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ANALYSIS

Russia's Nuclear Power and Finland's Foreign Policy

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Abstract:
It is a widely shared wisdom that energy is a central component in Russia's foreign policy. The public discussion in Finland of the Fennovoima nuclear power plant, built now by Rosatom, shifted after the onset of the Ukrainian conflict. The insistence by some Finnish political and economic actors that the Russian nuclear power deal has nothing to do with foreign and security policies is worrying, as the measures taken both by the Finnish and Russian actors clearly demonstrate that the nuclear business, in particular, is highly political.

Finland's Nuclear Power: From Russia Rather than Europe

In autumn 2015, Finland's government accepted the nuclear power plant (NPP) proposal prepared by the Finnish–Russian power company Fennovoima (Finnish Power). The government decided to go ahead with the the Rosatom 1200 MW project even after Russia had occupied the Crimean Peninsula and launched a proxy-war in Eastern Ukraine. The Fennovoima NPP originally was supposed to be financed and built by a German–Finnish consortium, but the German energy company E.ON withdrew from the project in October 2012. This consortium sought to build a larger 1600–1700 MW NPP in Pyhäjoki, northern Finland, using either Areva's French or Toshiba's Japanese technology. The Finnish energy company Voimaosakeyhtiö SF—with investments from Finnish heavy industries, retail companies and municipal power and heat enterprises—held a 66 percent share, and the German E.ON covered 34 percent.

In 2013, Rosatom proposed not only to build the new Finnish nuclear plant, but also to cover the required investment costs, amounting to one third of approximately 8 billion euros for the entire project. The French Areva was (and still is) building the notorious Olkiluoto 3 NPP in southern Finland and, after having severe problems in quality assurance leading to delays and cost overruns, was not included in the new Fennovoima bid. Toshiba submitted a full application with hundreds of pages of technical details, but the Finnish side accepted Rosatom's application, which was only a couple of pages long. The Fennovoima management was certainly less interested in Toshiba's technology after the Fukushima accident, and attracted by Rosatom's generous offer to partially finance and build the NPP in addition to providing support and uranium fuel.

After Russia became involved in the war in Ukraine, the Fennovoima project was doomed to become politicized. In February 2014, at the same time as Russia orchestrated the occupation of Crimea, the Finnish Government signed a nuclear cooperation agreement with its eastern neighbor, with the head of Rosatom Sergei Kirienko acting as Russia's signatory. This deal reinforced Rosatom's position vis-à-vis other international nuclear companies trying to compete in the Finnish energy market.

The Pyhäjoki NPP process became even more interesting from the foreign policy perspective when the Finnish government set a 60 percent threshold for domestic financing—in order to be accepted, at least 60 per cent of Fennovoima ownership should be in the hands of Finnish or other EU actors. This decision came following increased public discussion concerning whether Finland should let Rosatom build and own the Pyhäjoki NPP in a situation where Russia is flouting international agreements and law. This issue became even more acute after several domestic investors withdrew from the project, meaning that the foreign ownership share might exceed 50 percent. Rosatom had expressed willingness to finance more than the 34 percent initially agreed upon.

In late 2014, the Finnish state majority-owned energy company Fortum, which produces heat and power in the Nordic and Russian markets, announced that it could invest 15 percent in the Fennovoima NPP. This would guarantee the necessary level of domestic ownership. Fortum's bid was conditional, and included transferring the hydropower assets of Gazprom in the regional energy company TGK-1 in Northwest Russia to Fortum. The negotiations on Russian hydropower assets continued between Fortum, Gazprom and Rosatom from late 2014 until summer 2015, but were not successful for Fortum. The hydro assets were clearly—both economically and strategically (geopolitically)—too important for Gazprom and Putin's regime to be used as a trade-off in the Fennovoima–Rosatom deal. In June 2015, contrary to the desires and expectations of Fortum and the Finnish government, the Russian gas monopoly did not hand over the hydro assets, but instead introduced a Croatian company as a new domestic investor. It was soon revealed that the Croatian Migrit Energija was owned by two sons of Russian oligarchs with newly acquired Croatian citizenship. Thus, this "Croatian" miniature enterprise of two persons, with a liquidity of a few mil-

lion euros, was supposed to invest 150 million euros in the Fennovoima project. It was clear that this was a Russian shell company, especially since Sberbank Rossii was to be the creditor for this Croatian company. This gambit by Rosatom and Putin's regime politicized the project even further. The Finnish government had promised the Finnish Parliament that the needed domestic ownership shares would be acquired by June 2015. But as no domestic, i.e. European, investors were found before the deadline, the Russian party tried to push the project further with the help of this Croatian puppet.

This maneuver gave the Russian side an opportunity to keep the process alive, while testing the Finnish side. The deadline set by the government to gather the necessary domestic investors was superficially met, but it was clear that the Finnish government would refuse to accept the Croatian company as domestic. Moreover, this bid further diminished Fortum's chances to succeed in their hydropower trade-off. Parties in Moscow were well aware, e.g. via the former head of Rosatom and the Russian Ambassador to Finland Alexander Rumyantsev, that the Finnish conservative government was keen on pushing through the Fennovoima NPP. Finally, in early autumn 2015, Fortum announced that it would step in as an investor (covering 6.6 per cent), and therefore guarantee the required domestic euros for the plant. To everyone's surprise, the investment commitment was made without Fortum getting its hands on Northwest Russian hydropower. This outcome caused suspicion that the Finnish government had pressured Fortum—an independent listed company—to make the asymmetric move following ministerial level negotiations in Moscow.

Tabooification: Criticism as "Russophobia"

This chronology demonstrates that major energy deals, not least nuclear, have foreign policy ramifications. However, Russia is a party to the war in Ukraine, and Finland has, along with other EU member states, imposed economic sanctions on Russia that specifically target the energy sector. In light of this, the assurances that the Fennovoima NPP has nothing to do with foreign and security policy made by Finnish and Russian actors who want to see the project materialize are, to say the least, odd.

Politicians who support the Rosatom NPP have accused its critics of being biased and unpatriotic, which in itself demonstrates that foreign policy plays a strong role in the project. Former Prime Minister Alexander Stubb has talked about the demonization of Russia. Critics of the project have been accused of Russophobia. It appears that criticizing a corporation owned by a country at war is considered equivalent to criticizing the entire country and its citizens. The same members of parliament that voted for sanctions targeting the Russian energy sector seem to have no problem with Finland's commitment to a project that is of great symbolic and actual importance to Vladimir Putin's government. This illustrates how sensitive the topic is for Finns.

What makes the discussion so interesting and also problematic are the assurances that energy policy, especially regarding nuclear power, can be separated from foreign policy. Finnish energy policy is presented as being immune to the power that is exercised globally through energy. These arguments do not hold up in the face of critical research.

Energy Plays an Important Role in Russian Politics

From the early 2000s, when energy exports greatly increased Russian revenues, the Russian government has been building its national identity on a foundation of energy prosperity and military strength. Channeling energy money into the population's well-being and, even more so, into enhancing the country's military power has made Putin's government popular. Energy has become an important tool for building Russia's Great Power identity. Energy prosperity has allowed Russia to emphasize its special status and helped detach it from the framework of European mutual dependence and the institutional integration promoted by the EU.

During the Ukraine war, the Russian identity became even more closely linked to energy. The national media has suggested that Europe's energy dependency facilitates Russia's actions in the Ukraine. Putin's government and the Russian people have interpreted Europe's tepid response to the occupation of the Crimea as a sign of European weakness. This is seen as evidence that Russia is an energy superpower in both speeches and actions. It is difficult to agree with the idea that Russia is a reactive party in the Ukraine crisis. After all, it responded to very moderate sanctions with increasing force.

Natural gas plays a key role in building an energy superpower, but the fact that Russian oil, coal and uranium are so essential to the European energy supply also contributes to this identity. In Russia, the progress of the Rosatom project in this particular political situation is presented as a victory that makes it possible to combine traditional power policy with the idea of an energy superpower. It promotes the Putin government's target of normalizing the Ukrainian situation and creating a new frozen conflict on its borders.

Finland is being given the opportunity to assume a multidimensional role in this process. As a country with strict control over its nuclear power, Finland is an important reference for Rosatom in terms of promoting

Russia's soft power image on a global scale. The project also gives Finland a special position in Russian policy in exchange for overlooking Russia's actions in the Ukraine. This may be one reason why some Finns want to see the Rosatom project become reality: we accept a project that supports Russia's Great Power ambitions and move to a "new normal" that promotes peace without threatening our traditional special status. But does this operating model really further peace in the long run?

Can Nuclear Power Really Promote Peace?

A key argument in favor of the Rosatom project is the assumption that nuclear power promotes peace. Although this idea has not been directly expressed as such, it is included in, for example, a statement made by Jouni Backman, Social Democratic MP and Parliamentary Group chair, who said "we have cooperated with Russia on nuclear power cooperation for decades, and one crisis is not going to change that." This call for pragmatism can be based on one of two assumptions. Either all economic cooperation with dictators and authoritarian governments promotes peace and democracy, or despite supporting ethically problematic development, trade and politics should not be mixed. The first of these is extremely idealistic and the latter is cynical. Backman's further argument supports the cynical interpretation: "We've never had any problems." In other words, nothing else matters as long as energy is available on a reliable basis.

Regardless of their real reasons, Backman and the Centre Party's Mauri Pekkarinen are encouraging Finland to overlook the occupation of the Crimea and eastern Ukraine in the same way we turned a blind eye to the occupation of Czechoslovakia in the 1960s. It is clear that this furthers the greatest desire of Putin's government: Europe should separate the economy from politics now that Russia has achieved its military targets. It also inevitably paints a picture of Finland as a country that, regardless of the global political situation, enjoys a historical special status granted to it by Russia—and, in this case, a reasonably priced NPP guaranteed by the Russian state.

What if we wanted to use energy policy to promote peace? In that case, cooperation should focus on completely different areas than Russian nuclear power, which is linked to the manufacturing of weapons of mass destruction—both organizationally and via its fuel chain. Uranium mining and nuclear power generation promote a centralized energy infrastructure, which allows power to be exerted in the energy sector and throughout society by a significantly smaller group than is possible in a decentralized energy system.

Furthering nuclear power is a perfect fit for Putin's authoritarian government, because secretive activities make it easier to keep control in the hands of the country's leadership. The impact of nuclear energy on production and consumption is opposite to that of solar electricity, wind power or bioenergy. Bioenergy is produced and consumed over a broad area, in which case economic diversification—in Russia and in Finland—also promotes democracy. A larger part of the population, many organizations and small and medium-sized companies are all involved in energy production. Like uranium, the oil and gas sector is based on specific points of production and employs only 2 percent of the population in Russia, even though hydrocarbon exports account for more than half of Russia's budget. Finland could more effectively promote peace with Russia by means of trade built around renewable energy than by importing nuclear energy.

Is Nuclear Energy an Exception?

So, what makes nuclear power an area of energy supply that should be left outside the scope of power policy? Nothing. However, in radio interviews with Finnish Broadcasting Company Yleisradio, both National Coalition Party MP Sinuhe Wallinheimo and the former Minister of Defence Carl Haglund suggested that a nuclear power project with Russian backing is not a security policy issue.

Former ice hockey goalkeeper Wallinheimo "does not believe that Russia will pressure Finland" and states that "for this reason, the nuclear power business should be separated from politics in a pragmatic sense." He does, however, see Russia's KHL ice hockey league as part of "old geopolitical thinking" that links former bordering states to the Russian sphere of influence and "burnishes Russia's political image." Ice hockey is geopolitical, but nuclear power is not in his worldview.

On the other hand, Minister of Defense Haglund states that construction and operation of an NPP is not related to security policy. However, declining to use a Russian supplier would be an open insult to Russia. Operation is regulated by the Nuclear Energy Act and is based solely on society's need for energy. The fact that a minimum level of domestic ownership was set as an additional condition for the Fennovoima project makes this selective disregard for security policy quite lame. If there was no foreign policy risk associated with the ownership and operation of NPPs—and the production and selling of nuclear electricity was simply business—no such ownership limitations would have been set for the project. Thus, nuclear energy policy must also be part of foreign and security policy.

Will Finland's Energy Dependency Decrease?

One of the reasons used to justify the Fennovoima project has been reducing Finland's dependence on electricity imported from Russia. After Rosatom was selected as the supplier and part-owner, supporters of the project have changed their tune. In his energy policy report to Parliament, former Prime Minister Stubb claimed that "contrary to intuition, the project will decrease our dependence on Russia energy." According to that statement, the project would no longer reduce Finland's dependence on imported electricity, but would now reduce our dependence on Russian energy.

However, nuclear electricity will not replace Russian gas because a significant amount of gas consumption occurs in industrial processes and co-production of electricity and heat. If, on the other hand, we assume that Rosatom's plant would completely replace the electricity that now comes to Finland from Russia, the dependency would actually decrease in terms of electricity. The new NPP's 1,200 megawatts is three times what is now imported from Russia to Finland. However, Rosatom's one-third ownership share allows it to sell 400 megawatts of the electricity production to whomever it wants.

Electricity trade became bilateral in 2015, which means that Rosatom can sell its own share to Russia if it so desires, leaving the situation unchanged with regard to electricity supply. Furthermore, cross-border electricity trade is completely controlled by another Russian state-owned company called Inter RAO. Finns do not have the power to decide how much electricity crosses the border. It's easy to recall the electricity import situation in 2011 and 2012, when, after citing economic reasons, Inter RAO reduced electricity imports during peak winter hours, thus managing to manipulate the price of electricity in Finland. What would be the outcome when the impact of such measures is measured in minutes rather than days or weeks, as it is in the case of gas?

Former Prime Minister Stubb tried to reassure people by stating that nuclear power produced by Rosatom also accounts for approximately half of Ukraine's electricity and has remained outside the scope of military actions. We must remember, however, that Ukraine's chronic dependence on Russian energy is based on the joint impact of nuclear power and gas and that Russia has used this as a means of exerting pressure for decades. There is no need to use nuclear power to influence Ukraine. But such a possibility does exist, which makes gas an even more effective method of applying pressure.

In his opinion piece published in the Helsingin Sanomat newspaper, Finnish Energy's Petteri Haveri declared that electricity trade between Finland and Russia as well as the Rosatom project are governed only by economic interests. Haveri forgot, perhaps intentionally, that the economy is only one component in Russia's energy policy. This is particularly true in the case of the state-owned Rosatom Corporation.

Not even energy experts or veteran politicians are likely to deny that Russia has used energy to promote its foreign policy. Finland is part of Russia's energy diplomacy even though we have never had any problems with energy deliveries from Russia. Our dependence on fossil energy from Russia (66 percent of imported energy comes from Russia) does, however, emphasize the risks of electricity production. The fact that the possibility for manipulation even exists is enough. It is understandable that supporters of Finland's special status close to Russia may be naive concerning Rosatom, but does the National Coalition Party (a liberal right-wing party) truly believe that Finland could somehow avoid the pressure that comes with such dependency?

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ANALYSIS

The Ukrainian Nuclear Energy Partnership with Russia: The End of an Era of Cooperation

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Abstract

The annexation of Crimea and the armed conflict in Donbas have played a decisive role in accelerating the diversification of commodity supplies and services to Ukrainian nuclear power plants (NPP) and reducing their dependence on Russian companies. The policy of import substitution in nuclear energy leverages the potential of Ukrainian companies as much as possible. Additionally, Ukrainian organizations are implementing engineering support to modernize and extend the life cycles of power plants, in cooperation with well-known European and US companies without the need to bring in Russian specialists. Cooperation between Ukraine and Russia in the area of nuclear energy will in the near future likely continue only in the area of nuclear fuel.

Introduction

The Ukrainian and Russian nuclear industries continued a close partnership after the break-up of the USSR for more than twenty years. This is not astonishing, since many nuclear energy experts in Ukraine graduated from polytechnic institutes and universities in Russia, began their careers in NPPs which are today on Russian territory, or in Soviet nuclear energy companies and scientific research institutes; vice versa, Russian specialists worked in Ukrainian NPPs or in the Ukrainian State Committee for Nuclear Energy, as long as it existed, or in the Ukrainian Energy Ministry.

However, everything changed in the spring of 2014. The annexation of Crimea, the armed conflict in Donbas, involving the use of modern weapons delivered by Russia, and the participation of professional Russian military units in this conflict, prompted the Ukrainian ministries and "Energoatom"[1], the operator of all Ukrainian NPPs, to review their partnership with Russia and to reduce it as much as possible.

Supplies of Nuclear Fuel and Services at Various Stages of the Nuclear Fuel Cycle

The Ukrainian societal and political crisis and the following annexation of Crimea and destabilization of South-Eastern Ukraine by Russia forced the states of the European Union to initiate a discussion on energy security going beyond the traditional energy sources such as natural gas and oil.

This led to the publication, on 28 May 2014, of the "European Energy Security Strategy", which was based on a detailed examination of European energy security carried out by European experts (whose report was published on 16 June 2014). Chapter 7.2 "Uranium and nuclear fuel" of the "Strategy" notes that "Russia is a key competitor for European companies in nuclear fuel production and offers integrated packages for investments in the whole nuclear chain. Therefore, particular attention should be paid to investments in new NPPs to be built in the EU using non-EU technology, to ensure that these plants are not dependent only on Russia for the supply of the nuclear fuel: the possibility of fuel supply diversification needs to be a condition for any new investment […]. Furthermore, an overall diversified portfolio of fuel supply is needed for all plant operators".[2] This is a completely new point of view in European energy policy.

Ukraine became aware of the problem of diversifying nuclear fuel supplies for its NPPs as early as the mid-1990s. It took the first steps to diversify these supplies as early as 2000, when Ukraine launched the project of qualifying nuclear fuel from Westinghouse. In 2008, "Energoatom" and Westinghouse signed a contract for the delivery of nuclear fuel with a volume sufficient for three Ukrainian NPPs per year. This contract was renewed in the spring of 2014; on 30 December 2014, in light of the political situation, both parties signed a supplementary clause covering additional deliveries in the case of force majeure, such as a complete refusal by Russia to deliver nuclear fuel to Ukrainian NPPs.

At present, Ukrainian NPPs receive nuclear fuel under a ten-year contract, dating to 2010, between "Energoatom" and the Russian company "TVEL". Both sides agree on the schedule and volume of these deliveries for the following year at the end of every year with an additional clause to the contract. On average, the

1 Full Ukrainian designation: DP NAEK (Derzhavne pidpriyemstvo Natsionalna energogeneruyucha kompaniya [State Enterprise National Nuclear Energy Generating Company]) "Energoatom".

2 Communication From The Commission To The European Parliament And The Council – European Energy Security Strategy, p. 16, <http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52014DC0330&from=EN>

volume of the Ukrainian nuclear fuel market is around 600 mln. USD per annum. The contract stipulates that Russia carries out uranium isotope enrichment for all the nuclear fuel delivered by "TVEL".

The Ukrainian state enterprise "Yadernoye toplivo" ["Nuclear Fuel"] owns ten percent of the shares of OAO "Mezhdunarodnyy tsentr po obogashcheniyu urana" [MTsOU, "International Center for Uranium Enrichment"] in Angara, Russia; the shares were bought in October 2010. The ownership of a mere ten percent of shares allows the use of only 60,000 Separative Work Units (SWU) at reduced prices at the facilities of MTsOU. This in turn permits the enrichment of a quantity of uranium 235 sufficient for only four percent of the annual amount of uranium concentrate necessary for the production of nuclear fuel assemblies for Ukrainian NPPs. "Energoatom" delivers about 30–40% of uranium concentrate produced in Ukraine. The use of MTsOU facilities began in 2012 and continued every year up to and including 2016.

According to the contract between "Energoatom" and Westinghouse signed in spring of 2014, uranium concentrate and the service of uranium 235 isotope enrichment were supplied by the French company AREVA. From 2017, these services will be purchased from the British–Dutch–German company Urenco. From 2008 to 2012, the Russian company "Tekhnosnabeksport" supplied enriched uranium for the production of nuclear fuel for "Energoatom" using Westinghouse technology in a plant in Switzerland.

Ukraine also cooperates with Russia in the treatment of spent nuclear fuel. It ships spent elements from two reactors of Rivne NPP (RAES-1 and -2) for processing to Chelyabinsk oblast. Elements from the three units of South Ukraine NPP, from the two reactors of Khmelnytskyy NPP, and from the other two units of Rivne power plant are sent for long-term storage to Zheleznogorsk (in Krasnoyar krai). The market for these services is estimated at 150 mln. to 200 mln. USD per annum.

On 3 November 2016, the board of the State Nuclear Regulatory Inspectorate of Ukraine discussed the positive results of the state nuclear and radiation review of the project for an Integrated Storage Facility for Spent Nuclear Fuel[3], which is supposed to be built in the Chernobyl exclusion zone with technology from the US company Holt Intern. After the completion of all state procedures, the State Nuclear Regulatory Inspectorate of Ukraine will issue a license to "Energoatom" for the construction and commissioning of the Integrated Storage Facility for Spent Nuclear Fuel. Construction will begin already in the spring of 2017; the first stage is to be completed by the end of 2018. Ukraine already has experience in the construction and operation of a dry storage facility for spent nuclear fuel on the site of Zaporizhzhia NPP, which was commissioned in 2001. Consequently, "Energoatom" will discontinue the export of spent nuclear fuel to Russia after the commissioning of the Integrated Storage Facility for Spent Nuclear Fuel.

Designs for New Nuclear Facilities

On 16 September 2015, the Ukrainian parliament abrogated the Agreement between the Cabinet of Ministers of Ukraine and the Government of Russia for cooperation on the completion of the third and fourth reactors of Khmelnytskyy NPP, which was signed in 2010. The Russian firm "Atomstroieksport" was supposed to build two VVER-1000 Project 392B reactors, with commissioning expected in 2015–2016.

The project was not begun in the years before the war, as the Ukrainian side was not satisfied by the conditions of the loan for the completion of the third and fourth reactors of Khmelnytskyy power station. According to the above-mentioned Agreement, the Russian side was to grant a government loan covering 85% of construction and commissioning costs (which according to the feasibility study were estimated at 5 bln. USD), as is usually the case for Russian-built NPPs using Russian technology in other countries. However, after the signing of the Agreement, the Russian side announced it would only grant a commercial loan with significantly higher interest. The choice of suppliers for machinery and services during construction was a second cause for disagreement. The Russian side disregarded preliminary agreements on the maximum use of Ukrainian vendors and contractors.

Then the accident at the Fukushima Daichi NPP occurred. Although it is not a member state of the European Union, Ukraine joined the initiative of the EU to conduct extraordinary safety checks of all nuclear reactors (the so-called stress tests). The results of these stress tests led to the State Nuclear Regulatory Inspectorate of Ukraine tightening demands for new nuclear energy installations, drawing upon the recommendations of the Western European Nuclear Regulators Association (WENRA) as contained in the report on the safety of new NPP designs, published in November 2012. These demands are as follows: a revision of the management of serious accidents and the establishing of acceptance

3 Designation on the website of the Chornobyl Center for Nuclear Safety, Radioactive Waste and Radioecology (<http://www.chornobyl.net/en/index.php?newsid=1204640734>); in the Russian original, the term indicates this will be a dry cask storage facility (storage of the spent fuel and nuclear waste in casks after cooling in the spent fuel pool).

criteria (i.e., plans for a new NPP should guarantee that serious accidents with a core melt will not lead to radioactive fallout beyond the sanitary protection zone, which would lead to the evacuation of the population); the implementation of more stringent safety margins for an extended range of possible natural and man-made hazards or combinations of hazards (in particular, the safety margin for seismic events is to be increased to 100%); guaranteeing that safety systems continue to work during a full station blackout and failure of the ultimate heat sink (guarantee of the "survival" of the reactor for at least 72 hours during a full blackout, the so-called autonomy of the "nuclear island[4]", and for at least two weeks during an external blackout, the so-called autonomy of the site of the NPP).

The design of the VVER-1000 reactors, which was featured in the Agreement on the completion of the third and fourth reactors of Khmelnytskyy NPP, did not conform to the new demands. For various reasons, the Ukrainian side was not satisfied with the new Russian proposal for the AES-2006 reactor. Amongst other factors, the previous tender stipulated that already existing structures were to be used for the third and fourth reactors of Khmelnytskyy NPP, while the new design was based on the assumption that construction of structures would start afresh, which meant that costs would double. Moreover, it would have been fairer to issue a new tender including leading world companies owning nuclear installations. Russia's aggression against Ukraine led to a stop of these fruitless negotiations and the official declaration of the abrogation of the Agreement.

Another project that has been suspended is the construction of a facility for the production of nuclear fuel on Ukrainian territory using technology from the Russian company "TVEL". For this project, a Ukrainian-Russian joint venture was launched (ChAO "Zavod po proizvodstvu yadernogo topliva"; the Ukrainian state company "Yadernoye toplivo" owns 50% of the shares plus one share, and the Russian company "TVEL" 50% minus one share). A directive of the Ukrainian cabinet of ministers approved a feasibility study and a site for the facility on 27 June 2012.

According to Ukrainian legislation, the construction of a facility for the production of nuclear fuel (as well as any other nuclear installation) can only begin if the State Nuclear Regulatory Inspectorate of Ukraine has issued a license for the "building and commissioning of a nuclear facility". Two essential conditions for the issuance of such a license is the acceptance by the State Nuclear Regulatory Inspectorate of Ukraine of a Preliminary Safety Analysis and the approval of the project by the Ukrainian Cabinet of Ministers.

The State Nuclear Regulatory Inspectorate of Ukraine accepted the Preliminary Safety Analysis for the facility for the production of nuclear fuel on 4 December 2013. However, the project was not approved during 2014/2015, in spite of a positive expert review of the documentation for the project "Construction of a Facility for the Production of Nuclear Fuel" by the state company "Ukrgosstroiekspertiza". The new leadership of the Ukrainian Ministry for Energy and Coal Mining looked into the conditions of the contract and arrived at the conclusion that the project was not beneficial for Ukraine, as, according to the contract, Ukraine would not be the owner of the technology but would merely have the right to use it. In case of force majeure, Ukraine could lose this right. Moreover, the projected capacity of the facility would have exceeded Ukrainian needs, while there were no plans for the sale of surplus nuclear fuel. The annexation of Crimea and the military aggression by Russia in Donbas served as a reason to freeze the project in this case as well.

Due to the expiry of the deadline as defined by law for the review of application documents, i.e. on formal grounds, on 24 November 2015 the State Nuclear Regulatory Inspectorate of Ukraine refused to issue a license to the joint venture "Zavod po proizvodstvu yadernogo topliva" for the construction and commissioning of the facility.

Modernization and operational life extension of Ukrainian NPPs: machinery and engineering services

Ukrainian legislation regulating the use of nuclear energy for peaceful purposes does not envisage institutions such as the Chief Designer of the Reactor Plant or the Chief Scientific Coordinator, which existed in Soviet times and continue to do so in Russia. In Ukraine, the plant operator bears full responsibility for the safety of nuclear installations. It is the operator who chooses and qualifies machinery and services vendors. Nevertheless, Russian colleagues, drawing upon present-day and Soviet experience, are of the opinion that all operators of VVER reactors, including the Ukrainian operator, are obliged to coordinate technical modernizations of reactors and replacement of machinery that are part of the ongoing operational life extension of Ukrainian NPPs beyond the original thirty years of the design.

As part of the effort to reduce dependence on Russia for spare parts, Ukrainian companies are introducing new products. For example, the Ukrainian company PAO "Turbatom" is now producing rotor blades for high-speed turbines made by the Russian company "Silovye

4 The central part of a NPP.

mashiny". "Turbatom's" original area of specialization is the production of slow-speed steam turbines for NPPs. Possibilities for producing spare parts, e.g., for diesel generators from the Russian company "Dizelenergo", are being explored. This applies to other machinery as well.

Ukrainian companies are developing and producing radiation monitoring systems for tracer radionuclides of the primary coolant, radiation monitoring systems for all Ukrainian NPPs (so-called "standard" control stations), hardware and software packages for automatic technical process management systems, and control systems for NPPs with VVER reactors.

From 2007 to 2012, Russian experts from technological institutes and companies specializing in design and construction (e.g., OKB "Gidropress" from Podolsk, "Gazproyekt", "Tsentr materialovedeniya i resursa", RNTs "Kurchatov institute", TsKTI-Vibroseism (St. Petersburg), FGUP "TsNII konstruktsionnykh materialov "Prometei" (St. Petersburg), and others) contributed to work on the extension of the operational life of reactors 1 and 2 of Rivne NPP and reactor 1 of South Ukraine.

At present, "Energoatom" relies on Ukrainian organizations and companies for safety research and calculations; among these organizations are some that are well-known from Soviet times, such as the Scientific and Research Institute for Building Design, "Energoproyekt" located in Kiev and Kharkov (project managers for Ukrainian NPPs), the Kiev Institute of Engineering Research and Studies, the G.G. Subbotin Institute of Geophysics, the Institute of Nuclear Research, the E. Paton Institute of Electric Welding, the Kharkov Physical and Technical Institute of the National Academy of Sciences of Ukraine, and many others that have been founded in the 25 years since Ukrainian independence.

Lately, there has been significant cooperation between "Energoatom" and the following European firms: the Nuclear Research Institute Řež (Czech Republic), Skoda (Czech Republic), UNIX (Czech Republic), IBERDROLA Ingenieria Construccion (Spain), Technischer Überwachungsverein (Germany), AREVA (France), and Scandpower (Sweden). It goes without saying that US companies have entered the Ukrainian engineering services market as well.

It can be seen that Russia has completely lost the engineering services market for Ukrainian NPPs and other nuclear installations, including the treatment of spent nuclear fuel and nuclear waste. The Ukrainian NPP operator is perfectly capable of implementing scientific and technical support for the safe operation of nuclear reactors without Russian organizations. The reports of many international missions of organizations such as the International Atomic Energy Agency and the World Association of Nuclear Operators serve as further confirmation.

Outlook

Ukraine will wind down cooperation as far as possible with the Russian companies that used to supply commodities and services for Ukrainian NPPs and nuclear facilities for the treatment of spent nuclear fuel and nuclear waste, and even more so for projects of new nuclear installations.

However, due to the specific characteristics of the technology concerned, such as the fuel assembly for VVER-type reactors, which is mastered by only two companies in the world ("TVEL" and Westinghouse) and due to the fact that the contract between "Energoatom" and "TVEL" will be in force until 2020, there will be continued cooperation in the area of nuclear fuel deliveries. In my opinion, a new contract between the Ukrainian operator and the Russian company after 2020 will be significantly different from the present contract. Uranium concentrate and isotope enrichment will most probably be bought on the world market and "TVEL" will only be engaged in [fuel] production. Ideally, Ukraine will have a second vendor for the sake of competitive pricing and technological competition; the question is only what share of the Ukrainian nuclear fuel market this vendor will have.

Translation from the Russian: Matthias Neumann

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The Author's Publications

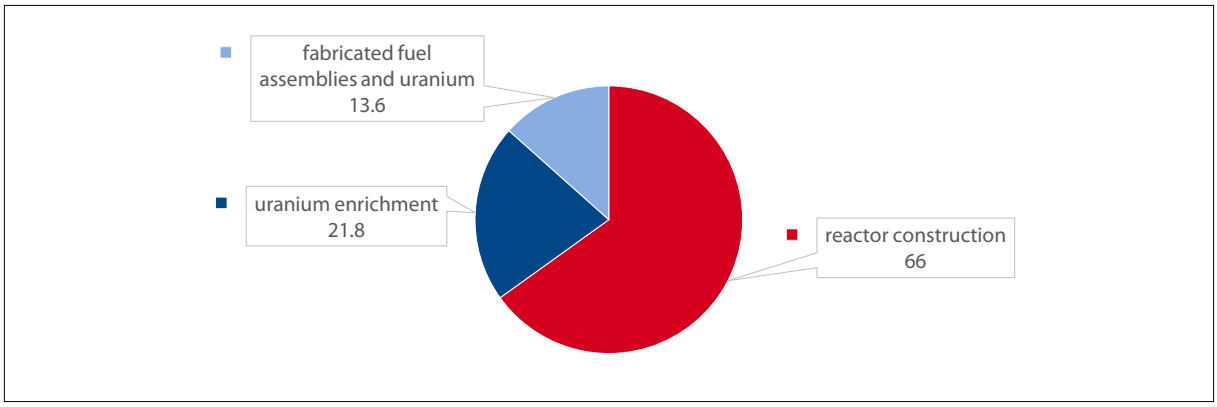
- «Почему не стоит противопоставлять атом и возобновляемые источники энергии» – Государственное информационное агентство Украины «Укринформ», 4 November 2016, <http://www.ukrinform.ua/rubric-economics/2114465-comu-ne-varto-protistavlati-atom-i-vidnovluvani-dzerela-energii.html>

- «Очередная истерика Кремля: Россия боится потерять ядерный рынок Украины» – авторская колонка в Интернет-издании «Апостроф», 7 May 2016, <http://economy.apostrophe.ua/article/jenergetika/2016-05-07/ocherednaya-isterika-kremlya-rossiya-boitsya-poteryat-yadernyiy-ryinok-ukrainyi/4815>
- «Дестабилизация атома» – авторская колонка Интернет-издания «Цензор», 1 April 2016, <http://biz.censor.net.ua/columns/1722/destabilizatsiya_atoma>

STATISTICS

Russian Nuclear Power Reactors Abroad

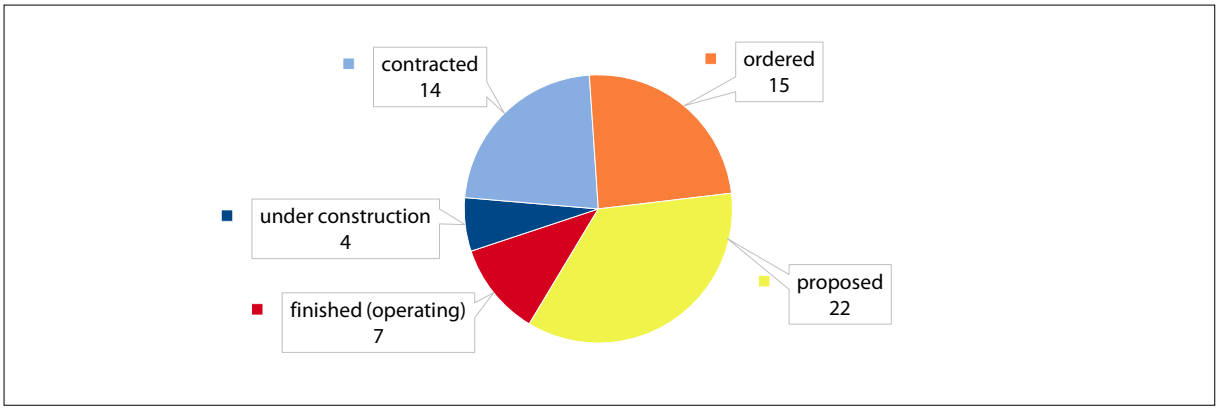
Figure 1: Rosatom's Export Portfolio (as of 2015; bln USD)



Note: Rosatom has a monopoly on exports of nuclear technology and services from Russia.

Source: World Nuclear Association, <http://www.world-nuclear.org/information-library/country-profiles/countries-o-s/russia-nuclear-power.aspx>

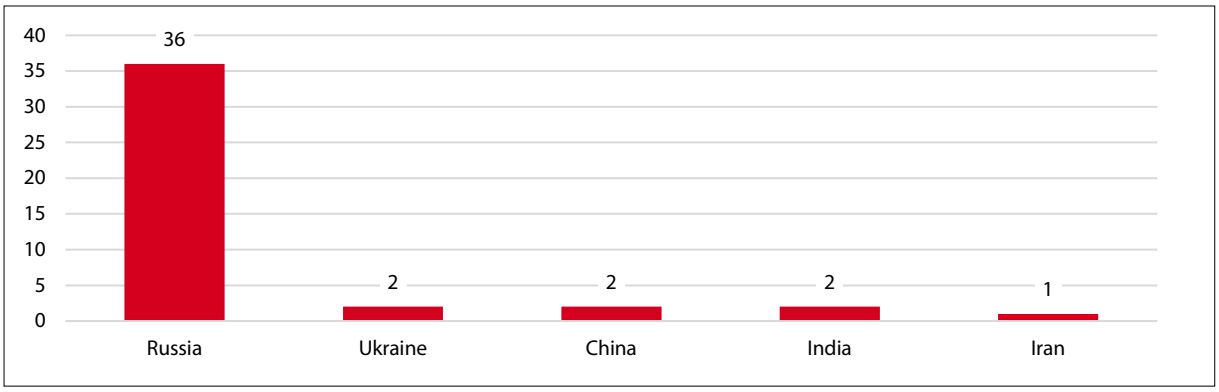
Figure 2: Rosatom's Nuclear Reactor Export Portfolio (as of 2016, number of reactors)



Note: Rosatom has a monopoly on exports of nuclear technology and services from Russia.

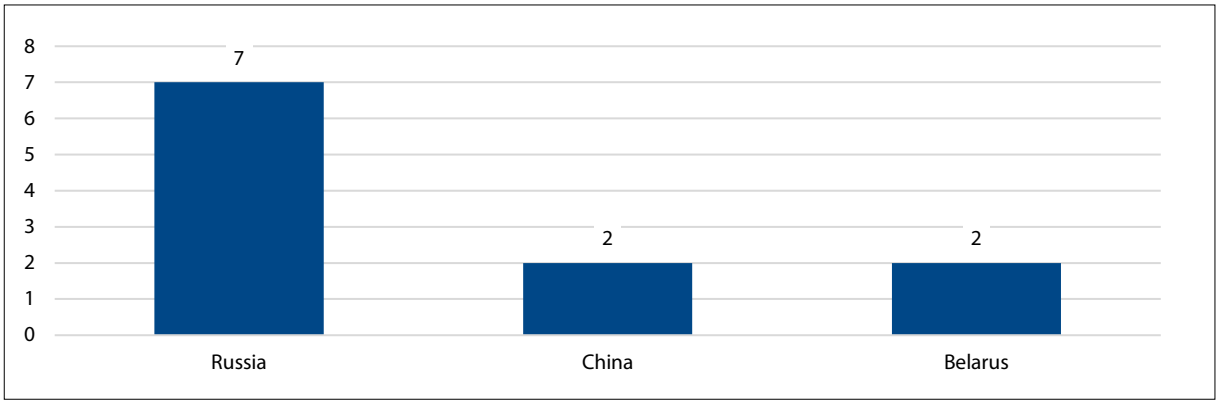
Source: World Nuclear Association, <http://www.world-nuclear.org/information-library/country-profiles/countries-o-s/russia-nuclear-power.aspx>

Figure 3: Global Distribution of Operating Russian Nuclear Power Reactors (post-Soviet)



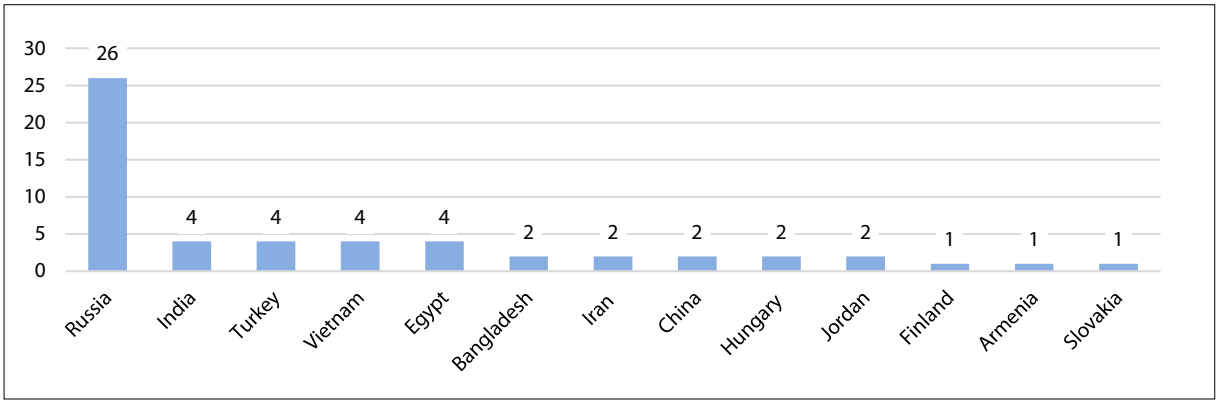
Note: Reactors constructed outside Russia before the end of the Soviet Union are not included.
Source: World Nuclear Association, <http://www.world-nuclear.org/information-library/country-profiles/countries-o-s/russia-nuclear-power.aspx>

Figure 4: Global Distribution of Russian Nuclear Power Reactors Under Construction



Source: World Nuclear Association, <http://www.world-nuclear.org/information-library/country-profiles/countries-o-s/russia-nuclear-power.aspx>

Figure 5: Global Distribution of Russian Nuclear Power Reactors Contracted or Ordered



Source: World Nuclear Association, <http://www.world-nuclear.org/information-library/country-profiles/countries-o-s/russia-nuclear-power.aspx>

Table 1: Nuclear Power Reactors in Operation in Russia

Reactor	Type V=PWR	MWe net, each	Commercial operation	Scheduled close
Balakovo 1	V-320	988	5/86	2045
Balakovo 2	V-320	1028	1/88	2033
Balakovo 3	V-320	988	4/89	2034
Balakovo 4	V-320	988	12/93	2023?
Beloyarsk 3	BN-600 FBR	560	11/81	2025
Beloyarsk 4	BN-800 FBR	789	(2016)	2056
Bilibino 1–4	LWGR EGP-6	11	4/74–1/77	Dec 2018, Dec 2021
Kalinin 1	V-338	950	6/85	2025?
Kalinin 2	V-338	950	3/87	2032
Kalinin 3	V-320	988	11/2005	2034
Kalinin 4	V-320	950	9/2012	2042
Kola 1	V-230	432	12/73	2018 or 2033
Kola 2	V-320	411	2/75	2019 or 2034
Kola 3	V-213	411	12/82	2026
Kola 4	V-213	411	12/84	2039
Kursk 1	RBMK	1020	10/77	2022
Kursk 2	RBMK	971	8/79	2024
Kursk 3	RBMK	971	3/84	2029
Kursk 4	RBMK	925	2/86	2030
Leningrad 1	RBMK	925	11/74	2019
Leningrad 2	RBMK	971	2/76	2021
Leningrad 3	RBMK	971	6/80	2025
Leningrad 4	RBMK	925	8/81	2026
Novovoronezh 3	V-179	385	6/72	2016?
Novovoronezh 4	V-179	385	3/73	2032
Novovoronezh 5	V-187	950	2/81	2035 potential
Novovoronezh 6	V-392M	1114	(Jan 2017)	
Smolensk 1	RBMK	925	9/83	2028
Smolensk 2	RBMK	925	7/85	2030
Smolensk 3	RBMK	925	1/90	2034
Rostov 1	V-320	990	3/2001	2030?
Rostov 2	V-320	990	10/2010	2040
Rostov 3	V-320	1011	9/2015	2045
Total: 36		27,167 MWe		

Note: V-320 is the base model of what is generically VVER-1000; V-230 and V-213 are generically VVER-440; V-179 & V-187 are prototypes. Rostov was formerly sometimes known as Volgodonsk. Most closure dates are from January 2015 'roadmap'. Many reactors have been uprated but current net capacities are unknown. Rostov 1&2 are operating at 104%.

Source: World Nuclear Association, <http://www.world-nuclear.org/information-library/country-profiles/countries-o-s/russia-nuclear-power.aspx>

Table 2: Russian Nuclear Power Reactors in Operation Abroad

Country	Plant	Type
Ukraine	Khmelnitski 2 & Rovno 4	2 x V-320 reactors, 1000 MWe
Iran	Bushehr 1	V-446 reactor, 1000 MWe
China	Tianwan 1&2	2 x AES-91
India	Kudankulam 1& 2	2 x AES-92

Source: World Nuclear Association, <http://www.world-nuclear.org/information-library/country-profiles/countries-o-s/russia-nuclear-power.aspx>

Table 3: Russian Nuclear Power Reactors Under Construction Abroad

Country	Plant	Type	Est. cost	Status, financing
China	Tianwan 3&4	2 x AES-91	$4 billion	Under construction from Dec 2012
Belarus	Ostrovets 1&2	2 x AES-2006 (V-491)	$10 billion	Loan organised for 90%, construction start 2013

Source: World Nuclear Association, <http://www.world-nuclear.org/information-library/country-profiles/countries-o-s/russia-nuclear-power.aspx>

Table 4: Russian Nuclear Power Reactors Contracted Abroad

Country	Plant	Type	Est. cost	Status, financing
India	Kudankulam 3&4	2 x VVER-TOI	$5.8 million	Confirmed, loan organised for 85%, construction start 2017?
Bangladesh	Rooppur 1&2	2 x AES-2006 (V-392M)	$4 billion	Confirmed, loan organised for 90%, construction start 2017?
Turkey	Akkuyu 1–4	4 x VVER-TOI	$25 billion	Confirmed, BOO, construction start late 2016?
Vietnam	Ninh Thuan 1, 1&2	2 x AES-2006 (V-491)	$9 billion	Confirmed, loan organised for 85%, construction start 2020?
Finland	Hanhikivi 1	1 x AES-2006 (V-491)	€6 billion	Contracted, Rosatom 34% equity, also arranging loan for 75% of capital cost, construction start 2018?
Iran	Bushehr 2&3	2 x AES-92 (V-466B)		Construction contract Nov 2014, NIAEP-ASE, barter for oil or pay cash
Armenia	Metsamor 3	1 x AES-92	$5 billion	Contracted, loan for 50%

Source: World Nuclear Association, <http://www.world-nuclear.org/information-library/country-profiles/countries-o-s/russia-nuclear-power.aspx>

ABOUT THE RUSSIAN ANALYTICAL DIGEST

The Russian Analytical Digest is a bi-weekly internet publication jointly produced by the Research Centre for East European Studies [Forschungsstelle Osteuropa] at the University of Bremen (<www.forschungsstelle.uni-bremen.de>), the Center for Security Studies (CSS) at the Swiss Federal Institute of Technology Zurich (ETH Zurich), the Resource Security Institute, the Institute of History at the University of Zurich (<http://www.hist.uzh.ch/>), the Institute for European, Russian and Eurasian Studies at The George Washington University, and the German Association for East European Studies (DGO). The Digest draws on contributions to the German-language Russland-Analysen (<www.laender-analysen.de/russland>), the CSS analytical network on Russia and Eurasia (<www.css.ethz.ch/en/publications/rad.html>), and the Russian Regional Report. The Russian Analytical Digest covers political, economic, and social developments in Russia and its regions, and looks at Russia's role in international relations.

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