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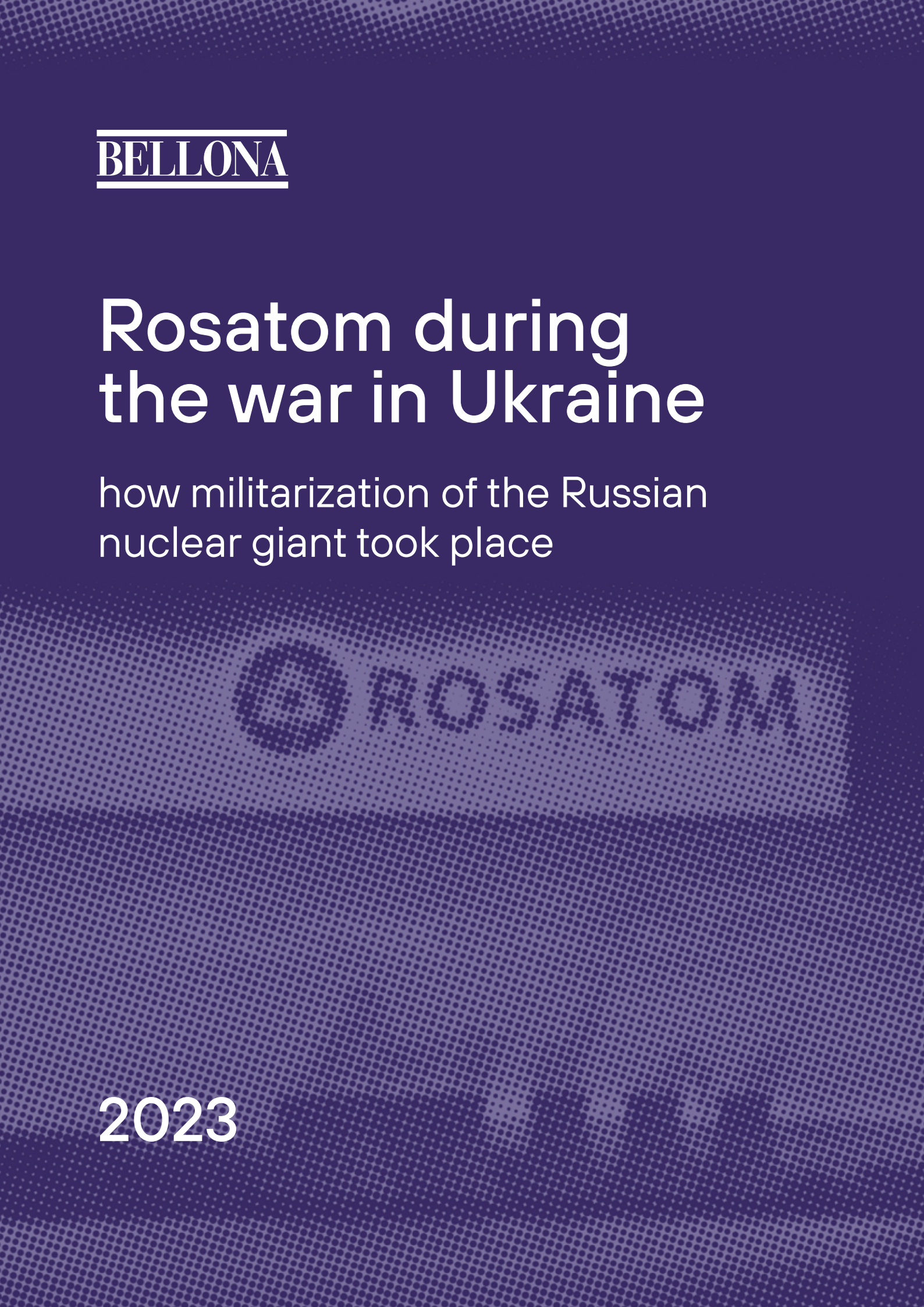
Rosatom during the war in Ukraine

how militarization of the Russian nuclear giant took place



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BELLONA

Rosatom during the war in Ukraine: how militarization of the Russian nuclear giant took place
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Foreword

Russia's war on Ukraine has been going on for over a year and half now, taking the lives of hundreds of thousands of people, causing the destruction of towns, villages, industrial and energy facilities, and turning entire regions into environmental and social disaster zones.

According to numerous recent expert assessments, in 2023 the active militarization of all aspects of Russian life began, including the economy. The nuclear industry, controlled by the Rosatom state corporation, is one of the main fields of the Russian national economy, which initially included the nuclear weapons sector in its structure. When the war began, Rosatom became actively involved in solving Russian military occupational tasks in Ukraine, i.e. it became a militarized part of the Russian state.

The present report seeks to analyze and outline our view of what has happened during these one and a half years of war, and how the Rosatom state corporation, one of Russia's most important and influential departments, has changed under militarization.

After the outbreak of the war in Ukraine, Bellona prepared its first report which gave a survey of the nuclear industry in Russia with figures and facts relevant to the period up to mid-2022.[1]

In preparing the aforementioned report, the authors proceeded from the understanding that the war in Ukraine will lead to large and long-term changes, primarily in the warring countries, and this will undoubtedly affect their nuclear industries. With this in mind, Bellona set the goal of establishing the nature of Rosatom at the beginning of what was already threatening to turn into a protracted military and political conflict. The authors also tried to take into account the challenges which began to emerge as a result of Russia's full-scale war against Ukraine. Primarily, they focused on changes in the world political, economic and global climate situation, and also the implementation and effectiveness of international sanctions levied against Russia. To ensure all information was correct, in their first report Bellona experts made maximum use of official reports and resolutions concerning Rosatom, information from Rosatom's public reports and its divisions for 2021, and also the opinions of recognized and authoritative experts quoted from the media.

In the present report, Bellona sets out its vision of events in Russia's nuclear industry from mid-2022 up to the present day, and also of the future prospects for the Russian nuclear industry within the country and abroad.

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[1] *https://bellona.ru/2023/10/03/atom-russia/*

Introduction

The war motivated Bellona to make a detailed study and analysis of the processes taking place at one the largest and most influential nuclear companies in the world, the Rosatom state corporation. The main question which Bellona experts attempt to answer in the present report is what has changed in the Russian nuclear sector in one and a half years of war, and how, given that Rosatom plays quite an active role in military events.

Chapter 1. How militarized Rosatom functions – structural and material features. This chapter gives a brief analysis of the changes that have taken place in the structure of Rosatom since the outbreak of the war in Ukraine. In particular, we pay attention to the new non-traditional businesses which Rosatom is currently developing. According to information published before the war began, by 2030 Rosatom intends to increase the percentage of its turnover from new businesses to 30%.[2]

Chapter II. Results of activity of Rosatom's main divisions in the wartime period. This chapter examines certain features of the activity of Rosatom's main divisions which appeared in the war period. Special attention is given to the economy of divisions' foreign projects. The nuclear weapons complex is covered in more details, particularly events at the Novaya Zemlya nuclear testing ground.

Chapter III. Rosatom's foreign projects in the wartime period. Foreign nuclear projects have great significance for Russia and Rosatom in particular. This is just not an economic, but also a military-political state task and interest. Throughout the wartime period, the active re-orientation of Rosatom's project activity has been observed. For obvious reasons, Rosatom is leaving the European and North American markets and actively looking for a place in South Asian and African countries. Recently, Rosatom has become more active in South America. To create an anti-western coalition, Russia now needs friends more than ever, and it is unimportant who they are and what authority and international recognition they have. Therefore, Rosatom, remaining in the field of state interests, will continue to look for partners in countries that are "friendly" to Russia.

Chapter IV. Rosatom at occupied nuclear facilities. Bellona provides very detailed coverage of what is happening on occupied nuclear sites in Ukraine. This chapter gives an analysis of certain features of the state of the Zaporizhzhia NPP (ZNPP) and events taking place at this site, in particular information on the presence of IAEA representatives at the nuclear plant and the tasks that they solve there.

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[2] *https://www.gazeta.ru/business/news/2018/09/25/n_12083143.shtml*

Chapter I.

How militarized Rosatom functions – structural and material features

In the report, "The Nuclear Industry of Russia on the eve and at the start of the war", Bellona gave a detailed description of the structure and management system of the Rosatom state corporation in the period up until 24 February 2022.[3] In the present report, the authors try to answer the question as to what has changed in this sphere since the war began.

The Rosatom structure and its management bodies have not seen fundamental changes, which was to be expected, as in global companies of this kind structural changes take place slowly and with difficulty, and usually under special conditions.

At the same time, it should be noted that over the one and a half years of war, around 50 enterprises have been added to the structure, mainly working in scientific and non-nuclear fields. These are primarily enterprises that facilitate the work of the Northern Sea Route (NSR), and also develop Rosatom's new business such as wind energy, nuclear medicine, digital products, infrastructural solutions, additive technologies and energy storage units, industrial control systems and electricity equipment, ecological solutions and so on.

Additionally, the structure of the "Environmental solutions" division has begun to change. Rosatom increasingly positions itself as an "environmentally friendly" company, and has activated projects on sites of accumulated environmental hazards (not radioactive hazards), and also in sustainable development spheres. Rosatom joins federal scientific, environmental and social programs, as a way to receive additional financing from the budget. The rise in environmental and social activity can also perhaps be explained by the Rosatom management's wish to draw society's attention away from the corporation's involvement in the war, and also from environmental nuclear radiation problems, for example eliminating the nuclear legacy

[3] *https://bellona.ru/2023/10/03/atom-russia/*

of the Soviet Union, the safety situation at the captured ZNPP and at NPPs in Russia's border regions, and so on.

In 2023, Rosatom was joined by the major generating company Kvadra, a structure previously part of the former United Energy Systems of Russia, and which today carries out transportation of heat and electricity in regions of Russia's Central Federal District.

The main nuclear enterprise that was included in Rosatom's structure was the Zaporizhzhia NPP. On 3 October 2022, Rosenergoatom founded the company "Operating organization of the Zaporizhzhia NPP", and on 5 October by decree of President Putin, ZNPP facilities passed into Russian federal ownership. Three days later, the Russian government founded the federal state unitary enterprise "Zaporizhzhia nuclear power plant" with the head office in Moscow. We should note that on Rosenergoatom's official website, and in Rosatom's public reports information resources, information about the structure, management bodies and the activity of this new site is either missing entirely or only appears in a very curtailed and vague form.

As for the management bodies of Rosatom, changes were mainly connected with personnel shuffles, starting with changes in the supervisory bord, which is the corporation's highest management body. In January 2023, the first deputy director of the FSB, army general Sergey Korolyov, who is under international sanctions of the European Union and other countries, was appointed to the Rosatom supervisory board, as was Maxim Oreshkin, assistant to President Putin on economic issues. Thus, by appointing entrusted high-ranking figures from the FSB and Putin's own economic block to Rosatom's highest management body, Putin demonstrated the importance of Rosatom for the state and for achieving his own goals.

Throughout the entire wartime period, the chairman of the Rosatom supervisory board Sergei Kiriyenko, who also the first deputy head of the Russian presidential administration, has been at the center of attention. Several times in 2022 and 2023, Kiriyenko visited the Zaporizhzhia NPP and other occupied Ukrainian territories. According to information from numerous media bodies, Kiriyenko was appointed by Putin as one of the main political curators ("observers") of all occupied Ukrainian territories.[4] This appointment undoubtedly raised the stability of Kiriyenko's personal status in the present state structure of Russia, and accordingly increased the internal political and economic capabilities of Rosatom, of which he is practically the head.

In the period from 2022 to 2023, there were changes to the heads of such Rosatom organizations as the directorate for the nuclear legacy, the federal environmental operator, the department for work with regions and public organizations, the communications department and several others. The purposes of the staff changes are completely different, but one gets the impression that one of the main reasons for changing the management staff of regional and communications departments was connected with preparations by organizations and regions of Rosatom's presence for the presidential elections in 2024, where the presidential administration plans that Putin will receive at least 80% of the vote.

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[4] *https://www.rbc.ru/politics/27/04/2022/626713529a7947c57f2a80f8*

In its public reports for 2022, Rosatom singles out two groups of factors which currently have the greatest influence on its global activity – the economic and geopolitical situation, and the technological landscape. Rosatom states that it does not plan to change its strategic goals until 2030, but in the present crisis caused by geopolitical tension, it intends to provide for a high level of flexibility in both domestic Russian and international activity. The corporation still plans to increase its share on international markets by 2030, and increase its presence in over 50 countries of the world, expanding its long-term portfolio of orders, though it admits that compared with the pre-war period, the key risks of its activity have increased since 2022.

Furthermore, Rosatom's strategy maintains the general industry focus on the development of innovative technologies and achieving ambitious goals for each priority field. Rosatom has set the goal to increase turnover to 4 trillion rubles by 2030. Over half of this turnover will be provided by foreign orders, and the percentage of new products should exceed 40%. In 2022, the portfolio of foreign orders of Rosatom had already dropped by 2.9% compared with 2021 and came to USD 135.9 billion (USD 139.9 billion in 2021). At the same time, it should be noted that Rosatom's turnover from foreign orders increased in 2022 by 31% compared with 2021 and reached USD 11.8 billion.[5]

Rosatom's public report states that political and currency risks for the corporation reached critical level in 2022. Rosatom explains that political risks increased because of a change in the regulatory and political climate in foreign nations, leading to restrictions on activity by the corporation and its organizations. It is clear that currency risks increased for economic reasons, and also as a result of the international sanctions levied against Russia, which were followed by unfavorable changes in currency rate, and difficulties with banking operations.[6]

Thus, we can see that the war increased the key risks of the corporation, which in their turn may negatively influence realization of the strategic goals which Rosatom plans to achieve by 2030.

[5] *http://www.proatom.ru/modules.php?name=News&file=article&sid=10554*

[6] *https://www.report.rosatom.ru/go/rosatom/go_rosatom_2022/rosatom_2022_ru.pdf*

Chapter II.

The activity of Rosatom's main divisions in the wartime period

In the report for 2022, Bellona revealed the structure of Rosatom in detail, its divisions, enterprises, organizations and the system of their management. As we noted above, fundamental changes have not taken place in the structure and system of management of the corporation during the wartime period. However, in each division and organization of Rosatom, certain changes have taken place, and nuances have emerged in connection with war-related global events and geopolitical changes. Additionally, the main areas of the corporation's activity have faced problems arising from the sanctions levied against Rosatom by nations of the pro-Ukrainian coalition. These sanctions aim to limit the corporation's capabilities on international market, and thus reduce financing of the Russian invasion of Ukraine and Rosatom's influence as the promoter of Russian political and economic interests abroad.

2.1. Uranium production
(Mining division of Rosatom)

Uranium fields in Russia and abroad are owned by the Mining division of Rosatom (managing company Atomredmetzoloto (ARMZ))

Rosatom has completed a deal for the purchase of 50% in the Budyonovskoe field in Kazakhstan, which has put it in second place in the world by volume of uranium supplies. At present Uranium One Group, part of the Rosatom group, owns 50% of shares in the Budyonovskoe field, 30% of the Northern Khasaran field, 49.98% of shares in the Zarechnoe field and 70% of shares in the Akdala and Inkai fields located in Kazakhstan.

Production (mining) of uranium by ARMZ dropped by over 11% from 2021 to 2023. In 2022, ARMZ enterprises mined a total of 2,500 tons of uranium, and Uranium One, in which the foreign mining assets of Rosatom are concentrated, mined around 4,500 tons. By volumes of uranium mined, Rosatom and Russia in 2022 moved from second to third place in the world, yielding to China and its two companies CGN and CNNC.

Russian nuclear energy consumes around 5,000 – 5,500 tons of uranium per year. In the last five pre-war years, Russia delivered an average of 2,500 tons of uranium per year to the US and the EU, providing for up to 15-20% of their requirements. As the total volume of production by ARMZ and Uranium One does not cover internal expenses and deliveries abroad, Rosatom is forced to compensate for this deficit by secondary sources of fuel, such as accumulated supplies of depleted uranium hexafluoride (DUHF).

The attempts by the international coalition to limit Russian deliveries of uranium to markets of the EU and the US may have the desired results if these deliveries are replaced by suppliers from other countries which are capable of increasing production in the next 1-2 years, for example from Kazakhstan, Namibia, Canada and Australia, which produce 75% of the world's uranium. This is probably a sensible idea if long-term goals are concerned, although the Yermak-McFaul expert group proposes to reduce the volume of international supplies of raw uranium from Russia without delay. Nevertheless, in the 11th sanction package passed against Russia, there are no restrictions against Rosatom in this field. Perhaps it was decided that the economic effect from this step would not affect the implementation of the most pressing task – to restrict financing of the war with Ukraine, as Rosatom's profit from uranium deliveries abroad comes to around $500 million at current prices, and increasing production in other countries is very difficult from an economic and technological standpoint. Perhaps all the participants of the sanctions were simply unable to reach an agreement on this point.

In 2022-2023, the mining division of Rosatom began to develop its non-uranium business very actively, attempting to eliminate the deficit in Russian technologies of products on the basis of titanium, zirconium, oxides of rare earth metals, lithium, niobium, tantalum and scandium. Several projects are realized for this purpose, the chief ones being:

- the project "Lithium in the Russian Federation" – establishing the production of lithium carbonate hydroxide on the basis of the Kolmozero lithium field in the Murmansk Oblast;

- the "Phosphogypsum" project – creating a complex for production of rare earth metals and gypsum production from phosphogypsum, including individual oxides of rare earth metals;

– the "Titanium" project – creating a mining and enriching combine for processing ilmenite-zirconium sands of the Tuganskoe field in the Tomsk Oblast for producing titanium concentrates (ilmenite, rutile);

– the "Scandium" project – creation of a facility for by-product production of scandium oxide and alumina-scandium ligature at the Dalur industrial site.[7]

[7] *https://www.report.rosatom.ru/go/rosatom/go_rosatom_2022/rosatom_2022_ru.pdf*

2.2. Conversion, enrichment and manufacture *(Fuel division of Rosatom)*

Enterprises for enrichment and conversion of uranium, and also for fabrication of nuclear fuel are concentrated in the fuel division of Rosatom (managing company TVEL).

TVEL provides services, including at international level, for conversion and enrichment of uranium, and also for fuel deliveries. At present Rosatom remains the main participant of the world market for enrichment (36% of the market[8]) along with URENCO (UK, Germany, Netherlands) – 33%, Orano (France) and CNNC (China) – 13% each. These companies together control over 90% of the market.

In the previous report, Bellona provided information on international fuel deliveries of TVEL. As of early 2022, the company delivered fuel for experimental reactors in 9 countries and provided nuclear fuel for 38 power reactors abroad. However, after the war began many European countries suspended cooperation with Rosatom or ceased it altogether, refusing to enter into new contracts for the supply of nuclear fuel. Official reports state that at present fuel deliveries are being made to China for the CRF-600 reactor under construction and to Uzbekistan to the experimental VVR-SM reactor. In 2023, delivery of the first batches of nuclear fuel were made for reactors of the first power units of the Akkuyu NPP (Turkey) and the Rooppur NPP (Bangladesh).

It is hard to say what the prospects are for Russian deliveries of fuel abroad, but although Ukraine has abandoned Russian fuel for good, there are still five countries in the EU that have Soviet reactors: the Czech Republic, Slovakia, Hungary, Bulgaria and Finland. They have 19 reactors (4 VVER-1000 units and 15 VVER-440 units), and the percentage of nuclear power in these countries is quite high (from 30% to 50%), which currently makes them dependent on Russia to a certain degree. From the technical standpoint, these countries cannot entirely abandon Russian fuel, although most of them have taken active steps to switch to alternative fuel.

For example, Bulgaria and the Czech Republic intend to start converting their four VVER-1000 reactors to fuel from Framatome and Westinghouse from 2024. The situation with fuel for VVER-440 reactors, which still requires elaboration and testing, is more complex, but there is the option that Ukraine has already taken, and that has been followed by Finland, which in November 2022 signed an agreement for planning, licensing and delivering a new type of Westinghouse fuel for two VVER-440 units in the period from 2027 to 2030.

A number of other steps should also be noted that European countries and companies have taken in response to the war. The Swedish company Vattenfall has stopped purchasing the

[8] *https://network.bellona.org/content/uploads/sites/4/2023/10/2023_ATOM.pdf*

new type of fuel of Russian manufacture for the Ringhals NPP. Vattenfall will use fuel from the French company Areva or the American company Westinghouse. The German government has prohibited Rosatom from acquiring 25% of shares of the fuel plant in the west of the country, which at present is owned by the French company Framatome.

Thus, by the end of 2022, after Ukraine completely abandoned Russian fuel, the number of NPP power units worldwide to which Rosatom delivered fuel dropped from 75 reactors to 62 (of which 37 are located in Russia), and its global share on this market dropped from 17% to 14%. In 2023, Russia delivered fuel for 19 power units in 5 countries of the EU. From 2024 their number may drop by four, and by 2030 by another two. If the tendency continues and Europe is successful in introducing alternative fuel for VVER-440 reactors, by 2030 Russia may be completely deprived of orders for nuclear fuel from the EU, with the exception of Hungary with its 4 units. If the Paks-2 NPP project is realized in Hungary, then two more units operating on Russian fuel may be added to this number. At the same time, taking into account the current construction of power units in Turkey, Egypt, China, Bangladesh, Belarus and Iran, by 2030 Rosatom may acquire up to 20 additional foreign power units purchasing Russian nuclear fuel, which will perhaps compensate for the loss of the European market.

A considerable number of foreign contracts in which Rosatom's share exceeds 30% remain operational. So ousting Rosatom from this market is a rather difficult task.

At the same time, as experts from the Yermak-McFaul group correctly note, in the medium-term perspective the West may reduce its dependence on Russian uranium conversion by increasing the capacities of the Orano plant in France and the ConverDyn plant in the US. According to the World Nuclear Association (WNA), western enterprises for uranium conversion at present work at 40% of capacity, but it is expected that from 2026 their capacity will increase up to 90%.

It should be noted that in 2022-2023, the fuel division of Rosatom delivered a wide range of non-nuclear production and services in such fields as metallurgy, chemistry, machine building, additive technologies and power accumulators. In October 2022 in the Kaliningrad Oblast, works began on building the first "gigafactory" in Russia, where lithium-ion batteries (cells) will be manufactured. It is reported that the capacity of the gigafactory at the first stage will be 4 GW/h per year, which will provide lithium-ion batteries for 50,000 electric cars.

2.3. Russian NPPs
(Electricity division of Rosatom)

The electricity division of Rosatom (managing company Rosenergoatom Concern, REA) is the operator of all nuclear power stations located on the territory of Russia.

The percentage of nuclear power in Russia's energy balance in recent years has remained at a level of around 20%. In 2022, a record figure was achieved for Russia in electricity generation at NPPs at a level over 223 billion KW/h. However, it is expected that for 2023 a decrease in generation will be observed for the first time in 20 years, not counting the COVID year of 2020. This is caused by the aging of Russia's nuclear reactors and the lag in putting new nuclear facilities into operation compared with the rate of decommissioning old units of the high-power channel type.

The international activity of the REA and its presence on the international market are minimal. At the same time, the concern has become the main and practically sole division of Rosatom which is actively involved in the military operation to capture nuclear sites of Ukraine. Neither the Chernobyl military operation or the capture of the Zaporizhzhia NPP could have been organized without the involvement of Rosatom specialists. Bellona has described the events that have taken place at the captured nuclear sites of Ukraine in its work documents[9] and digests.[10]

At the same time, it is notable that information is severely restricted concerning the activity of managers of the concern and individual staff members of the Balakovsky and other Russian nuclear plants involved in the processes taking place at the ZNPP. The media and official reports only mention the general director of Rosatom Alexey Likhachev and an official of dubious reputation, the political analyst Renat Karchaa, who previously had no connection to Rosatom. Most of the information comes from the local administration.[11] Likhachev carries out a representative function in contacts with the IAEA, and Karchaa, an official with the status of advisor to the head of the REA, is present at the ZNPP.

Evidently, Rosatom does not have an independent plan concerning the further use of the ZNPP. But if a plan for the use or destruction of the ZNPP is formulated, the personnel and leadership of the REA will be the chief advisors, and probably the executors. Everything will depend on the scenario for the use or destruction of the ZNPP, if Russia decides to go ahead with it.

In international business, the REA was only present in 2023 as an advisor and executor of certain operations at the Akkuyu NPP (Turkey), the El-Dabaa NPP (Egypt), and also at the Belarussian NPP.

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[9] *https://bellona.ru/publications/*

[10] *https://bellona.ru/2023/atomic-digest*

[11] *https://dixigroup.org/wp-content/uploads/2023/08/ukr-paper_arhitektura-rosijskoyi-dezinformacziyi.pdf*

2.4. Machine-building and engineering *(machine-building and engineering division of Rosatom)*

The machine-building division (managing company Atomenergomash) is part of Rosatom and is the main supplier of key and auxiliary equipment for NPPs of Russian design under construction, including plants abroad. Additionally, Atomenergomash manufactures equipment for the oil and gas industry, heat energy and plants for thermal processing of waste.

During the wartime period, Rosatom's machine building division faces the same difficulties as the rest of Russian industry. Primarily, there are disruptions in business ties with foreign partners, and global changes in economic relations. For example, the suspension of activity by Rosatom's largest asset in Ukraine, the Energomashspetsstal plant in Kramatorsk, has already led to a considerable rise in price and delay in construction of the largest Russian nuclear icebreaker "Russia", of the 10510 "Leader" design. Machine-building enterprises have concentrated on domestic Russian orders, primarily involving the development of the Arctic, the icebreaker fleet, deliveries of liquified natural gas (LNG) and construction of floating power units. There have been reports that certain enterprises of Atomenergomash have become focused on fulfilling military commissions, which is quite possible in wartime conditions.

Construction of nuclear sites abroad is the responsibility of the machine-building, construction and planning divisions of Rosatom (Atomstroiexport, Atomenergoproekt). One of the main focuses of these divisions during the war has become supplying a wide range of equipment as part of the import substitution program. This primarily involves realization of a project for import substitution of automated information management systems, and also import substitution in IT technologies and in research and development (R&D).

Rosatom's export services bring a revenue of around USD 9 billion per year, of which 6 billion comes from construction of nuclear power plants in other countries. This is Russian revenue that is spent partially on the war. For this reason, the Yermak-McFaul group proposes to introduce gradual sanctions against Rosatom's activity in building NPPs abroad. Above all, this means freezing any new contracts for construction of NPPs outside of Russia. In fact, at the beginning of the war Rosatom only had contracts remaining for the Hanhikivi NPP in Finland, which was annulled after the war began, and also the Paks-2 NPP project in Hungary. Rosatom called the annulment of the contract for the Hanhikivi NPP outrageous, and the two parties filed lawsuits against each other in an international court of arbitration. As for the Hungarian project, on 18 August 2023 in Budapest a supplement was signed to the EPC-contract for construction of the Paks-2 NPP[12] between the construction client, Paks II. Nuclear Power Plant Ltd, and the general contractor of the project, the Russian company Atomstroiexport (the engineering division of Rosatom).

[12] *https://www.paks2.hu/web/paks-2-en/w/the-amendment-of-the-epc-contract-has-been-signed*

Thus, after the war began, the Paks-2 NPP project was the only project of Russian construction of NPPs remaining in the European Union. It is planned that the two VVER 1200 reactors will be put into operated at the beginning of the 2030s. At the same time, it has been reported that Hungary, despite friendship with Moscow, plans to diverse its nuclear fuel policy, and does not rule out the possibility of ordering fuel for its NPPs from French companies. Hungarian Prime Minister Viktor Orban reported a plan to replace Russian nuclear fuel for VVER-440 reactors with French fuel, stating that the government intended to realize this plan by 2034.[13]

In 2022-2023, Rosatom continued construction projects that had already commenced in Belarus, China, Turkey, Egypt, and Bangladesh. In future it plans to realize its main projects for construction of NPPs solely in the developing counties of Asia, Africa, and the Middle East, and also in a number of CIS countries.

Rosatom is taking enormous efforts to gain a firm foothold in Africa and promote its projects there. According to its general director, Rosatom intends to offer African nations projects of technological sovereignty, which will mean that not only major NPPs are built on the continent, but also small plants in countries lacking developed energy systems, and also floating plants in countries with a long coastline. Rosatom states that many African nations show great interest and potential for nuclear power.

However, it should be taken into account that the technological sovereignty that Rosatom talks about must be provided and paid for. New African partners will require expertise that they do not have, and it will also be necessary to create an entire system to ensure nuclear and radiation security and physical protection of nuclear materials, which must comply with all international conditions and requirements. Otherwise, Rosatom's African partners will become a new world problem – they will present a nuclear threat, primarily from the spread of nuclear materials. Undoubtedly, Rosatom's plans in Africa are part of the state initiatives of Russia, which is losing all its ties and markets in civilized countries of Europe and on other continents. Russia is trying to develop the potential of the African continent by promoting its own interests, which is also shown by other Rosatom initiatives, including its activity as a general sponsor of the "Russia – Africa" summit held in St. Petersburg, where Rosatom presented nuclear technologies for the development of Africa.

The West is examining the possibility of influencing Rosatom's potential projects by introducing secondary sanctions against countries and companies which violate the sanctions against Russia, and also offer parallel services. Because of this influence, developing countries planning construction of NPPs may face a dilemma in selecting a project. With the growth of the global interest in nuclear power, especially in developing countries, the number of Rosatom's potential competitors and projects increases, from South Korea, France, the US and China, especially in the small modular reactor segment. And here any decrease in the competitive ability of Rosatom may play a role in the selection of potential clients.

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[13] *https://news.mail.ru/economics/57762310*

Another option proposed by experts working on sanctions is to stop cooperation with Rosatom on NPPs which are being built at present, and even to stop construction itself, after the precedent set by Finland. For all sides, this is a complex and expensive issue, as numerous partners and contractors are involved in these projects. For example, turbines for many foreign NPP construction projects of Rosatom are installed using technologies and with the involvement of the French company GE Steam Power (formerly Alstom Power Systems), and control systems for the Paks NPP in Hungary are scheduled to be installed by the French-German consortium Framatome SAS-Siemens Ag and the South Korean company KERCO, which won the contract to build part of the El Dabba plant for USD 2.26 billion.

The withdrawal of these companies from projects for various reasons may seriously delay these projects down, but also will entail major losses for the companies themselves, and also conflicts with the countries where these projects are being realized. Therefore, it is unrealistic to expect that China, India, Egypt, Turkey or Bangladesh will suspend or cancel these projects voluntarily. Additionally, the reaction of many of these countries to sanctions against Russia has been to draw the maximum benefit from the existing situation, for example by purchasing Russian oil at a major discount.

At the same time, taking into account that these and other developing countries intend to develop nuclear power further, in future projects they may make concessions to allies of Ukraine and the West, and make a choice in favor of Rosatom's competitors, if their offers are more beneficial for them. This may become a convenient pressure point for diplomatic and economic efforts against Rosatom. For example, Turkey is now selecting a contractor for its second NPP, and besides Rosatom Ankara is also examining an offer from South Korea. Kazakhstan is also studying various offers for its nuclear power plant with the involvement of China, France and the US, as well as Rosatom. It will make its choice in the current year of 2023 after a referendum, and its decision will be very telling.

In Europe, the main conflict concerning the construction of Russian NPPs is developing around the Paks-2 NPP in Hungary. The Hungarian government, which has already issued Rosatom a license to build two VVER-1200 power units (the first concrete is expected to be poured in 2024 or 2025), is categorically opposed to sanctions against Rosatom and blocks many other sanctions against Russia. Hungary itself is very dependent on subsidies from the European Union, but so far the result of this conflict remains unclear, and in many ways its outcome will show the effectiveness of sanction pressure on Rosatom.

2.5. Northern Sea Route ("Sevmorput" directorate)

Rosatom has the function of the infrastructure operator of the Northern Sea Route and is responsible for the organization of shipping on the route, construction of infrastructural sites, navigation-hydrographic provision and the system of navigation safety in Arctic conditions.

In 2022-2023, Rosatom worked actively on realizing the federal projects "Northern Sea Route – 2030" and "Development of the Northern Sea Route", which in late 2022 was united into a single project. It was announced that up to 2030 Rosatom would spend 1,457.2 billion rubles from the federal budget and extra-budgetary funds on developing the Northern Sea Route. The main task of the project is to increase cargo flow on the NSR up to 80 million tons in 2024 and up to 150 million tons in 2030, and also to increase the total capacity of sea ports up to 110 million tons and 115 million tons in 2024 and 2030 respectively. According to Rosatom data,[14] in 2022 the volume of cargo transported on the NSR came to 34.03 million tons, a decrease of 816 tons from 2021 that was caused by international transit dropping by 10 times (from 2 million tons in 2021 to 200,000 tons in 2022). This still made it possible to exceed the target figure for the federal project – 32 tons of cargo in 2022.[15]

Taking into account the extension of the planning horizon from 2024 to 2030, new events have been added which were previously not part of federal projects, such as the Unified digi-tal services platform for the NSR, the development of a satellite group, construction of addi-tional nuclear icebreakers and LNG-powered icebreakers, development of a transit container line, construction of sites of federal ownership at the "Nagleinyn" terminal of the Pevek Port (Baimskaya mining company), "Utrenny" at the Sabetta port (Novatek), and at the ports "Sever Bay" (NK Rosneft), "Yenisei" (Severnaya Zvezda, AEON holding).

Russia plans to expand the fleet with icebreakers of the 22220 design ("Arctic") and the 10510 design ("Leader"). The nuclear fleet should receive new vessels of nuclear maintenance for icebreakers of the 22220 design, four LNG-powered icebreakers, emergency rescue, hydro-graphic and cargo vessels of the ice class (including container transporters). At the same time, the Russian government, planning the budget for 2024-2026, intends to reduce financing of nuclear icebreakers by 9 billion rubles, as the cost of series icebreakers has increased by two times, and the schedule for the launch of the superpowered Leader icebreaker has been delayed until the end of 2029.[16]

At present, FSUE Atomflot has 31 vessels: 7 nuclear-powered vessels, 5 nuclear-powered support vessels, 19 other vessels and watercraft, and 10 onshore facilities for handling radi-oactive materials.

On August 1, 2022, a Russian government decree established the Main Directorate of the Northern Sea Route (Glavsevmorput) on the basis of Atomflot, which is responsible for organ-izing navigation, including the issuance of navigation permits, in Arctic waters. The passage of foreign vessels along the Northern Sea Route is regulated by a separate law.

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[14] *https://t.me/rosatomru/1398*

[15] *https://network.bellona.org/content/uploads/sites/4/2023/09/EiP_87_ARCTIC_PDF-1.pdf*

[16] *https://www.kommersant.ru/doc/6267903*

2.6. "Environmental solutions" division

The Environmental Solutions Division (formerly the Division of the Final Stage of the Lifecycle) is the Rosatom structure in which all enterprises and groups that coordinate and manage virtually all environmental projects are now concentrated. The Division includes 6 main enterprises and 19 branches and offices, which are located in various regions of Russia, as Bellona wrote about in a previous report.[17]

In 2022 and 2023, a number of structural and personnel changes took place in the division and at these enterprises, which experts believe may lead to changes in major environmental projects, such as the elimination of the nuclear legacy and other sites of accumulated environmental damage, as well as to adjustments in Rosatom's environmental strategy. Structural changes, which continued in 2022 and 2023, mainly concerned enterprises of the nuclear legacy block, where there was a redistribution of facilities and responsibility for storage, processing, and disposal of radioactive waste (RW), as well as for decommissioning of nuclear and radiation hazardous facilities. During the wartime period, the three heads of the main organizations – the Directorate for Nuclear and Radiation Safety, FSUE FEO (formerly ROS RAO), and FSUE NO RAO – were replaced for various reasons.

Before the war, the process was underway for transferring RW storage sites from FSUE FEO and individual enterprises to FSUE "United Ecological, Technological, and Research Center for RW Decontamination and Environmental Protection" (FSUE RADON), which in 2019 was categorized by Rosatom as a specialized sectoral operator for handling nuclear legacy sites. Of the fifteen RW storage sites, only four, located in Chelyabinsk, Kazan, Blagoveshchensk, and Kirovo-Chepetsk, were transferred to this operator before the war. In 2022 and 2023, for various reasons, facilities were not transferred. Rosatom attributes the suspension of this process to the absence of a nuclear legacy law or other federal regulation that could establish basic rules and eliminate obstacles that constantly arise at the level of local executive authorities, i.e., governors.

In August 2023, FGUP RADON received a license from Rosatom State allowing it to operate stationary facilities located in former branches of FGUP FEO: NPC - Sergiev Posad, Moscow, Volga, Urals, North-Western Territorial District, Siberian Territorial District, Volga Territorial District, Southern Territorial District, Urals Territorial District, the «DalRAO» Far Eastern Center, and the «SevRAO» Northwestern Center Thus, this document made it possible to transfer all the branches previously part of FSUE FEO to FSUE RADON. At the same time, the heads of FSUE RADON note that the SevRAO and DalRAO facilities will remain under the jurisdiction of FEO until the completion of projects implemented at the enterprises of these branches. Experts estimate the completion date of all SevRAO and DalRAO projects to be approximately 2035-2040.

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[17] *https://bellona.ru/2023/10/03/atom-russia/*

The second problematic issue is the decommissioning of nuclear facilities. This issue concerns regulating relations, duties and responsibilities between FGUP Radon and organizations of enterprises that deal with decommissioning issues, such as Rosenergoatom, TVEL and other divisions of Rosatom. For example, the "Experimental and Demonstration Center for Decommissioning of Uranium-Graphite Reactors" (ODC UGR) has been operating for 15 years, and it is very difficult to transfer such established enterprises to other divisions seeking to occupy a niche in this business. In addition, a sectoral integrator company for decommissioning of nuclear facilities and radioactive waste treatment has been established on the basis of TVEL.

These and a number of other Rosatom enterprises are seeking contracts for work on decommissioning of nuclear facilities, as this is a socially and economically more attractive business. This is an issue of fierce business competition that has emerged within the state corporation in dealing with problems of eliminating nuclear legacy and other (non-nuclear) sites of accumulated environmental damage remaining from previous years. Perhaps these difficulties are indeed to some extent related to the fact that to date there is no federal-level document regulating relations for eliminating the nuclear legacy.

The projects to eliminate the nuclear legacy in the Arctic were the hardest hit by the war. With the outbreak of war in Ukraine, all international companies and states withdrew from joint projects with Russia, terminating their financing, as well as technological, political, social, and other participation. The removal of spent nuclear fuel from the emergency storage facilities in Andreeva Bay, the coastal maintenance bay in Gremikha, and the Atomflot base slowed down. Projects to raise submerged and sunken facilities of nuclear and radiation hazard in the Arctic seas have been put on hold, with unclear prospects for resumption. Rosatom states that the Russian government has a plan to complete work on raising hazardous facilities in the Arctic seas by 2035.

At the same time, it is noteworthy that the cost of the work envisioned by this plan is about 22 billion rubles in late 2022 prices. Given that this is budget money, the question remains when the government will be able to finance these complex operations. There is also the question of craft with raising equipment, i.e. ships or floating platforms. Russia does not yet have such craft, and their construction is neither underway nor planned.

Several years ago, Rosatom was authorized to eliminate the facilities of accumulated environmental damage, where waste of hazard class 1 and 2 was stored. The work to create an integrated system for treating class 1 and 2 waste that was entrusted to Rosatom is carried out by FSUE "Federal Environmental Operator". As noted above, the FEO began transferring its facilities, duties and responsibilities for providing services in the field of RW treatment and the nuclear legacy elimination to FSUE Radon.

During the wartime period (2022-2023), the FEO focused on solving the problems of eliminating accumulated environmental damage at storage facilities for non-radioactive waste of hazard classes 1 and 2. Since March 1, 2022, the FEO has carried out activity for the collection, transportation, treatment, disposal and neutralization of Class 1 and 2 waste throughout

Russia. Additionally, during the wartime period, the FEO, overcoming problems linked with the termination of supplies of foreign equipment and technology, has continued to implement projects to eliminate hazardous (non-radioactive) waste sites in the Leningrad Region (Krasny Bor site) and in Usolie-Sibirskoye in the Irkutsk Oblast, along with recultivation of the territory of the Baikalsk Pulp and Paper Mill (BPPM).

Under federal project «Infrastructure for treating class 1 and 2 waste», FEO is creating a network of eco-industrial parks to treat waste. It is planned to build two eco-industrial parks from scratch in the Tomsk and Irkutsk Oblast and create a production facility for treating chemical generators in the Nizhny Novgorod Oblast. In addition, four eco-industrial parks are being created on the basis of former facilities for the destruction of chemical weapons in the Saratov (Mikhailovsky village), Kirov (Mirny settlement), Kurgan (Shchuchye) Oblasts and in the Udmurt Republic (Kambarka).

The activity of the Environmental Solutions Division is financed primarily from the Federal Target Program (FTP NRS-2), which was launched in 2016 with the prospect of extending it until 2035, although initially it was planned to complete the program in 2030. According to the current plans for the program, 76 facilities of the nuclear legacy must be decommissioned between 2023 and 2035. Of these, 7 underground uranium-graphite reactors (UGR), 2 icebreakers, 3 nuclear maintenance vessels, and 26 large nuclear fuel cycle (NFC) facilities are to be decommissioned. It is planned to allocate around 95 billion rubles for activities related to decommissioning facilities of nuclear and radiation hazard and conservation of RW storage facilities, which is 23% of the total budget financing for the FTP NRS-2.

Rosatom experts believe that by 2035 only about 50% of the problems of the nuclear legacy will be solved. Initially, funding for FTP NRS-2 was quite stable, but later budget cuts were made, with the last cuts taking place in December 2022. According to the most optimistic forecasts, experts estimate that solving problems of the nuclear legacy problems is estimated by experts will cost over 2 trillion rubles. The work that will be carried out under NRS-2 FTP by 2035 is only a small part of the larger iceberg of problems of the nuclear legacy. It is impossible to predict how this problem will be solved further, as this will depend on the international political and economic situation, as well as the internal situation in Russia.

2.7. Directorate of the Nuclear Weapons Complex *(NWC)*

The Directorate of the Nuclear Weapons Complex of Rosatom State Corporation ensures the implementation of the state policy in the field of armaments and the state defense order, and is the most closed structure of the corporation. Most of the information about events in the Directorate of the Nuclear Weapons Complex and at its enterprises that was made public

during the wartime period concerned various scientific, cultural, sports, and anniversary events. For example, the 75th anniversary of the leading enterprise of the NWC, the Mayak Production Association, was widely celebrated with great fanfare.

Rosatom is not just about nuclear weapons, which are the responsibility of the NWC Directorate. Additionally, it takes part in the maintenance of existing new weapons and nuclear-powered nuclear weapon carriers and the development of new ones – surface ships and nuclear-powered submarines of various purposes, and developing the "Burevestnik" cruise missile and the Poseidon underwater torpedo drone. It is impossible to say how much Rosatom spends on its defense programs. But judging by the fact that about 90,000 Rosatom personnel are employed in NWC structures (i.e., a quarter of total personnel), the budget of the state defense order for Rosatom's enterprises is quite considerable indeed. In congratulating the corporation's employees and veterans on the Day of Nuclear Industry Workers in September 2023, Alexei Likhachev noted that the «impeccably fulfilled» state defense order has grown by many times in recent years.[18]

Russia's expenditures on the state defense order are difficult to estimate accurately, but defense spending in the state budget has indeed increased by many times during the war. In the draft state budget for 2024, defense spending rose to 10.8 billion rubles.[19] (USD 112 billion) – up 40% from 2022 and nearly triple that of pre-war 2021. At the same time, ICAN estimates that in 2022 Russia's nuclear weapon expenditure amount to 669.6 billion rubles or about USD 9.6 billion[20] (USD 8.6 billion in 2021[21] and USD 8 billion in 2020[22]), which is about 11% of Russia's 2022 defense budget.

According to the Nuclear Notebook project,[23] as of 2023 Russia has the largest nuclear arsenal in the world, with 4,489 nuclear warheads, of which 1,474 are on alert and are deployed on land- and sea-based intercontinental ballistic missiles. Nuclear Notebook estimates that this is about 12 warheads more than in 2022, mainly due to the addition of new intercontinental ballistic missiles and one new ballistic missile submarine, as well as the decommissioning of older warheads.

As of 2023, the Russian Navy had 11 strategic nuclear-powered submarines with ballistic missiles[24] (5 submarines of 667BRDM Delta IV design and 6 submarines of 955/955A Borey and Borey-A design) and more than ten other nuclear-powered submarines for various purposes, including six new submarines of 885 Yasen and 885M Yasen-M design, and one surface heavy nuclear-powered missile cruiser, "Peter the Great". In recent years, Russia has reached record levels in its shipbuilding capacity for nuclear-powered ships.

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[18] https://www.report.rosatom.ru/go/rosatom/go_rosatom_2022/rosatom_2022_3.pdf

[19] https://www.forbes.ru/finansy/497441-minfin-zaplaniroval-uvelicenie-rashodov-na-oboronu-v-2024-godu-pocti-na-70

[20] https://assets.nationbuilder.com/ican/pages/3785/attachments/original/1686495965/ICAN_Spending_Report_2023_sm.pdf?1686495965

[21] https://assets.nationbuilder.com/ican/pages/2873/attachments/original/1655145777/Spending_Report_2022_web.pdf

[22] https://d3n8a8pro7vhmx.cloudfront.net/ican/pages/2161/attachments/original/1622825593/Spending_Report_Web.pdf

[23] https://thebulletin.org/premium/2023-05/nuclear-notebook-russian-nuclear-weapons-2023/

[24] https://thebulletin.org/premium/2023-05/nuclear-notebook-russian-nuclear-weapons-2023/

At the beginning of 2022, 13 nuclear-powered submarines were under construction at the same time, and the heavy nuclear-powered missile cruiser "Admiral Nakhimov" was being modernized.[25] In the fall of 2022, it was reported that the main enterprise for the construction of fourth-generation nuclear-powered ships, PA Sevmash, had switched to a three-shift operation, i.e. it works around the clock. The basis of the renewed nuclear fleet should be made up of fourth-generation ships - strategic vessels of Borey and Borey-A/B design (costing at least 23 billion rubles in 2008 prices[26]) and multi-purpose vessels of Yasen and Yasen-M design armed with missiles and torpedoes (costing from 30 to 50 billion rubles each[27]). In 2022, the fleet will be joined by the nuclear-powered submarine cruiser of 955A Borei-A design, "Generalissimus Suvorov" and the "Belgorod" research submarine of 09852 design, the first vessel to carry Poseidon underwater drones with nuclear warheads. Three more new nuclear submarines are expected to join the fleet in 2023.

Rosatom is directly involved in the development, design, construction and even operation of all of Russia's nuclear weapons and nuclear-powered carriers.

2.7.1. Novaya Zemlya

The media are discussing reports that the testing ground for nuclear-powered missiles of the "Burevestnik" type («Skyfall» under NATO classification) may be moved to the Novaya Zemlya testing site from the Nyonoksa testing site in the White Sea, where an accident occurred in 2019 that caused fatalities, including Rosatom employees. Evidently, "Burevestnik" is the new weapon with new components and principles of impact that Putin is constantly talking about in his rhetoric of intimidation.

In mid-August 2023, the Director General of Rosatom and the Russian Defense Minister visited the Novaya Zemlya test site. Immediately afterward, Alexei Likhachev held a meeting with the Russian president. According to the report of the meeting published on the Kremlin's website, Likhachev reported on economic indicators that had been met and exceeded, new products, and training young specialists who had graduated with «gold» diplomas. However, it is doubtful that in a time of war and economic difficulties Putin took an interest in Rosatom's internal daily affairs.

It should be recalled that on February 21, 2022, in his speech to the Federal Assembly, President Putin instructed the Defense Ministry and Rosatom to prepare Russian nuclear weapons for possible tests. The decision on the test detonation of a warhead at a special test site could be made in response to similar weapons tests in the United States, Putin said. Putin's meeting with Likhachev was therefore most likely related to the latter's visit to the Novaya Zemlya test site. Fresh satellite images showing Rosatom aircraft at the Rogachevo air base and a concentration of transport and technology vessels near the Novaya Zemlya Pankovo test site may indicate that the test site is being completed, improved and prepared for new tests.

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[25] *https://thebarentsobserver.com/ru/bezopasnost/2022/01/stroitelstvo-atomnyh-podlodok-v-rossii-dostiglo-maksimuma-za-postsovetskiy*

[26] *https://www.newsru.com/russia/13feb2008/jury.html*

[27] *https://lenta.ru/news/2012/04/25/yasen/*

2.7.2. "Burevestnik"

In early 2017, the first reports appeared that testing of the "Burevestnik" missile had begun. In March 2018, Putin announced in his address to the federal assembly that the new missile had an unlimited range and that its flight trajectory was unpredictable. Unlimited range means that the missile, which is capable of carrying a nuclear warhead, is likely to have a nuclear engine with a large resource and much greater power than RTGs, for example. The fact that the "Burevestnik" has a nuclear engine was also indirectly confirmed after the accident at the Nyonoksa test site in August 2019. The accident disproves the official statement by Rosatom, which claimed that the rocket's engine uses a radioactive isotope power source. According to data published by the Russian meteorology service, the isotopic composition of the emission that occurred in the accident included isotopes such as Sr-91, Ba-140 and Ba-39, xenon and krypton. The experts therefore concluded that the missile probably had a nuclear reactor in which these isotopes form, which are a product of uranium fission and are not formed in conventional isotopic power sources.

According to eyewitnesses, the explosion took place underwater, i.e., the reactor of a sunken missile probably exploded during an attempt to raise it. The explosion damaged and contaminated the floating platforms, killing the people on them. There is no reliable information about the design of the reactor and its core. One can only assume that it is a modified version of the space transport reactors that were used by the Soviet space forces until about 1990.

The 2019 accident near Severodvinsk created social tension in the region and drew unwanted international interest. However, Putin has stated that no matter what, testing of the new weapon will continue. Perhaps these factors and decisions forced Rosatom and the Russian Ministry of Defense to shift further testing of "Burevestnik" to Novaya Zemlya. Around the same time, increased activity was noticed at the Novaya Zemlya test site near Pankovo. In August 2021, experts from the Institute of International Studies, by studying satellite images, concluded that Russia was preparing to test a nuclear-powered cruise missile at the Pankovo test site. Observations that were conducted in 2023 show that activity in the Pankovo area has not decreased. Additionally, ships and other vessels belonging to Atomflot have become a constant presence in the Matochkin Shar Strait area and other waters around Novaya Zemlya. This is evidence that Rosatom is directly involved in all new weapons tests and actively takes part in them.

At the same time, one should not forget that non-nuclear work with nuclear weapons systems, including subcritical testing of the nuclear component, has not stopped at the test site since 1990. According to a statement by one of the heads of the federal nuclear center, which is part of the NRC directorate, the readiness of the test site to resume nuclear testing is currently being maintained under a special program. Whether or not Russia is now preparing new nuclear tests is difficult to say for certain. However, aggressive statements in the state media by Russian politicians and certain figures from Putin's circle may be a sign that preparations for tests are underway. Russia's decision to withdraw ratification of the Comprehensive Nuclear-Test-Ban Treaty (CTBT), which has no practical consequences, only shows that Russia has started a game known as «nuclear blackmail,» in which Rosatom is actively participating. It is impossible to predict how this all may end.

Chapter III.

Rosatom's foreign projects in the wartime period

After the outbreak of war, Russia found itself in partial isolation from the countries of the pro-Ukrainian coalition. Changes in geopolitics, international economy, sanctions decisions and certain other recent events in the «nuclear world» will undoubtedly have an impact on the political and economic situation of Rosatom and its foreign projects.

At the end of 2021, Rosatom had 152 enterprises of various types in 41 (according to some sources, 54) countries in Europe, the Middle East, North Africa, and Asia-Pacific. In 29 countries of these regions, Rosatom did not just have representative offices, but was actively implementing more than 70 different projects that were at various stages of development and fulfillment. Bellona described Rosatom's projects on the eve of the war in sufficient detail in its previous report[28] and discusses them monthly in Nuclear Digests.[29]

With the outbreak of the war, Rosatom's business on various international nuclear markets began to show signs of instability and even decline, but not as quickly and radically as it did for Russian oil and gas companies, for example.

The portfolio of orders is shrinking. According to reports, in 2022 the portfolio of orders for the integrated company Atomenergoprom, which consolidates all of Rosatom's civilian as-sets, including foreign ones, decreased by 14.9% (to 841 billion rubles) compared to 2021. The net profit of Atomenergoprom in 2022 decreased by 21.7% compared to 2021, to 159.65 billion rubles. The decline was due to a decrease in NPP construction plans, as well as the fact that no new agreements were signed in 2022 for maintenance of facilities abroad. At the same time, it should be noted that Rosatom still has a considerable number of foreign facilities. In 2022, the portfolio of facilities serviced by Atomenergoprom amounted to 48 foreign power

[28] *https://bellona.ru/2023/10/03/atom-russia/*

[29] *https://bellona.ru/2023/atomic-digest*

units at various stages of construction, operation, individual work and consult-ing. Foreign projects to build new NPPs for Rosatom in wartime have become an even higher priority than before. This is due to Rosatom's fear of losing its position on markets and the Russian state's fear of losing political and economic influence.

In 2022 and 2023, Rosatom had 22 nuclear power plant units under active construction in seven countries, employing about 30,000 Rosatom personnel. Bellona provides basic information about these construc-tion projects in its report.[30] In addition, Bellona constantly analyzes what is happening at Rosatom's foreign construction sites and reports on this in its monthly digests.[31] In 2023, Rosatom made efforts to become more active in Africa. In July 2023, at the Russia-Africa Forum, Rosatom prepared and signed intergovernmental agreements and memoranda in the field of peaceful nuclear energy with Burundi, Zimbabwe, Morocco and Ethiopia. Rosatom's goal is to persuade African countries to participate in joint projects, particularly projects for building nuclear power plants of large or small capacity.

Table 1. **Foreign NPPs built by Rosatom**

Country	NPP (Unit №)	Reactor type	Launch date
Turkey	Akkuyu (1-4)	4 VVER-1200	>2024
China	Xudapu (3,4) and Tianwan (7,8)	4 VVER-1200	>2027
India	Kudankulam (3-6)	4 VVER-1000	>2024-2027
Egypt	El-Dabaa (1-4)	4 VVER-1200	>2028
Bangladesh	Rooppur (1,2)	2 VVER-1200	2024-2025
Iran	Busher 2 (1)	1 VVER-1200	?
Belarus	Ostrovets (2)	1 VVER-1200	2023

After the purchase of the Budyonovskoye field in Kazakhstan in 2023, Rosatom moved to second place in terms of uranium reserves and remains in third place in the world in terms of uranium production. In addition, the state corporation is a major player in the global ura-nium enrichment services market with a share of approximately 36%. Nevertheless, during the wartime period, a number of unpredictable events occurred in and around the interna-tional uranium market, which will undoubtedly have an impact, including on Rosatom's posi-tion in the nuclear market. For example, the military coup in Niger, which has two large uranium mines that account for about 5% of the world's uranium production. Niger is the leading supplier of uranium to the European Union, with a 24% share in 2021. It is difficult to predict how these events will affect the nuclear market, or to predict the likelihood of the events themselves.

[30] *https://bellona.org/publication/the-russian-nuclear-industry-during-wartime-2022-and-early-2023*

[31] *https://bellona.org/news/nuclear-issues/2023-10-bellonas-nuclear-digest-september-2023*

At the same time, it should be noted that over the past year and a half, various states and companies have taken initiatives to reduce Russian uranium supplies and their dependence on Russian enrichment and conversion facilities. The US and such EU countries as France, Sweden and the UK are the most active in this field. Russian uranium supplies to the markets of these countries reach up to 5,000 tons per year, and Rosatom's conversion and enrichment services account for about 30%.

It should be noted that, firstly, uranium supplies have a rather limited financial effect for Russia (the profit is no more than $500 million per year at current prices), and secondly, Russian supplies can be replaced by supplies from other countries capable of increasing production in the next 1-2 years, such as Kazakhstan, Namibia, Canada and Australia, which account for 75% of world production. But this may require the creation of new supply routes from Kazakhstan, bypassing Russia, since the main uranium supply route passes through Russia and the port of St. Petersburg.

The Yermak-McFaul expert group, as well as a number of politicians and other experts, propose working actively to reduce the dependence and risk level of trade with Russia in nuclear conversion and enrichment services to a minimum. This is quite a difficult task, since over the past few decades Rosatom has carved out a strong niche in these markets and still accounts for around 30% of the global uranium conversion market and about 36% of the enrichment market, bringing Russia between $1-2 billion per year, according to various estimates. The EU and the U.S. are about 30% dependent on Russia in these markets. Additionally, Russia is currently the world's sole supplier of HALEU (uranium with enrichment from 5% and 20%). In the long term, the Western nuclear industry is capable of refocusing and reducing its dependence on Russia for conversion and enrichment, but in the short term, expected shortages caused by the war already led prices in the conversion and enrichment markets to nearly double in 2022.

Obviously, in the context of the ongoing war, the situation requires political decisions and specific steps by major customers of the international nuclear market. The U.S. Congress Energy Committee approved a bipartisan bill to ban imports of Russian enriched uranium from January 1, 2028. In May 2023, the committee also examined a bill that would require the US Department of Energy to found a program for a domestic nuclear fuel cycle focusing on creating uranium enrichment facilities in the United States, thus ensuring the development of a domestic NFC and fuel supply security. On June 9, 2023, the US and UK governments announced the signing of the «Atlantic Declaration» for US-UK Economic Partnership, calling on the countries to expand cooperation for sustainable development of nuclear technologies, as well as significantly reduce dependence on Russian fuel and oust Russia from the global civil nuclear energy market.

The wartime period has seen increased activity by companies interested in ousting Rosatom from the global nuclear market. Urenco has approved an investment to increase enrichment capacity at its Urenco USA (UUSA) facility in Eunice, New Mexico. This expansion will include

adding many new centrifuge cascades to the existing facility, which will be the first project in Urenco's program to consolidate the nuclear fuel supply chain domestically and globally. The modernization, which will involve increasing capacities at the plant by 15% will add about 700,000 SWU/year to its current capacity of 4.6 million SWU/year. The first new cascades are planned to be put into operation in 2025. Cameco has signed a 10-year contract to supply natural uranium hexafluoride (UF6) for power unit 5 of the Kozloduy NPP. Kozloduy-5 is one of two reactors at the Kozloduy NPP, the only nuclear power plant in Bulgaria. Cameco will become part of an agreement for supplying nuclear fuel with Urenco and Westinghouse.[32]

According to the World Nuclear Association (WNA), Western uranium conversion facilities are currently operating at 40% capacity, but are expected to increase to 90% capacity from 2026.

Table 2. **Conversion capacity of companies. Source: WNA**

Converter power	Country	Designated capacity (tU)	Capacity used %	Utilization (tU)
Cameco	Canada	12 500	72%	9000
CNNC	China	15 000	53%	8000
ConverDyn	US	7000	0%	0
Orano	France	15 000	17%	2600
Rosatom	Russia	12 500	96%	12000
Total		62000	51%	31600

As for enrichment, Europe has enough capacity to meet its own needs, although some of the contracts have been ordered by customers from the United States and South Korea, which themselves lack capacity. So the problem may be more acute in the enrichment services market than in the conversion market. But experts are inclined to believe that reserves of enrichment capacity in Europe, particularly in Germany, the United Kingdom, and the Netherlands, could potentially compensate for the shortfall in Rosatom's supplies to the United States and South Korea.

In 2022, most EU countries that operate Soviet reactors have taken active steps to switch to non-Russian fuel. For example, Bulgaria and the Czech Republic intend to start converting their four VVER-1000 reactors to Framatome and Westinghouse fuel from 2024. The situation with fuel for VVER-440 reactors, which still needs to be developed and tested, is more complicated. However, Ukraine is already making progress in this area, and in November 2022, the Finnish company Fortum signed an agreement for the design, licensing and supply of new Westinghouse fuel for two VVER-440 units in the period from 2027 to 2030. A number of other steps taken by a number of countries and companies in response to the war should also be noted. The Swedish company Vattenfall refused to purchase new Russian-made

[32] https://www.atomic-energy.ru/news/2023/08/01/137679

fuel for the Ringhals nuclear power plant. Vattenfall will use fuel from France's Areva or the U.S. company Westinghouse. The German government has finally banned Rosatom from acquiring a 25% stake in the fuel plant in the west of the country, which is currently owned by the French company Framatome.

In the wartime period, Rosatom has intensified its activities for solving problems of import substitution. Due to sanctions imposed, Rosatom has begun medium-term (for the next five years) and long-term (until 2033) planning for the requirements of its enterprises. The unofficial name of this work is Atomplan.[33]

The aim of this work is to plan not only purchases, but also investments in future production facilities whose products are needed for ten years or more. Rosatom hopes to overcome dependence on imports by the end of 2023, which is highly doubtful, since planning has not even begun on construction of many enterprises and production sites whose products are needed today.

[33] *https://www.atomic-energy.ru/news/2022/08/12/127305*

Chapter IV.

Rosatom at occupied nuclear facilities

As noted earlier, individual Rosatom structures and representatives have been continuously present in the occupied territories since the beginning of the war, performing specific tasks at captured nuclear- and radiation-hazardous facilities. After Russian troops left the Chernobyl NPP zone on March 31, 2022, Rosatom representatives remained only in the Zaporizhzhia NPP region, including the town of Enerhodar and the site of the nuclear power plant itself.

The Zaporizhzhia NPP was seized by Russian troops on the night of March 4, 2022. During the seizure, there was a clash between the defenders of the plant and Russian troops. In the first months of the occupation, until the fall of 2022, despite the deployment of military personnel at the plant, Russian forces did not interfere with the operational management of the NPP. Ukrainian personnel continued to communicate with Energoatom and follow its instructions, and the plant continued to operate and generate electricity for the Ukrainian grid until September 2022.

On March 11, 2022, according to information[34] from Energoatom, the first Rosenergoatom employees arrived at the plant, high-ranking engineers from several Russian NPPs headed by Oleg Romanenko, chief engineer of the Rostov NPP.

In July 2022, Renat Karchaa, later introduced as an advisor to the Director General of Rosenergoatom, appeared at the plant and acted as the main information representative from the Zaporizhzhia NPP. He also accompanied IAEA Head Rafael Grossi during his visit to the plant on September 1, 2022 and on his next visits in March and June 2023.

Since September 1, 2022, an IAEA mission of two to four inspectors has been permanently present at the plant. During the year of presence, the mission has undergone 10 rotations of inspectors. The IAEA issues regular information reports on the situation at the plant, and

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[34] *https://t.me/energoatom_ua/2876*

their inspectors live directly on the territory of the plant, but their movement around the plant and inspection of it are severely restricted. Essentially, the Russian side and Rosatom representatives completely control the inspectors' movements and only show them what they consider necessary.

On October 5, 2022, Vladimir Putin signed a decree declaring ZNPP to be Russian property and instructed Rosatom to create the Zaporizhzhia NPP Operating Organization to manage the plant. This legal entity, registered in Moscow, was headed by Oleg Romanenko, who has long been present at the plant. A few days earlier, the legitimate director of Zaporizhzhia NPP, Igor Murashov, was kidnapped and then deported to Ukrainian-controlled territory. Later, in late November, Rosatom appointed Yury Chernichuk, former deputy chief engineer for modernization and resource management of the plant, as director of the Zaporizhzhia NPP.

Thus, starting from the fall of 2022, Rosatom took full control of the plant's management, including personnel decisions and key issues on the operational management of the plant.

After the station was taken over by Russian troops, 2 out of 6 NPP units – 2 and 4 – continued to operate in power mode.[35] Units 5 and 6 were shut down by decision of Energoatom as early as February 25, 2022,[36] Unit 1 was under repair, and Unit 3 was shut down by decision of the plant management[37] immediately after the occupation.

In September 2022, the remaining units were shut down and switched to cold shutdown, which is safest in the current situation. However, during the winter of 2022, two units of the plant were switched to the hot shutdown mode to supply heat and steam to the industrial site of the plant, and from spring 2023 one unit has remained in this mode, alternating with other units. Unstable operation of equipment not designed for long-term operation in the hot shutdown mode, lack of proper repairs, lack of personnel and spare parts – this all leads to an increased frequency of equipment failures and technological accidents, including destruction of radiation barriers.

In addition, military operations and sabotage around the ZNPP during its occupation resulted in shelling and damage both the plant site itself and the power lines connecting the plant to the unified power system. This repeatedly left the plant in a situation where there was no external power supply, and forced it to run backup diesel generators to operate cooling and safety systems. After the destruction of the Kakhovka HPP dam in June 2023, the ZNPP was also deprived of an external source of water supply in the form of the Kakhovka water reservoir. This all greatly increases risks of accidents at the plant.

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[35] *https://www.iaea.org/sites/default/files/publications/documents/infcircs/2022/infcirc978_rus.pdf*

[36] *https://www.nucnet.org/news/energoatom-shuts-down-zaporozhye-5-and-6-as-rest-of-fleet-remains-safe-and-operational-2-5-2022*

[37] *https://www.iaea.org/sites/default/files/publications/documents/infcircs/2022/infcirc976_rus.pdf*

The Zaporizhzhia NPP

Bellona considers the situation at the Zaporizhzhia NPP the most dangerous in terms of nuclear and radiation risks during the war in Ukraine and is keeping close track of the situation in various formats. Bellona prepared the separate report «Radiation Risks of the Capture of the Zaporizhzhia NPP»,[38] which analyzed possible risks associated with the situation surrounding the ZNPP, attempted to answer frequently asked questions and establish issues that are cause for concern and are worthy of attention in discussing news relating to the safety of the plant. In the monthly Atomic Digests, which Bellona has been publishing since February 2023, the Zaporizhzhia NPP and all events surrounding it are given priority.[39]

In the working paper «The War in Ukraine: Rosatom's Role», Bellona published a timeline of events that took place at the ZNPP during the first year of the war, i.e. in the period from March 2, 2022 to February 10, 2023.[40]

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[38] *https://bellona.ru/2022/12/30/zaes-capture-disaster/*

[39] *https://bellona.org/news/nuclear-issues/2023-10-bellonas-nuclear-digest-september-2023*

[40] *https://bellona.org/publication/rosatoms-role-in-the-war-in-ukraine*

Conclusion

There can be no doubt that in various forms, Rosatom takes an active part in Russia's war on Ukraine. Many Rosatom enterprises, organizations and officials are actively involved in pro-cesses that provide economic, financial, technological, direct military and other assis-tance to continue the war. The militarization of Rosatom and its support of the war increase the risks of nuclear and radiation incidents that are most likely to take place at seized nuclear facili-ties, as well as at facilities that are attacked by missiles and drones. The unprecedented sei-zure of nuclear facilities by Russian troops, the deployment of military equipment on them, and the minefields laid around them undoubtedly constitute nuclear sabotage, as well as a means of sophisticated intimidation and blackmail of the international community. Rosatom's direct influence on the processes that contribute to the continued occupation of Ukraine's nuclear facilities and increase military escalation is mainly carried out through financing military developments and operations, as well as through the direct participation of the corporation's structures and representatives in events on occupied territories.

Recently, the international community has been alarmed by the possibility of Russia resum-ing nuclear weapons testing. The unexplained and seemingly unnecessary visit by the head of Rosatom to the Novaya Zemlya nuclear test site in July 2023, followed by a meeting with Pres-ident Putin, has left experts and the public with questions. It is notable that Defense Min-ister Shoigu also took part in this visit. This may mean that Rosatom and the Russian Ministry of Defense have common interests and goals at the Novaya Zemlya site.

The question of imposing international sanctions against Rosatom remains open, which would make it possible to solve several important issues, at the very least. Firstly, these sanctions would reduce Russia's dominance in the global nuclear technology market and consequently deprive it of a portion of its financial revenues, and secondly, they would reduce Russia's potential foreign policy influence through Rosatom's projects, which the expert community describes as a «nuclear energy weapon".[41] But as Bellona has already noted in its reports and nuclear digests, so far the sanctions imposed on individuals and entities associated with Rosatom have had no serious impact on the nuclear state corporation's international and domestic business and its ability to promote the interests of Russia's political leadership. In many respects, these sanctions merely duplicate previously imposed restrictions in other jurisdictions where Rosatom's sanctioned structures are not active.

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[41] *https://www.nature.com/articles/s41560-023-01228-5#citeas*

Nevertheless, at present a situation can be observed where it is economically risky and even politically dangerous for the majority of developed and Western-oriented states to fall into any new dependence on Rosatom, or even cooperate with it. The pre-war oil and gas dependence of some countries on Russia and the negative consequences of this dependence is a vivid example of this danger and risk. Therefore, states and companies are looking for alternative markets and supply chains that will sooner or later eventually lead to a reduction in global dependence on Rosatom in such problematic areas as conversion, enrichment, and nuclear fuel production.

Obviously, Rosatom is also aware of what the loss of old supply chains entails, which is why the corporation has recently intensified its search for new partners and markets. Rosatom realizes that such markets as China and India are also gradually distancing themselves, as they are actively developing their own nuclear sectors. Therefore, while before the war Rosatom was mainly active in Asian countries, recently it has shown aspirations to make various deals with certain African countries and other countries in the global south. These efforts especially intensified after the Russian-African summit in July 2023 in St. Petersburg.

Analyzing Rosatom's African aspirations, one can see certain features that draw interest among experts. Firstly, after the war started, for Russia the whole world became divided into «friendly», «neutral» and «absolutely unfriendly» countries. Naturally, Rosatom is looking for certain opportunities for its foreign activities among «friendly» and sometimes among neutral countries, and they are mostly underdeveloped, authoritarian, or for some reason dependent on Russia. Therefore, there are doubts that projects in these countries will bring Rosatom large financial profits and technological dividends, especially given that such large projects as nuclear power plant construction and mining are usually realized with long-term Russian loans, and these countries are technologically underdeveloped.

Therefore, it seems that Rosatom's activity is aimed more at increasing Russia's political influence than at making money for the industry and for the country. Secondly, it is noteworthy that large and long-term projects are practically not offered to African countries. At present, there is a signed memorandum of understanding between TVEL and the South African company Necsa on cooperation in the field of nuclear fuel production. Otherwise, the projects are short-term and paid for by Russia. When it comes to the construction of nuclear units, this means either a floating NPP or a small-capacity NPP under the «build-own-operate» scheme. Other projects on which agreements have been signed are scientific, educational, cultural and other nuclear-related or socially-oriented fields of activity.

There are several countries in Africa that may be attractive to Rosatom because they have mineral fields which the corporation may be interested in mining in future. This primarily concerns South Africa, as well as Namibia, where Rosatom plans to start uranium mining in 2029, despite the fact that this country takes a markedly neutral attitude towards Russia. Niger, which holds third place in the world for uranium reserves, is not under consideration at present because French companies traditionally work in uranium mining in the country,

and the military and political situation there is currently unpredictable. As for the construction of nuclear power units, the only nuclear power plant that Rosatom is currently building in Africa is El Dabaa (Egypt), where construction of four units is scheduled for completion in 2028. Other possible projects for the construction of nuclear units are not worth discussing at present, as there are no real arrangements and signed agreements.

Potential partners for Rosatom's small projects in Africa could be Burundi, Zimbabwe, Morocco, Ethiopia, Uganda, the Central African Republic and several others with which the corporation is actively trying to sign various agreements and memorandums. In 2022, Russia made six agreements at government level with Angola, Egypt, Equatorial Guinea, Libya, Equatorial Guinea, South Africa and Zimbabwe on the promotion and mutual protection of capital investments, and intends to create a special fund to support Russian investors in African countries.

At the same time, it should be noted that Russia's foreign trade turnover with all African countries in 2022 amounted to about $18 billion, with 25% of supplies from Russia coming from wheat and olives, and 22% from oil and oil products. In addition, 60-70% of Russian investments are directed towards the exploration and production of oil, gas, uranium, bauxite, diamonds, iron ore and other minerals. For comparison, the European Union's trade turnover with Africa is about $300 billion, and about $250 billion for China and the U.S. These figures can illustrate Russia's economic prospects in Africa and the level of their influence on political relations with African countries.

Rosatom does not give up hope of winning back old partners or gaining new ones in former Soviet Union republics in Central Asia and the Caucasus. Rosatom is active in relations with Kazakhprom, mainly in purchasing new uranium deposits. At his last meeting with Putin, Rosatom head Alexey Likhachev proudly reported that the state corporation had become the second largest uranium producer in the world.

The latest deal to buy a 50% share in the Kazakh Budyonovskoye field is important for Rosatom, but it is noteworthy that the Kazakhstan media reported that the deal had criminal features, and Kazakhstan law enforcement agencies are currently checking the legality of the deal and the role of its participants.[42] Discussion continues about the possible construction of a Russian NPP in Kazakhstan, but no agreements have been reached yet. In an address to the nation on September 1, 2023 Kazakhstan President Kassym-Jomart Tokayev proposed to put the issue of NPP construction to a national referendum.

In May 2023, at a meeting between the head of Rosatom Alexey Likhachev and Armenian Prime Minister Nikol Pashinyan, the issue of building a nuclear power plant in Armenia on the site of an existing one was discussed. However, recent political events surrounding Karabakh and deteriorating relations between Russia and Armenia leave open the question of the reality of building a Russian VVER 1200 unit, for which a preliminary feasibility study was

[42] *https://kaztag.kz/ru/interview/samolety-nazarbaeva-uran-delo-dzhakisheva-raskryty-skhemy-oligarkhov-klebanova-i-kana*

proposed for consideration several years ago. It should be noted that today Armenia, along with the Russian project, is studying proposals for the construction of a modular reactor by companies from the US, South Korea, and France.

With Kyrgyzstan, Turkmenistan, Uzbekistan and other former Central Asian Soviet republics, Rosatom cooperates mainly in non-energy applications of nuclear technologies, healthcare, and also social and scientific spheres.

Summarizing all of the above, we may make several general statements concerning the work of Rosatom and events surrounding its activities in the wartime period.

The Rosatom State Corporation, as a part of Putin's political system, has become an important component of the state military machine in the wartime period, and contributes quite significantly to the militarization of Russia, especially in the nuclear weapons field and, consequently causes a rise in international tensions, According to available sources, during one and a half years of war Rosatom has maintained its nuclear business and strengthened its presence in the Russian domestic markets, in no small part through by expanding its presence in non-nuclear spheres, such as mining natural resources, digitalization, the IT-sector, ship-building, machine-building, sea transportation, eliminating facilities of accumulated environmental harm, nuclear medicine and several others.

Rosatom has also retained its presence on international markets for NPP construction and technical services in Asia, the Middle East and North Africa, and it not expected to lose these markets in the near future. Rosatom remains the world leader for the number of NPPs built abroad. European and North American market opportunities for Rosatom have begun to shrink, and it is clear that this process will continue, at least until the end of the war in Ukraine and the resolution of post-war issues. Rosatom retains its share on global markets of uranium conversion, enrichment and mining and is unlikely to lose this in the near future.

International sanctions have affected Rosatom's activities to a very small extent and have done it practically no economic and technological harm. However, by all indications, many countries, primarily in Europe, have begun to realize that Rosatom's activity may be directed towards achieving Russia's long-term political goals, which is a threat to their national security, and so they have resolved to take steps to limit Rosatom's presence on the global nuclear market.

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