. But even if such sites were ultimately built, their capacity would be enough to take care of only a small fraction of the waste accumulated over many decades.

Since the late 1980s, the Russian nuclear industry has been under heavy criticism from environmental movements for its lack of safety and poor economic performance. Criticism came not only from the Chernobyl accident and many smaller accidents at other nuclear plants, but also for the industry’s failure to reettle thousands of villagers residing in the areas surrounding the Mayak nuclear facility in the Ural region, areas that suffered severe contamination from the explosion at the plant in 1957. The industry’s response to these accidents clearly demonstrates a lack of responsibility for the damage caused and a poor safety culture in general.

Historically, the Russian environmental movement has been successful in halting reactor construction at several sites and disrupting deals aimed at importing radioactive waste into Russia. Civil society groups have also played an extremely important role in anti-corruption activities related to the nuclear industry. At the same time, citizen groups that level criticisms against the nuclear industry have come under serious pressure during the last decade. There were several arrests of activists even during public hearings on new nuclear reactors, arrests during protests having long been common in Russia. Recent widespread repression undertaken by the Russian government against civil society in the form of the infamous “Foreign Agent” Act has also heavily affected the activities of the anti-nuclear community. Several media reports suggest Rosatom may well be behind using the “Foreign Agent” legislation to drive this repression forward.

With vast resources and solid state support at its disposal, the Russian nuclear industry remains under almost no external control. The lack of transparency, widespread corruption, failure to demonstrate high levels of safety, and the unresolved waste and decommissioning issues must be of high concern to any potential customer of Rosatom’s on the international market.

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