DECOMMISSIONING RUSSIA'S OLD NUCLEAR POWER REACTORS

STATUS UPDATE ON KEY PROCESSES 2017

RUSSIAN SOCIAL-ECOLOGICAL UNION / FRIENDS OF THE EARTH RUSSIA,
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St.Petersburg, Sosnovy Bor, Chelyabinsk, Apatity/Murmansk, Oslo – May 2018

Decommissioning Russia's old nuclear power reactors
Status update on key processes 2017

Content

1. Introduction

Russia currently has 35 nuclear power reactors, of which 26 are operating beyond their designed lifetime. So far, 5 units have been shut down and the fuel has been unloaded, but dismantling has not started. In 2018, one additional unit will be closed. At the same time, decommissioning plans are lacking. Unit 1 at Leningrad nuclear power plant will be closed in 2018, and a general decommission plan has been made but this is not publicly available. Rosenergoatom plans to spend the next years to plan the dismantling of the unit. Several questions remain unanswered, for instance how to deal with the reactor graphite.

Also, final solutions are lacking for the handling of radioactive waste and spent nuclear fuel. Spent nuclear fuel from European NPPs with VVER-440, VVER-1000 and RBMK-1000 reactors are being transported to the closed nuclear towns Ozersk (Ural) and Zheleznogorsk (Siberia) regions of Russia for reprocessing and temporary storing. This strategy of transporting nuclear risk from Europe to the Urals and Siberia is being promoted without transparency and without real participation of the society and the authorities of the regions to where this movement takes place.

Decommission plans should be good enough to endure review not only from authorities at all levels, but also civil society including trade unions, environmental groups and neighbors. The lack of information poses an obstacle to good solutions, as do decisions taken in closed rooms. There should be an aim to promote knowledge and participation.

Information in this report is collected from open and available sources. We have put together in what we hope is understandable and readable form.

2. Summary: Main developments in 2017

We regard the following to be the main decommission-related developments in Russia in 2017.

Developments in decommissioning planning of Leningrad NPP

The first unit of Leningrad will be closed in 2018. The next years will be used for detailed planning, before dismantling will start 2021. Among the difficult questions are what to do with the reactor graphite, a problem that also Lithuania struggles with after their closure of Ignalina NPP. In the conception for decommissioning of Leningrad NPP units there are only a schedule and not a real plan for decommissioning. Decommissioning planning of Leningrad NPP will start after the first unit is closed. You can read more about decommissioning of Leningrad NPP's first unit in chapter 4.

Prolonged operation of Kola NPP's first units

Kola NPP seems to receive prolonged lifetime of its first two reactors, giving the units a total operation time of 60 years. This is twice as much as they originally were designed for. You can read more about prolongation of Kola NPP's reactors in chapter 5.

Continuing debate on the location of regional radioactive waste storages

The national disposal facilities for medium and low level radioactive waste, have resulted in protests several places. The first facility was put into operation in Novouralsk closed town in Sverdlovsk oblast

in 2016. Strong local opposition in Sosnovy Bor (Leningrad oblast) resulted in rejections of plans there. For the high-level radioactive waste, the most hazardous radioactive waste, a single national disposal site is proposed in Zelesnogorsk in Krasnoyarsk territory. Also here people showed their attitude against construction. You can read more about radioactive waste in chapter 7.

Old and new releases at Mayak

2017 marked the 50 years anniversary of the Kyshtym disaster in 1957. Still, the area around the Mayak facility is heavily polluted by radioactivity.

Autumn 2017 French researchers discovered traces of ruthenium, which later was found to origin from Mayak. Russian authorities refused any affiliation with the ruthenium, at the same time saying there was no danger. Although the ruthenium release was tiny compared to the radioactive pollution if Mayak, it is relevant to note that Russian authorities seem to continue with secrecy and lies, also when they seemingly would lose nothing from telling the truth. You can read more about Mayak in chapter 8.

New law about the status of Rosatom State Corporation

In December 2017, the Council of Federation of the Federal Assembly of the Russian Federation approved a law clarifying and expanding the powers of state corporation Rosatom and its supervisory board. The law was signed by Russian president Putin in January 2018[1]. The law gives the Supervisory Board of the Rosatom State Corporation supreme authority for approval of the activities of Rosatom, and excludes the relevant powers of the government of the Russian Federation.

Already before this law, local and regional parliaments, not to mention local civil society, were left with little chances of influencing nuclear-related decisions. With this new law, democracy takes another step back in Russia. You can read more about these legal changes in chapter 10.

Decommission law with new rules

In January 2017, Rostechnadzor adopted new decommissioning rules for Russia. For the first time, there were officially two scenarios for the decommission: immediate decommission and deferred decommissioning. You can read more about the decommission law in chapter 10.

Political changes at Rosatom

In 2016, Kirienko was replaced by Likhachev. Although we cannot point to any visible difference in policy during 2017, Likhachev is less public then Kirienko. In 2017, compared to 2016, there was one less meeting for the Public Council.

A larger change is the increased powers of the Supervisor Council of Rosatom, which has increased control over Rosatom, and the Russian government has lost powers to control the activities of the State Corporation Rosatom. Sergey Kirienko, deputy chairperson of the Russian President administration, was appointed chairperson of the Supervisor Council of Rosatom.

[1] Putin signed a law extending the authority of Rosatom State Corporation, Electronic Magazine Safety of nuclear technologies and the environment, January 8, 2018, www.atomic-energy.ru/news/2018/01/09/82230 .

3. Current situation for the nuclear power reactors in Russia

The all-Russia operator Rosenergoatom has 10 nuclear power plants with 35 power units totally. Below is information on all Russian nuclear power plants. A summary of the information can be found in our updated table of Russian nuclear power plants (table 1).

Table 1. Russian Nuclear Power Plants (NPPs)[2]

Red - power units operating on extended lifetime
Black - power units operating within the design operation time;
Green - power units stopped and fuel unloaded;
Blue - power units under construction

Name of Power Unit	Satellite cities of nuclear power plants, regional centers and distances to them	Type of power unit	Power Gross MW	Generation of power unit	Year of commissioning	Year of the end of the designed lifetime	Planned end after extended operation
Kola 1	Polyarnye Zori,	VVER-440/230	440	1	1973	2003	2033
Kola 2	11 km	VVER-440/230	440	1	1974	2004	2034
Kola 3	Murmansk - 170	VVER-440/213	440	2	1981	2011	2041
Kola 4	km	VVER-440/213	440	2	1984	2014	2044
Leningrad 1	Sosnovy Bor - 3.5	RBMK-1000	1000	1	1973	2003	2018 (21.12)
Leningrad 2	km	RBMK-1000	1000	1	1975	2005	2020 (12.12)
Leningrad 3	Saint Petersburg	RBMK-1000	1000	2	1980	2009	2025 (31.01)
Leningrad 4	35 km	RBMK-1000	1000	2	1981	2011	2025 (26.12)
Leningrad NPP - 2-1		VVER-1200	1200	3+	2018	2068	
Leningrad NPP - 2-2		VVER-1200	1200	3+	2020	2070	
Smolensk 1	Desnogorsk - 3	RBMK-1000	1000	2	1982	2012	2027
Smolensk 2	km away	RBMK-1000/	1000	2	1985	2015	2030
Smolensk 3	Smolensk 150	RBMK-1000	1000	3	1990	2020	2030
	km						
Kursk 1	Kurchatov - 4 km	RBMK-1000	1000	1	1976	2006	2021
Kursk 2	Kursk - 40 km	RBMK-1000	1000	1	1979	2009	2023
Kursk 3		RBMK-1000	1000	2	1983	2013	2028
Kursk 4		RBMK-1000	1000	2	1985	2015	2030
Kursk 5		VVER TOI	1255	3+	2020		
Kursk 6		VVER TOI	1255	3+	2022		
Novovoronezh 1	Novovoronezh	VVVER-440/210	417	1	1964	1984	End 1984
Novovoronezh 2	3.5 km	VVER-440/365	417	1	1969	1989	End. 1990
Novovoronezh 3	Voronezh - 45	VVER-440/179	417	1	1971	2001	End. 2016
Novovoronezh 4	km	VVER-440/179	417	1	1972	2002	2017
Novovoronezh 5		VVER-1000-187	1000	2	1980	2010	2035
Novovoronezh 6 (II-1)		VVER-1200	1114	3+	2016	2076	
Novovoronesh 7 (II-2)		VVER -1200	1114	3	2018	2078	
Kalinin 1	Udomlya - 4 km	VVER-1000	1000	2	1984	2014	2029
Kalinin 2	Tver - 125 km	VVER-1000	1000	2	1986	2016	2031
Kalinin 3		VVER-1000	1000	2	2004	2034	2064
Kalinin 4		VVER-1000	1000	2	2011	2041	2071

[2] Source: http://www.rosenergoatom.ru/

Beloyarsk 1	Zarechnny -3 km	AMB-1000	100	1	1964	1981	End 1983
Beloyarsk 2	Ekaterinburg - 15	AMB-200	200	1	1967	1989	End 1989
Beloyarsk 3	km	BN-600	600	2	1980	2010	2025
Beloyarsk 1		BN-800	880		2016	2046	
Balakovo 1	Balakovo -12.5	VVER-1000	1000	2	1985	2015	2045
Balakovo 2	km	VVER-1000	1000	2	1987	2017	2043
Balakovo 3	Saratov - 145 km	VVER-1000	1000	2	1988	2018	-
Balakovo 4		VVER-1000	1000	2	1993	2023	-
Bilibino 1	Bilibino - 4 km	EGP-6	12	1	1974	2004	2019
Bilibino 2	Anadyr - 610 km	EGP-6	12	1	1974	2004	2019
Bilibino 3		EGP-6	12	1	1975	2005	2020
Bilibino 4		EGP-6	12	1	1976	2006	2021
Rostov 1	Volgodonsk - 11	VVER-1000	1000	2	2001	2031	-
Rostov 2	km	VVER-1000	1000	2	2010	2040	-
Rostov 3	Rostov-on-Don -	VVER-1000	1000	2	2014	2044	
	250 km						

A previous version of this table was showed in our decommissioning of 2016[3]. During 2017, one more reactor has received extended operation, and today Russia has 26 nuclear power reactors that are operating beyond their designed lifetime, more than 70% of the total number of operating units. Generally, reactors have been prolonged for additional 15 years, but some have received longer time, even as much as 30 years giving a double operation time compared to the original designed lifetime.

During the last 33 years, 5 power units have been shut down for good. The fuel has been unloaded, but no dismantling process has started. Along with the power units that will need to be closed during the next 15 years, a huge decommission challenge is piling up. At the same time, plans and money are lacking.

7 new nuclear power units are currently in the process of being built in Russia. Six of those are mentioned in the table, Leningrad NPP-2, Kursk -2 and Novovoronezh-2. In addition, the floating NPP Akademik Lomonosov has been build but not yet test-run. It will be transported from St.Petersburg to Murmansk in 2018. Spesifications are KLT 40 S, 2 x 45 MW, 90 MW.

Leningrad NPP

Leningrad NPP (Sosnovy Bor) RBMK-1000 reactor. Rosenergoatom announced plans for the final stop power unit at the end of 2018 and began its planning for decommissioning to the state of a "brown field", meaning that the site will be released with restrictions (contrary to a "green field" end stage, where the site is released without any restrictions and in principle can host a kindergarten). All four reactors of RBMK-1000 LNPP, are planned to be stopped by December 2025.

[3] Decommission Network 2017: Вывод из эксплуатации Российских АЭС, обращение с ОЯТ и РАО в 2016 г. (English translation: Decommissioning of Russian power plants, handling of radioactive waste and spent nuclear fuel in 2016.) Available in Russian language at: http://rusecounion.ru/sites/default/files/inline/files/2%20Status2016_decom-rw-snf-Russia_RUS_0.pdf

Kola NPP

In October 2016, representatives of Kola NPP announced the extension of operation for another 15 years. Thus, the resource of these power units was doubled from the original plan, to 60 years.
In December 2017, the director of the Kola NPP Vasily Omelchuk said in an official statement that the plans for closing Kola NPP reactors where
1st reactor – 2033, 2nd reactor – 2034, 3rd reactor – 2041 and 4th reactor - 2044.

Smolensk NPP

All 3 reactors at Smolensk NPP have received 15 years prolonged operation, and are scheduled to close in 2027 and 2030. The last two reactors at Smolensk, along with the last in Kursk, will be the 3 last Chernobyl type reactors to close down.

Kursk NPP

According to the "Program for the development of the electric power industry of the Kursk region for 2018-2022, approved by Governor Alexander Mikhailov, the first of four operating power units of Kursk NPP will be decommissioned in 2022, simultaneously with the launch of the first power unit of Kursk NPP-2. If so, it will need additional 1 year in its prolonged operation.

This is the same strategy as in Leningrad region, where the old reactors will be closed when the new start up.

The next 3 Kursk reactors are scheduled to be closed in 2023, 2028 and 2030.

The commissioning of the second power unit of Kursk NPP-2 was planned in 2023 approximately according to the information in the media[4], in 2024 according to Rosenergoatom's presentation "For the investment session on the results of 2015"[5]. If the latter is correct, there might be some delays in closing of the old unit number 2.

Novovoronesh NPP

Novororonesh's first unit was stopped in 1984, the second in 1990. Decommission preparations started 2011, making Novoronesh the first full-scale nuclear reactor decommission in Russia. Also, the first and second units of the NPPP are testing the latest systems for decontamination and processing of radioactive waste[6].

Novovoronezh NPP power unit No. 3, VVER-440 reactor was finally shut down in 2016. In the future, it is planned to be decommissioned. Specific dates are not mentioned.

Kalininskaya NPP

The first two reactors are scheduled to close in 2029 and 2031, after lifetime prolongation. The two newer reactors, from 2004 and 2011, will operate until 2034 and 2041.

[4] Source: https://www.seogan.ru/rosenergoatom-xochet-uskorit-sroki-vvoda-kurskoiy-aes-2-na-neskolko-let.html
[5] Source: https://goo.gl/QHCiBg
[6] Source: http://publicatom.ru/blog/nvaes/23179.html

Beloyarskaya NPP

The two first reactors where closed in 1983 and 1989, soon after commission. Unit 3 is prolonged until 2025, and the new unit 4 from 2016 is scheduled to close in 2046.

After 17 and 22 years of operation, power units number 1 and No. 2 were stopped in 1981 and 1989 respectively, now they are in a long-term conservation mode with the fuel discharged from the reactor and at the first stage of decommissioning of nuclear power plants.

Balakovskaya NPP

The first unit was scheduled to close in 2015, but received prolonged operation to 2045. This means that, like Kola NPP reactors, Balakovskaya's first unit also received operation twice as long as originally designed.

Unit 2 and 3 were scheduled to close in 2017 and 2018.

In October 2017 Rostekhnadzor issued a license for further operation of the 2nd unit of Balakovo NPP until 2043 - so license was given for 26 years[7].

Bilibinskaya NPP

The operation at the small reactors at Bilibin NPP have all been prolonged 15 years and will close in 2019, 2019, 2010 and 2021, respectively. According to plans, the reactors will be replaced by floating nuclear power plants, travelling from St.Petersburg over the Baltic Sea, along Norway and to Murmansk in summer 2018.

Rostovskaya NPP

The 3 reactors are scheduled to close in 2031, 2040 and 2044, without any prolongation so far.

4. Decommissioning planning

Status of **federal plans** for decommissioning of nuclear power plants

A forecast of commissioning new and decommissioning old nuclear power plants in Russia before 2030 was published 12.08.2016 by editor in chief of electronic analytical magazine Geoenergetics[8]. This forecast of commissioning of new NPPs was based on the Order of the Prime Minister of Russia (from 1 August 2016 No. 1634-r) about the Scheme of territorial planning of the Russian Federation in the field of energy[9]. The construction of new NPPs are mentioned in the official document of Russian Government 1 August 2016 No. 1634-r. However, the decommissioning or closure of NPPs mentioned in the forecast are not based on similar official documents, but on the licenses of the lifetime extension and so on.

[7] Source: http://www.rosatom.ru/journalist/news/balakovskaya-aes-srok-ekspluatatsii-energobloka-2-prodlen-na-26-let/
[8] Source: http://geoenergetics.ru/2016/08/12/aes-v-rossii-do-2030-goda/
[9] Source: http://static.government.ru/media/files/eFBHWjAwsi3waUcgX5Cg0F4RPlbmItHe.pdf

According to the forecast, 21 nuclear units with total capacity of 13.042 MW will be finally stopped until 2030. Most notifiable, 10 of 11 RBMK-1000 reactors which is running on prolonged operation, will finally be stopped. Only 1 unit of RBMK-1000 on Smolensk NPP will remain in operation in 2030.

In the same period, 22 new nuclear units with total capacity 25.360 MW will be constructed and commissioned. The total capacity of 14 Russian NPPs with 36 nuclear reactors in 2030 will be 39.324 MW, according to the forecast. This is approximately the same number of reactors as in 2017, but the capacity of the 35 operating reactors totals to 26.983 MW today[10].

According to these plans, the construction of a new design of breeder-reactors will provide the creation of a closed nuclear cycle in Russia. But this is not realistic in the time-frame of the forecast, until 2030.

For instance, according to Dr. Boris Nigmatulin, Director General of the Institute of Energy Problems (Moscow), it is not real in the nearest future because[11]:

- There is no effective management of the decision-making process and no transparent discussions of the perspective designs of the nuclear reactors for the closed nuclear cycle.
- It is economically not reasonable in nearest future. Breeder reactors are extremely expensive, not effective for the fuel generation (U235 and Pu239) and dangerous.
- The Non-Proliferation Treaty pose a political barrier. For this technology it is reasonable to involve the not nuclear countries, without nuclear weapons.

As shown in the previous chapter on status on nuclear power plants, reactors that are already closed have not started the process of dismantling. They even lack proper decommissioning planning. Information on when dismantling will start, are not given. There is no news about the federal plans for the decommissioning of NPPs, which is continuing their operation in a regime of lifetime extension.

At the same time, the newspaper Kommersant published an expert analysis on commissioning of new power units of NPPs, which should replace the old power units[12]. According to this analysis, which is based on information from Rosatom[13] and the Ministry of Energy of the Russian federation[14], for economic and political reasons, the new nuclear power units will start electricity generation later than planned. It is assumed that the timing of the commissioning of new nuclear power units can move for a period from 6 months to 2 years.

It can be expected that, as a result of such a shift in the deadline for one year of commissioning the second power unit of Leningrad NPP-2 (scheduled for February 2020), the deadline for the final shutdown of the second power unit of the Leningrad NPP with the RBMK-1000 reactor may also be shifted.

We note however that, in 2019 and 2020, the beginning the electricity generation of the Belarusian NPP with VVER-1200 reactors is planned. Given that Lithuania will not buy energy

[10] http://www.world-nuclear.org/information-library/country-profiles/countries-o-s/russia-nuclear-power.aspx
[11] Source; http://www.proatom.ru/modules.php?name=News&file=article&sid=7838
[12] Source: https://www.kommersant.ru/doc/3448572
[13] Alexander Lokshin, the first deputy head of Rosatom state corporation
[14] recommendation of Arkady Dvorkovich, the deputy Prime Ministry of Russia

from the Belarusian nuclear power plant, its energy will be supplied to Russia. In this case, there may not be an energy deficit in North-West Russia and the second power unit of Leningrad NPP could shut down after 45 years of operation, like planned.

Demonstration centres for decommissioning

Despite the alarming lack of decommissioning plans, we see some progress in recent years. There are experimental demonstration centers for the decommissioning of the power units of the NPP in Novovoronezh (the decommissioning of VVER-440), the closed town of Seversk (decom of uranium-graphite reactors), and the closed town of Zheleznogorsk (treatment of RW and SNF).

At the same time, these centers are mainly focused on obtaining technological experience associated with decommissioning. International experience with decommissioning of power plants in other countries shows the importance of interaction between authorities, operators, regulators and the public to ensure not only technological, but also socio-environmental, and economic security. This approach is summarized in our Concept of plans for decommissioning of NPPs[15].

Status of decommissioning planning on Leningrad NPP

An article describing the decommission plan of the Leningrad nuclear power plant was published by an anonymous author in the Russian nuclear magazine *Atominfo.ru* in 2014[16]. According to this publication, the decommissioning project should be developed before the final stop of the 1st block in 2018. However, this was not done.

A decommission conception for Leningrad nuclear power plant units was finished and adopted by Rosatom in 2015. It has the status as an internal document and is not published. Thus, debate over the conception is difficult, and Rosatom might lose potential valuable inputs.

The conception resembles more a brief schedule than an actual plan. The 66 pages are mainly technical descriptions of the reactors. The conception states that it was developed on the basis of the Rosatom Concept of 2008 and Rosenergoatom in 2009. But where the Rosatom concept from 2008 emphasizes discussion with the public and involvement of local and regional authorities, the Leningrad decommission conception contains to presentation of environmental impact assessment of the decommission project, public hearings or about the role of the government of Leningrad oblast. Still, there is a discussion of the strategy in the conception, and a choice of immediate decommissioning is made.

When unit 1 of Leningrad NPP will finally stop in 2018, it will be transferred to a so-called nuclear-safe status. This means that spent nuclear fuel will be unloaded from the reactor and placed in the cooling pool on site. At the same time, a decommission project will be

[15] Decommission Network 2008: CONCEPT OF A DECOMMISSION PLAN FOR OLD NUCLEAR POWER REACTORS Guiding Principles from Environmental NGOs. Available at: http://rusecounion.ru/sites/default/files/inline/files/6%20conception2008_ENG%20smaller.pdf

[16] Планы по выводу из эксплуатации Ленинградской АЭС (Decommissioning plans for Leningrad NPP), http://www.atomic-energy.ru/smi/2014/08/25/50976

developed and a license to decommission will be obtained[17]. Thus, the decommission planning documents that do exist, are not detailed project documents, but merely strategies.

According to the conception, decommissioning of the first unit of Leningrad nuclear power plant is meant to take 32 years, and involve the following general steps:

- 2018 - 2023, a decommissioning project will be developed.
- In 2023 the operator of Leningrad Nuclear Power Plant will receive a license for its decommissioning.
- In 2023 – 2030 preparations will be made for dismantling: deactivation of the equipment without dismantling.
- Up to 2040s transport of spent nuclear fuel to the Mining Chemical Combine in ZATO Zheleznogorsk, Krasnoyarsk Territory.
- 2030 – 2045: dismantling of equipment with the preservation of the reactor module.
- 2045 – 2050: the reactor module will be dismantled.

Sergey Yefimenko, the deputy director Leningrad NPP (old RBMK reactors) and Leningrad NPP-2 (new VVER reactors) made a presentation about the decommission plans of the first unit of Leningrad NPP on the International Conference Decommission 2017 in Peterhof (SPb., October 3-5). The main focus of the presentation was on the radioactive waste (RW) management. There is no final solution for the RW repository (storage) in NW Russia for the decommissioning of Leningrad NPP and Kola NPP. According to not official information, the perspective site for the RW is in the place of extraction of apatite near the city of Apatity in Murmansk oblast.

Spent nuclear fuel will be transported to the temporary dry spent nuclear fuel on the bank of the Yenisei River, at the Mining and Chemical Combine in ZATO Zheleznogorsk, the Krasnoyarsk Territory at the end of the decommissioning of Leningrad NPP in 2050ies.

Main challenges for decommissioning of Leningrad NPP

Even though the first reactor is scheduled to close in December 2018, decommissioning plans are still lacking. In October 2017, Sergey Yefimenko, deputy director LNPP and LNPP-2 made presentation about the decommission plans of the first unit of LNPP on the International Conference Decommission 2017 in Peterhof (SPb., October 3-5). From this it became clear that the first 5 years will be used for planning, before obtaining of a decommission license.

Vladimir Kuznetsov, a former deputy head of the Reactor department of Leningrad NPP, Ignalina NPP and Chernobyl NPP, has given critical comments of the official Conception of the decommissioning of Leningrad NPP. He gave his comment after participating at a decommission conference in St.Petersburg in October 2017, a conference where also the deputy director of Leningrad NPP

[17] Information according to Vladimir Pereguda, director of LNPP. More information: https://docviewer.yandex.ru/view/2731061/?*=kzmll5qUkGO%2F%2B5gZRZf2CblQ4Mp7InVybCI6Imh0dHA6Ly93d3cubGFlcy5ydS9jb250ZW50L3ByZXNzYS92ZXN0bmlrLzIwMTUvVkxfMjNfMjAxNXMucGRmIiwidGl0bGUiOiJWTF8yM18yMDE1cy5wZGYiLCJ1aWQiOiIyNzMxMDYxIiwieXUiOiIxNzY0MTA0NTgxMzk4NDM3MDQ5Iiwibm9pZnJhbWUiOnRydWUsInRzIjoxNDk3OTU4NTM0OTAzfQ%3D%3D&page=5&lang=ru

participated. Kuznetsov was able to read the conception after receiving it from Oleg Bodrov, although it is not formally officially available yet.

According the Vladimir Kuznetsov, the concept for decommissioning of Leningrad NPP does not describe important decommissioning aspects such as:
- Final solutions for long-term isolation or reprocessing of spent nuclear fuel;
- Handling of highly radioactive graphite;
- A final solution for long-term isolation of radioactive waste.

Also, Kuznetsov notes that the conception provides an inadequate assessment of the decommissioning costs of the 4 power units of Leningrad NPP with RBMK-1000 reactors. The concept says 55 billion rubles or about 800 million euros. For comparison: the estimation of the cost of decommissioning of the Ignalina nuclear power plant with two RBMK-1500 reactors has increased approximately 3 times after 10 years from the beginning of the decommissioning: from 1 billion to 2.9 billion euros. Even more, this amount does not include the future costs for the final isolation of spent nuclear fuel.

According to our vision, it is reasonable to add that the conception should include (but does not include) description of procedures for coordinating interests with regional authorities, local authorities and the public and civil society in Leningrad Oblast, St. Petersburg and Sosnovy Bor.

No technical solution for the graphite moderator

The main technical challenge for decommissioning of Leningrad NPP is the graphite moderator. As neutron moderator, 1700 tons of graphite (carbon C12) are used in each RBMK-1000 reactor, which during operation of the reactor is converted into biologically active radioactive carbon (C^{14}) with a half-life of 5 750 years. This is highly active, long-lived radioactive waste and can be stored (buried) only in deep geological formations. With four reactors, there are 6 800 tons (about 3.200 m^3) of radioactive graphite.

The lack of technology for how to handle the graphite, caused a crisis in decommissioning of the RBMK-1500 reactors at Ignalina NPP in Lithuania and lead to postponed deadlines of decommissioning. Lithuanian authorities have suggested to put the radioactive graphite to a temporary high radioactive storage, in barrels. This means that the graphite must be moved two times, first from the reactor to the temporary storage, and then to the repository.

Russia is the host country for the GRAPA project, initiated in February 2016 by the IAEA and to be implemented within three years[18]. The goal of the project is to solve a wide range of tasks, including the development of safe technologies for extracting radioactive graphite (including C^{14}) from reactors, processing, temporary storage and disposal. The project benefits from the infrastructure: two industrial sites with stopped uranium-graphite nuclear reactors, and the technical base in closed nuclear town ZATO Seversk (Tomsk Region,

[18] Международный центр по работе с радиоактивным графитом создадут в РФ (International center for work with radioactive graphite will be established in the Russian Federation), RIA Novosti https://ria.ru/atomtec_news/20160225/1380496760.html

Siberia). The center is created on the basis of JSC *"Experimental and demonstration center of uranium-graphite reactors*". Countries with experience in handling graphite waste - the Russian Federation, the United Kingdom, the USA, France, Germany and others - participate in the project. It is expected that recommendations for the long-term isolation of radioactive graphite will be given in early 2019. The challenges with what to do with the graphite is not only a Russian RBMK problem, but general for all nuclear weapons-producing countries. Therefore, international cooperation is important. The world has accumulated about 250.000 tons of irradiated graphite, including 60.000 tons in Russia.

Lack of solutions for radioactive waste and spent nuclear fuel

Also, it exists no solution for long-term isolation of radioactive waste, which will be formed during decommissioning. According to various estimates, in the process of decommissioning of the four power units at Leningrad NPP, radioactive waste from 160 000 to 400 000 cubic meters of all hazard classes are generated.

There are no social-environmental acceptable technologies for long-term isolation of spent nuclear fuel. Today there is only a national temporary SNF repository for 50 years on the territory of Zheleznogorsk. There are no environmentally acceptable technologies for reprocessing or long-term isolation of spent nuclear fuel from RBMK-1000 reactors.

During 2016 and 2017, spent nuclear fuel has been moved from Leningrad nuclear power plant to the national temporary dry storage on the Mining Chemical Combine in Zheleznogorsk (Krasnoyarsk Territory). All spent nuclear fuel from the wet storage facility of Leningrad NPP (building 428) is planned to be moved by the beginning of 2040ies. According to deputy director of Leningrad nuclear power plant Yefimenko, up to 2030 only spent nuclear fuel which was produced in the Soviet time will be moved, after that they will start to transport the commercial spent nuclear fuel from after LNPP became business company.

Recent developments in Leningrad NPP decommissioning planning 2017

In January 2017, Vladimir Pereguda, General Director of Leningrad NPP and LNPP-2 informed that the first unit RBMK-1000 would stop in 2018.

There is no estimation how much the cost of decommissioning of the Leningrad nuclear power plant will be. It will clearer when the amount of radioactive waste for processing is estimated and what kind of technology for the disposal of graphite will be adopted, as well as the costs of using these territories in the future. The first unit of VVER-1200 of LNPP-2 will be put into operation in 2017. This unit will substitute the first unit of RBMK-1000[19].

In April 2017, chief engineer of Leningrad NPP Konstantin Kudryavtsev informed on Scientific and Practical Conference "The contribution of the Leningrad Nuclear Power Plant and enterprises of the atomic industry of the city of Sosnovy Bor to solving environmental problems in the Leningrad Region and the North-West region of Russia": *"A safety program is currently being developed at the stage of preparation for decommissioning. After the shutdown of the reactor, it is necessary to unload SNF from it, and only after this the stage of real decommissioning of the first unit will begin. SNF will be*

[19] Source: http://mayaksbor.ru/news/atomgrad/pro_reaktory_staryy_i_novyy_pro_zakrytyy_vodoistochnik_i_obezdnuyu_dorogu/

transferred to safe long-term storage in the Krasnoyarsk Mining and Chemical Combine. In addition, in parallel, considering the possibility of further use of the released objects and areas [of the first units of Leningrad NPP]. " [20]

In June 2017, Yevgeny Gorbunov, Head of the Radiation Technology Department of Leningrad NPP explained that the decommission of Leningrad NPP would result in "brown field" as an end-stage. This is according to the 20 years strategy of Leningrad NPP, the development of technologies on the reactors RBMK-1000 on Leningrad NPP up to 2025.

The brown field strategy for end stage of decommissioning of Leningrad nuclear power plant, allows for expansion of the production of radioactive isotopes. The plans are not concrete, but goes in direction of medical isotopes. An idea is to establish a medical center for the treatment of cancer of the thyroid gland in the territory of decommissioned power units.

This will ensure the preservation of jobs for employees of the withdrawn nuclear power plant, as well as the use of these technologies by 2035 at other nuclear power plants that will be decommissioned before 2035: Smolenskaya, Kurskaya NPPs with reactors RBMK-1000 will use the same end stage[21].

Status of decommissioning planning of Kola NPP

At a round table in November 2017, Director Kola NPP V.V. Omelchyk, said that plans for the withdrawal of the Kola NPP will be implemented according to this plan:

- Decommission of the 1st reactor at Kola NPP is planned in 2033
- Decommission of the 2nd reactor at Kola NPP is planned in 2034
- Decommission of the 3rd reactor at Kola NPP is planned in 2041
- Decommission of the 4th reactor at Kola NPP is planned in 2044

In 2018, Kola NPP will submit a package of documents to Rostekhnadzor to apply for prolongation of the operation of the station for 15 years until 2033.

Rosatom has not published any decommissioning plans for 1st and 2nd power units of the Kola NPP, not even 5 years before the end of the extended operation time, ending in 2018 and 2019. All what is heard is prolongation of all four reactors, with operation prolonged until 2033 to 2046 for the reactors.

According to the strategy of regional development to 2025, extension of the lifetime of Kola NPP power units 1 and 2 after 2018 and 2019 plans for the period before replacement of capacities by Kola NPP-2.

However, plans for construction of Kola NPP-2 have been stopped. The first reason is that Rosatom has a VVER-1200 MW reactor. This type of reactor is not suitable for the Murmansk region because of its high power. The second reason, now there are four VVER-440 MW reactors at Kola NPP. 3 reactors are working, while one reactor is on technical inspection and repair. The total power of our nuclear power plant is 440 MW x 4 = 1760 MW. If two VVER-1200 x 2 reactors are to be built, this is

[20] Source: http://mayaksbor.ru/news/atomgrad/leningradskaya_aes_privlekaet_uchenykh_k_obsuzhdeniyu_perspektiv_razvitiya_atomnoy_energetiki_region/

[21] Source: http://mayaksbor.ru/news/atomgrad/izotopnyy_bum_leningradskoy_aes/

2400 MW. This is very much, even in the case of electricity export. In the Murmansk region, one VVER-1200 reactor is sufficient. But, in this case, how to carry out technical works and repairs on the reactor this reactor is one for Kola NPP-2. Therefore, Rosatom did not take a decision on the construction of the Kola NNP-2. Perhaps Rosatom will create a new VVER-1000 reactor, in this case there will be an excess of electricity in the region of 2000 MW. As a result, the decision to build the Kola NPP-2 is suspended.

At the round table of the Kola NPP on November 17, it was informed that construction of the Kola NPP - 2 will begin in 2024. It is planned to build one VVER-600 reactor. Its commissioning is planned for 2031-2035. Now, they are not ready to let you know how the cooling of the reactor will go by dry or wet cooling towers, this project is still under development. The station's director noted that this new reactor will have to replace the old reactors 1 and 2, which is planned to be closed 2033-2034.

Other relevant developments on decommissioning

In 2016 started the decommissioning of experimental reactors for nuclear submarines at the Scientific Research Institute of Technology named after A.P. Alexandrov (Sosnovy Bor). The nuclear submarine nuclear facility (KM-1) was built in 1978 with the purpose of carrying out tests and complex studies of its reactor facility with the liquid-metal coolant Pb-Bi. Since December 1989 after the completion of the campaign at the KM-1 facility, they were transferred to the regime Conservation.

The spent nuclear fuel from the reactor was transported in 2017 for processing to the Mayak production association, in ZATO Ozersk, Chelyabinsk region[22]. Until the end of the 2017, all SNF will be processed at the RT-1 (PA Mayak) radiochemical plant[23].

5. Status on prolonged operation of old NPPs

Upgrades and prolongation of Kola NPP reactors

Kola NPP is situated 12 km from the town Polarnye Zori in Murmansk region. It consists of 4 power units of reactor type VVER-440. Kola NPP generates about 60% of all electricity in the Murmansk region and also sends power to the Republic of Karelia.

From 2001 to 2005 reconstruction of units 1 and 2 was carried out, providing a lifetime extension by 15 years. In 2007, reconstruction of units 3 and 4 begun and in 2011 licence from Rostechnadzor was obtained for unit 3. In 2014, license for operation of unit 4 was given for 25 years – an unprecedented event; a lifetime extension granted straight away for this long-time period has not yet been repeated in Russia.

Representatives of Kola NPP announced the extension of operation for the two first energy units for another 15 years. This means that the planned shut-down of reactor number 1 will be moved from 2018 to 2033, and number 2 from 2019 to 2034. Thus, the resource of these power units was doubled, to 60 years. This was announced at the Murmansk business week in November 2016[24].

[22] Source: http://www.atomic-energy.ru/news/2017/04/28/75382
[23] Source: http://www.atomic-energy.ru/news/2017/04/28/75382
[24] Source: https://minec.gov-murman.ru/news/188262/

In 2018, Kola NPP will submit a package of documents to Rostekhnadzor to extend the plant's operation for 15 years to 2033. This is supported by the fact that Rosatom is in search of a contractor for the development of a project to extend the life of the power unit number 1 of the Kola NPP to 60 years[25]. However, it is very difficult to monitor information on this topic, Rosatom does not publish its decisions publicly.

Upgrades and prolongation are explained by the need for additional energy for a large investment project - the Murmansk transport hub. The Murmansk transport hub is one of three large support projects for the development of the Arctic zone[26]. The plans are ambitious but whether there are tools to match them, are questionable. In 2018, or in 2019 if delayed, two new ice-breakers will be commissioned, the first in 10 years. At the same time, 3 old ice-breakers will be decommissioned. The federal budget for the Arctic program is only 800 million rubles in 2018, but the plans are 2,5 billion rubles in 2019 and the same in 2010. Whether this much actually will be allocated remains to be seen.

Kola NPP is being prepared to prolongation 15 years, until 2033. In May 2017, specialists of the Kola NPP started the process of annealing the reactor vessel of the power unit number 1, to refresh the reactor for further operation. The aim of this work was to allow restoring the physic-mechanical characteristic of the metal of the reactor, where the metal was influenced by radiation emissions[27]. It finished in the middle of June 2017.
In 1989, at power units 1 and 2, and in 2016 at the power unit 2, a similar annealing procedure was already carried out. Similar restoration work has previously been successfully carried out at VVER-440 reactors at Rivne (Ukraine), Novovoronezh (Russia), Greifswald (Germany), Kozloduy (Bulgaria) and Armenia (Armenia).

In July 2017, Kola NPP staff performed an emergency training at the Kola NPP, with the participation of the OPAS group (rendering assistance to nuclear power plants in emergency situations) and technical support centers[28].

Planned shut-down of the oldest reactors at Leningrad NPPs

Leningrad nuclear power plant is situated on the southern shore of the Gulf of Finland of the Baltic Sea. The first power unit was put into operation in December 1973, and is the oldest in the world Chernobyl type reactor. The next units went into operation in 1975, 1979 and 1981. Reactors of this type was only build inside of USSR territory; in Ukraine and in Lithuania in addition to Russia. Now this reactor type is only operating in Russia.

Vladimir Pereguda, the director LNPP, confirmed in December 2017 that the final stop of the 1st unit of LNPP with RBMK-1000 reactor will be in December 2018, after 45 years of operation[29].

[25] Source: https://www.seogan.ru/rosatom-nachinaet-raboti-po-prodleniyu-sroka-sluzhbi-pervogo-energobloka-kolskoiy-aes-do-60-let.html
[26] Source: http://neftegaz.ru/news/view/152108-V-Minekonomrazvitiya-rassmotreli-proekty-3-pilotnyh-opornyh-zon-razvitiya-arkticheskoy-zony-RF
[27] Source: https://ria.ru/atomtec/20170530/1495375878.html
[28] Source: http://tass.ru/ekonomika/4521975
[29] Source: http://www.proatom.ru/files/as133.pdf

But according to information which has not been published in mass-media, there are new problems with the graphite on the 1st unit. This time, the problem is not the distance between the technological channels and graphite, but the short distance between the graphite and the biological shielding. May be the 1st unit will need to be stopped again for new repair operations of the graphite before December 2018.

The plans of final stop of the 1st and 2nd units of LNPP connected with the plans of the beginning of the operation of the 1st and 2nd units of LNPP-2. The fresh fuel for the 1st unit of LNPP-2 already on the territory of construction site of LNPP-2. The physical start-up of the 1st reactor is planned for the end of 2017, and the energetic start-up of the first power unit is scheduled for 2018.

In this way, simultaneous (parallel, synchronous) operation from 2017 to 2025 of the RBMK-1000 and VVER-1200 reactors is planned. The operator of LNPP and LNPP-2 confirmed the plans for synchronous commissioning of the first power unit of LNPP-2 (VVER-1200) and the decommissioning of the oldest power unit of Leningrad NPP (RBMK-1000) at the end of 2018.

However, the synchronization of units 2 looks more difficult: the beginning of the operation of the second unit of Leningrad NPP-2 with reactor VVER 1200 will not be in 2020 as planned, but in January 2022, 2 years later[30]. On October 30, 2017, the reactor of the second power unit of LNPP-2 began to be transported to Sosnovy Bor from Izhorskiye Plants (St. Petersburg). This second power unit of Leningrad NPP-2 was scheduled to be commissioned in 2020. But the planned deadline for the commissioning of the 2nd power unit of Leningrad NPP-2 (February 2020) may be delayed for a later date. According the official information from the Russian Ministry of Energetic, this decision has an economical reason. The postponing of the commissioning of the second power units of Novovoronezh NPP-2 (VVER-1200) for 1 year and Leningrad NPP-2 for 2 years will reduce the prognoses of the growth rates in the wholesale electricity prices in 2019-2020 from 12.9% per year to 11.1% % in year.

Closing of the 2nd unit of Leningrad NPP with reactor RBMK-1000 was planned in 2020, after the end of the lifetime extension license from 30 to 45 years. The beginning of the operation of the 2nd unit of LNPP-2 was planned to be synchronized with the final stop of unit 2 of the old Leningrad nuclear power plant, RBMK. The delay of the second reactor of the new power plant LNPP-2 means that the final shutdown of the second power unit of LNPP (RBMK-1000) and the beginning of its decommissioning might also be postponed to a later time. The alternatives are either some energy deficit or lifetime extension of the 2nd unit of Leningrad nuclear power plant more than 45 years. However, problems with the graphite might lead to difficulties for lifetime extension.
So far, no decision has been taken to begin construction of the third and fourth power units of Leningrad NPP-2 with VVER-1200 reactors. At the same time, the third and fourth power units of LNPP should be finally stopped for decommissioning in 2023 and 2025.

Thus, it is hardly possible to synchronize the commissioning of LNPP-2 (3d and 4th units) and the final stop and beginning of the decommissioning of LNPP 3rd and 4th units, because the construction period of VVER-1200 is 10 years.

[30] Source: http://www.interfax.ru/russia/596807

According to the RF Ministry of Energy, the price of the second block of Novovoronesh NPP-2 is 97.03 billion rubles without VAT and interest on loans, whereas the second unit of LNPP-2 is 101.5 billion rubles. The shift in times "will not lead to an increase in value."

6. Financing of decommissioning

For more information on this subject, please refer to the report *How to pay? Financing of decommissioning of nuclear power plants*, published by Naturvernforbundet[31]

Background

In 2006, our network of non-governmental environmental organizations published a report on Russia's decommissioning fund (Decommission Network 2006)[32]. The report collected far more knowledge than what was publicly available before. Our method of repeatedly sending letters to the authorities, with more and more specific questions as the situation became clearer yielded credible results.

The main findings were that money was collected into a decommissioning reserve, 1,3 % of the gross income from the power sales. The reserve was common for all Russian nuclear power plants, and money was not linked to any actual reactor. The collection started only at the end of the planned operation time of the first generation, with little time to build up substantial capital. We also found that money from the reserve was spent on already closed reactors in Novovoronesh and Beloyarsk, which did not generate allocations to decommission themselves (ibid:14). The pessimistic conclusion was: too little, too late.

10 years later, the situation had improved. The regulation had been changed; now collection of funds has been changed from 1,3% previously to "up to 3,2%" of revenues and more money is put into the reserve annually.

Current situation

The federal law "On the Use of Atomic Energy" prescribes that the operator must have adequate capacity, including financial, material and other resources to complete the task of decommissioning. The operator, in conjunction with other institutions responsible for the use of nuclear energy, and with the involvement of their budgetary resources, should create a fund to cover the costs associated with the decommissioning of nuclear facilities, radiation sources and storage facilities, as well as to fund research and technical experimental work aimed at ensuring the safety of nuclear facilities. Six sources to the reserve are defined; four of them are dedicated revenues from the federal and regional budgets, one is revenues from public and private sources. The last source is allocations from the operating organization, meaning the decommission reserve. The regulation also provides that in new power plants the income from the electricity shall be paid to the fund from the reactor's first day of work, and for existing facilities, these funds will supplement allocations from the budget.

[31] Naturvernforbundet 2017: How to pay? Financing of decommissioning of nuclear power plants. Can be found at: http://rusecounion.ru/sites/default/files/Report%20How%20To%20Pay%202017.pdf

[32] Decommission Network 2006: Status of Russia's decommission fund. Report 2006. Written by Kjersti Album; Oleg Bodrov, Julia Korshunova and Elena Kruglikova. Also available in Russian language. Can be found at: http://decomatom.org.ru/public/decom_fund_eng.pdf

How much must be taken from the budget compared to the fund is not clear. The state program "Nuclear and radiation Safety 2008 – 2015" was approved by the Russian government July 13, 2007 (Decree number 444). The entire program received 129 billion rubles from the federal budget from 2008 to 2015 (FCP undated). Thus, money used each year from 2008 to 2015, is on average more than what is put into the fund in 2015. The total amount in the fund per January 2015, is also far below the amount in the program on nuclear and radiation safety.

In November 2015, at the request of the Internet magazine "7x7", Marina Nikolaeva from the communications department at Rosatom State Corporation confirmed in a letter that decommissioning funds are accumulating in the reserve, according to the decision of the Russian Federation Government of 30.01.2002 № 68. According to the letter, the funds accumulated in the decommission reserve was about RUB 10 billion in January 2015, which corresponds to approximately EUR 160 million. Rosatom also stated that in 2015, the plan was to allocate RUB 5.6 billion in 2015. This gives hope for a more responsible attitude to the process of decommissioning of old nuclear power units.

Challenges in financing decommissioning

At the same time as money in the reserve increases, Russia's reactors grow older and closer to their real closing time and it is less time for accumulating money for decommissioning. Although the collection of money for decommissioning has improved, it is still far from what is needed to decommission the Russian nuclear power reactors.

According to the experience of recent years, both Russia and other countries intend to extend the life of the oldest reactors to 30 years beyond the design lifetime, which means that the operation of the most reactors will be 60 years. Thus, they will continue to collect decommission money for a longer period. Still it seems obvious that the Soviet-constructed reactors will not collect enough money for their decommissioning. The current reserve, with its rules for funding and management, will be far from enough to pay for decommissioning. These costs will fall heavily on future generations of Russian taxpayers.

The concept of the fund as it is today, implies that as older reactors closes without having collected sufficient funds, it will be necessary to operate an increasing number of new nuclear power plants to raise sufficient funds for the final decommissioning of the old units. Budget funds are already used, but will likely need to increase.

Money from the decommission reserve is still spent on reactors which were closed before the collection started, but we do not know how much each year, or following what plans. Rosatom states in the above-mentioned letter that in the next decade, it is planned to spend money from the decommission reserve on decommissioning of units 1 and 2 of Beloyarsk NPP, unit 1-4 of Bilibino NPP, unit 1-3 of Novovoronesh NPP, and unit 1 and 2 of Leningrad NPP. They further confirmed that decommissioning of Kola NPP is not planned, as the facility is earmarked for an extension of its designed lifetime. Rosatom also reiterated that talking of the cost of works on decommissioning reactors, is premature.

We don't know the costs of decommissioning for the Russian nuclear power reactors, as comprehensive and detailed decommission plans are still missing. Thus, it remains unclear whether the funds that are accumulated will be enough for a safe decommissioning. Moreover, the use of budget funds clearly indicates that there is not enough money collected. The situation being as it is,

using money from the budget for decommissioning old reactors seems like a good alternative solution.

We agree that Rosatom's decommission program definitely has some positive impact, such as decommissioning of nuclear reactors 1 and 2 of Novovoronezh NPP, Beloyarsk 1 and 2 etc, but a big challenge is lack of information. On the official web-site of the program[33] there is only common generalized information provided without description of specific activities and costs, making it difficult to analyze the result and issue public control of the program.

It should be noted that this program contains a vast variety of measures, altogether. The program covers construction of a centre for the processing of spent nuclear fuel in Krasnoyarsk, export of nuclear sources of Antarctica and the North Pole, liquidation of old military storage facilities for radioactive waste, as well as decommissioning of nuclear reactors 1 and 2 of Novovoronezh NPP, Beloyarsk 1 and 2 nuclear power plants, military reactors in Zheleznogorsk and Seversk, construction of storages for radioactive waste etc.

7. Radioactive waste

Radioactive waste in Russia

Handling of radioactive waste constitutes one of the most difficult tasks relating to decommissioning of nuclear power plants. Already before decommissioning begins, there are huge amounts of radioactive waste in Russia, coming from military and civil nuclear facilities.

As of the end of 2015, 5.58×10^8 m^3 of radioactive waste (excluding spent nuclear fuel) was accumulated, with a total activity of 8.9×10^{19} Bq. The radioactive waste is located in 44 regions of Russia at 120 enterprises in 830 radioactive waste storage facilities. These facilities represent an enormous potential hazard, and the management of radioactive waste at these sites is associated with significant problems of ensuring regional and global security. Across Russia, there are 54 storage facilities for radioactive waste with the total capacity of $4{,}06 \times 10^8$ m^3.

There is discrepancy between the official numbers of radioactive waste. A new report from Rosatom for 2016[34]says that says that 5.56×10^8 m^3waste has been accumulated by 2016. At the same time, the Rosatom report for 2015 says that says about 5.58×10^8 m^3 waste is accumulated. That means that 2015 numbers are larger than the 2016 numbers[35].

The average annual production of RW in Russia is about 1250 000 m^3 of solid radioactive waste (RW) and about 1.9 million m^3 of liquid RW.

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[33] федеральная целевая программа Обеспечние ядерной и радиационной безопасности (Federal Target Program Nuclear and Radiation Safety)
http://www.consultant.ru/document/cons_doc_LAW_190535/e2e1f12fa8cac3ae3fff4d2022f8d7a0ff3c4adf/
And presentation of the of the Rosatom head Kirienko in 2015, Федеральная целевая программа «Обеспечение ядерной и радиационной безопасности на 2016 – 2020 годы и на период до 2030 года»
http://static.government.ru/media/files/9O2o2sCzKL0cRa79RzJi4w9HIh47uUBT.pdf

[34] Source: *http://www.rosatom.ru/upload/iblock/d9a/d9a7d8a9569667eb38bcfc153a7016fe.pdf*,

[35] Source: http://za-prirodu.ru/page/po-majak-sostojanie-i-problemy-1#cut

The largest amount of liquid RW is formed at the Mayak PA: about 600 thousand m^3 per year. A small part of the high-activity liquid RW from Mayak is vitrified, and the medium-active RW is merged into the reservoir B-17 (Lake Staroye Boloto). The low-active ones are released in the Techa cascade reservoirs (TKV), consisting of water reservoirs B-3, V- 4, B-10, and B-11.

About 932 thousand m^3 of liquid RW (400 thousand m^3, 480 thousand m3 and 52 thousand m^3, respectively) are annually produced at the MCC, SCC and NIIAR, which are almost completely pumped into the reservoirs. At the nuclear power plants, about 4 thousand m3 of liquid RW are generated per year.

The remaining liquid RW (about 164 thousand m3) is formed at uranium mining enterprises (Atomredmetzoloto JSC), nuclear weapons complex institutes (All-Russian Scientific Research Institute of Experimental Physics, Institute of Physics and Power Engineering) and enterprises of TVEL JSC (Machine-Building Plant).

The main sources of liquid radioactive waste generation are shown in figure 1. As shown, the biggest amount of liquid radioactive waste is generated at the Mayak plant. Nuclear power plants (NPPs) generate about 4 thousand cubic metres per year, 0,2%. RIAR is the state research centre "Research Institute of Atomic Reactors", MCP is the mining and chemical plant, SCP is the Siberian Chemical plant. These are the main enterprises of the nuclear fuel cycle in Russia.
Temporary storage of radioactive waste is provided by the "Enterprises for the management of radioactive waste "RosRAO" (the former system of special combines "Radon") and storage facilities at nuclear power plants, nuclear fuel cycle enterprises, etc.).

For more than 20 years, the plant ECOMET-S has been working on the processing of metallic RW with a maximum capacity up to 9.000 t/year. It is located on the shores of the Baltic Sea, on the territory of Leningrad NPP in the town of Sosnovy Bor. As a result of such processing, the amount of RW has significantly decreased, and the resulting secondary waste is stored in temporary storage facilities.

Rosatom's strategy on radioactive waste

According to the Russian law on radioactive waste, they must all be buried.
The Rosatom strategy for radioactive waste, is to construct a network of national disposal facilities for medium and low level radioactive waste (hazard classes 3rd and 4th) in 10 priority sites in Russia[36], and transport radioactive waste there. As will be shown below, this has resulted in protests several places.

In the map in figure 1, the location of these 10 sites are shown.

[36] "Radioactive waste and spent nuclear fuel management in Russia. View of NGOs, page 7 http://greenworld.org.ru/sites/default/greenfiles/RAO&OYAT_eng_2017.pdf

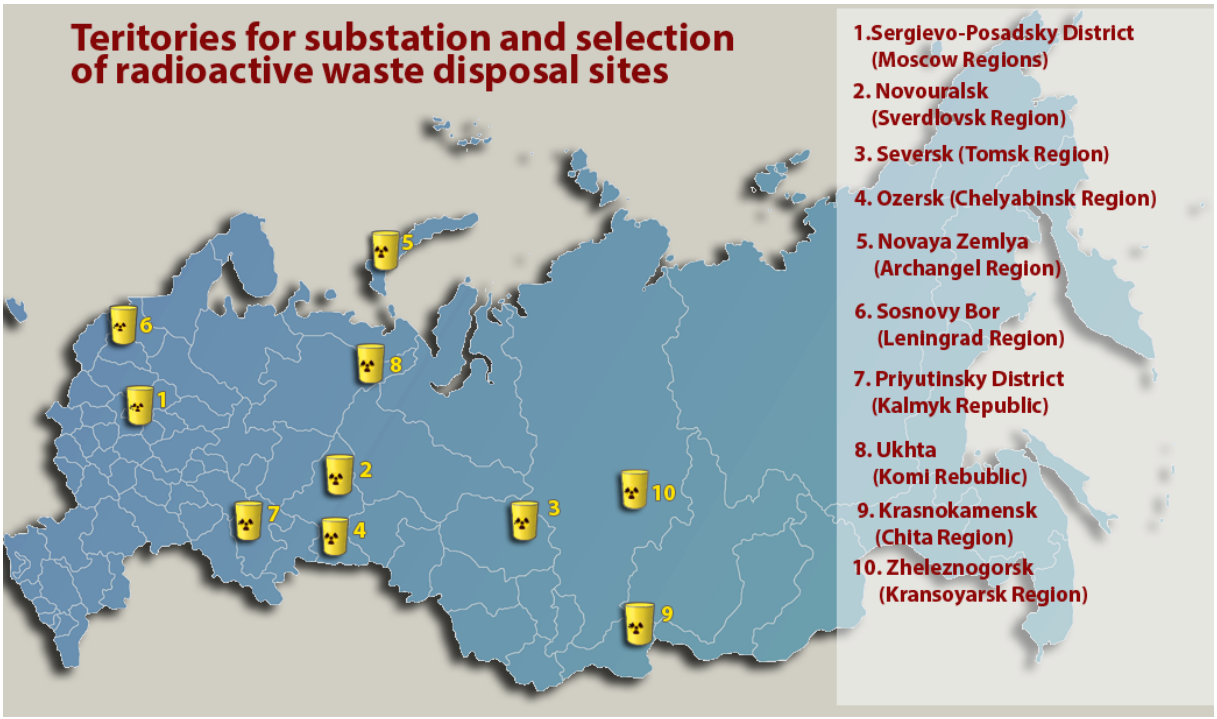

Figure 1: priority sites for radioactive waste disposal[37]

Regarding classes 3rd and 4th, the technical solution is final isolation of radioactive waste, like cemeteries. This is in contrast to the option of storages with constant monitoring and options for later removal.

Please note that Rosatom classifies liquid radioactive waste as belonging to the 5th class. They will continue to be pumped underground.

For the high-level radioactive waste, the most hazardous radioactive waste (hazard classes 1st and 2nd), a single national disposal site is proposed in Zelesnogorsk in Krasnoyarsk territory. Also here people showed their attitude against construction, in fact more than 112.000 people signed a petition against the proposal[38]

RosRAO, the Russian operator for handling radioactive waste, and promoter of the national disposal site in Zelesnogorsk (Krasnoyarsk territory), announced that it will not build a disposal site, but a laboratory to investigate the possibility of building such a high-level waste disposal facility.

However, this is manipulation of the public, since the project of the disposal facility (not the laboratory) passed the state ecological expertise, and the government of Russia decided to build this disposal facility.

[37] Ibid, page 8

[38] https://www.change.org/p/%D0%BC%D1%8B-%D0%BF%D1%80%D0%BE%D1%82%D0%B8%D0%B2-%D1%8F%D0%B4%D0%B5%D1%80%D0%BD%D0%BE%D0%B3%D0%BE-%D0%BC%D0%BE%D0%B3%D0%B8%D0%BB%D1%8C%D0%BD%D0%B8%D0%BA%D0%B0

Even though proposals have resulted in public outcry, there is not really any public debate about locations or strategy for the radioactive waste. But a debate is taking place among experts in the field of the use of nuclear energy. They discuss the concrete locations, at public hearings of radioactive waste disposal sites, magazines for experts, round tables etc. Also, experts discuss the storage or repository, the construction of containers and how many barriers of protection, surface burial or underground.

Location of facilities for disposal of low and medium radioactive waste

So far, only one Russian radioactive waste disposal facility was put into operation, in Novouralsk in 2016.

Initially, the National Operator for Radioactive Waste Management outlined 10 places where it is advisable to build RW repositories. These places were close to the places of the greatest accumulation of radioactive waste. Later, when geological, economic and social conditions for construction began to be learned, plans began to change.

Facilities can now be expected to be constructed in Moscow oblast (Sergiev Posad district), Tomsk oblast (Seversk closed town), Chelyabinsk Region (Ozersk closed town), Arkhangelsk Region (Novaya Zemlya), Murmansk oblast (Apatity or Monchegorsk), Zabalkalsky krai (Krasnokamensk town in Chita), Krasnoyarsk Territory (Zheleznogorsk closed town), in addition to the already existing facility in Sverdlovsk oblast (Novouralsk closed town).

As shown above, most of the national disposal facilities are proposed in closed nuclear towns. Although it is not uncommon for nuclear countries to place waste facilities near nuclear societies where people are more likely to be positive, civil society will be more restricted when hearings or round tables are held in closed towns with other rules. We see that time after time the same experts are selected.

Prime Minister of Russia Medvedev signed on August 1, 2016 order No. 1634-r "Scheme of territorial planning of the Russian Federation in the field of energy". In Appendix Number 7 of this decree, the "List of facilities for storage, burial and processing of radioactive wastes planned for deployment" was approved. In this list, the characteristics of 6 radioactive waste disposal sites (RWR) are given:

- PZRO-1 (near-surface) on the territory of Sosnovy Bor, Leningrad region, 50.000 m^3. National repository of radioactive waste of medium and low activity levels;
- PZRO-2, (near-surface) in ZATO Novouralsk, Sverdlovsk Region, 48.000 m^3. The point of disposal of radioactive waste classified to the 3rd and 4th grades, on the industrial site of the joint stock company "Ural Electrochemical Combine", municipal entity "Novouralsk City District",
- PZRO-3, (near-surface) in ZATO Ozersk, Chelyabinsk region, 100.000 m^3. The point of disposal of radioactive wastes, assigned to the 3rd and 4th grades, on the industrial site of the federal state unitary enterprise "Production Association Mayak", municipal entity "Ozersky city district".
- PZRO-4, (deep) in ZATO Zheleznogorsk, high-level radioactive waste: 1st class 4.500 m^3, 2nd class 155.000 m^3
- PZRO-5, (deep) ZATO Seversk, Tomsk Oblast, 50,000,000 m^3 deep burial of liquid radioactive waste in underground wells "Polygon of sites 18 and 18a";

- PZRO-6 (near surface) ZATO Seversk, Tomsk Region. 200.000 m^3. 3rd and 4th grades, at the industrial site of the joint-stock company Siberian Chemical Combine.

These sites are specified in the Order of the Government of 2016. But they are negotiated with the authorities in the regions. PZRO-5 already exists. There radioactive waste is pumped underground. Now it will be expanded.

The national disposal facilities for medium and low level radioactive waste (hazard classes 3rd and 4th), have resulted in protests several places. The only facility constructed so far, the PZRO-2, was put into operation in Novouralsk closed town in Sverdlovsk oblast in 2016.

There has been debate over the location of these sites for some years now. In 2015 attempts to promote the construction of disposal sites in Sosnovy Bor (Leningrad oblast) and Ukhta (the Komi Republic) was met with an acute reaction of the public, as well as regional authorities. For example, more than 50,000 people was categorically against the construction of disposal sites for medium and low-active waste (3rd and 4th hazard classes) in Sosnovy Bor, located on the shores of the Baltic Sea near St. Petersburg. The governmental decision is not yet taken, but it seems that the repository will be placed in Murmansk instead of Leningrad oblast. Still, Sosnovy Bor will most likely host only the temporary storage for decommissioning of Leningrad nuclear power plant.

For Ukthta and Kalmykia, activities are put on hold due to the fact that the local authorities did not support the proposal of Rosatom.

In Kranoyarsk, Rosatom invited two government-loyal NGOs in Zheleznogorsk to conduct a public environmental review for the disposal facility for radioactive waste. These organizations gave a positive conclusion. Both suggested strategy of disposal rather than storage, in line with the Rosatom policy. However, it would be more environmentally and socially friendly to choose storage[39]. Storage gives the possibility to retrieve the waste, for instance in case the canisters turn out to not keep the waste securely. Also, the process in which locations are decided, is flawed, without real participation.

Debate about repository in Sosnovy Bor

Perhaps the only case of effective participation of the regions in the promotion of the project for the disposal of radioactive waste occurred in nuclear town Sosnovy Bor, Leningrad region:

The first national repository for radioactive wastes of the 3rd and 4th hazard classes (medium and low-active wastes) was planned with a single industry nuclear town of Sosnovy Bor, on the shores of the Baltic Sea, near St. Petersburg. Thanks to the initiative of the NGO Green World, the public of Sosnovy Bor and the active position of MP Nikolai Kuzmin, chairman of the Standing commission on ecology of the Legislative Assembly of the Leningrad Region, the project was declared dangerous at public hearings in the nuclear city of Sosnovy Bor. The same decision was made by the Standing Commissions on Environmental Safety of the Legislative Assemblies of the Leningrad Region and St. Petersburg.

[39] Decommission Network 2017: Radioactive Waste and Spent Nuclear Fuel Management in Russia: View of Non-Government Organizations. Available at: http://rusecounion.ru/sites/default/files/inline/files/1%20RW%20and%20SNF%20in%20Russia_ENG.pdf

As a result, the National Operator for Radioactive Waste Management RosRAO informed that the project will not be implemented in Sosnovy Bor, near St. Petersburg. But this scenario is rather an exception, not a rule. As a rule, the settlement of projects for the construction of radioactive waste disposal facilities, their deployment, takes place with the participation of interested experts of Rosatom in single-industry cities with the participation of residents of these cities, and residents of the regions cannot actually participate in these discussions.

Disposal facility for radioactive waste in North West Russia

There are no solutions for the radioactive waste repository or storage in North West Russia for decommissioning of Leningrad and Kola nuclear power plants.

In 2017, Rosatom started discussion on the choice of a site for the construction of a storage facility for radioactive waste in the Murmansk region. Members of the Rosatom Public Council, scientists, engineers of Rosatom were involved in this discussion. They had to decide on the choice of a storage site at the end of the third quarter of 2017. However, as far as we know, the decision was not made, the site was not chosen.

According to Oleg Muratov, executive secretary of the St. Petersburg branch of Russian Nuclear Society and member of Rosatom Public Council, Rosatom started a program for investigation of the possibilities to construct of the repository for low and middle radioactive waste in Murmansk Region. According to Muratov, the National operator decided to move the location of the RW repository from Sosnovy Bor to Murmansk Region. They have 2 perspective sites, both are former mines. One of the promising sites in the area of Monchegorsk. According to Muratov the investigations of the characteristics of the sites will be in 2017, but the decision-making process will be in 2018 or later. There is already a radioactive waste storage in the Murmansk region. The repository can be on one of these sites. This experience is already available in Sergeev Posad in Moscow, at the former enterprise "Radon".

However, the Governmental decision about the Repository in Leningrad oblast (in Sosnovy Bor) has not cancelled yet. Maybe the National Operator will move the location from Sosnovy Bor to another part of Leningrad Oblast, but not to Murmansk region. This will be clearer after the final stop of Leningrad NPP and decommissioning planning. Because during the decommissioning, storage space for 150.000 – 400.000 m3 will be needed. Therefore, it will be reasonable to find the repository location as close as possible with Leningrad NPP. But it will be after the 2018.

Nikolay Kuzmin, chairperson of the environmental commission of Leningrad Oblast legislative assembly organised a discussion about the radioactive waste management February 14. He invited Oleg Bodrov and Oleg Muratov.

Andrei Polonsky - radiochemist from Moscow offers his unique technology to reduce the volume of liquid radioactive waste by a factor of 100. In his opinion, if this technology is implemented, the amount of waste after the decommissioning of the Leningrad NPP can be reduced many times. In this case, it will be economically and environmentally and socially reasonable to transport this solid radioactive waste to Murmansk region and put it to the place where apatite was previously mined.

Disposal facility for high-level radioactive waste for the whole Russia

Rosatom decided to build a plant RT-2 for reprocessing spent nuclear fuel from VVER-1000 reactors in Zheleznogorsk in the Krasnoyarsk Territory. The purpose of RT-2 is the extraction of Uranium 235 and Plutonium 239 for production of fresh MOX fuel for a fast neutron reactor (breeder) and REMIX fuel for VVER reactors.

In the process of reprocessing spent nuclear fuel, high-level waste of the 1st, 2nd hazard class is formed. Their burial is possible, according to Russian law, in deep geological formations. For this, Rosatom decided to build a cemetery near the RT-2 plant in the nuclear city of Zheleznogorsk for these very dangerous wastes.

As mentioned above, the high-level radioactive waste is planned to be disposed of in Zhelesnogorsk, in Krasnoyarsk territory. In fact, there are planned 3 repositories there: one federal disposal site for radioactive waste of 1st and 2nd class (which will be active for tens and hundreds of thousands of years) and two regional disposal sites for radioactive waste of 3rd and 4th classes (where the period of activity is up to 300 years)[40].

Opposition to the plans voice these arguments[41]:

- Unwillingness to become a burial site for radioactive waste from other regions in Russia. Or even other countries, as in the case of radioactive waste from reprocessing of imported SNF or spent radioactive sources from abroad.
- Insufficient validity of environmental safety of the proposed projects.
- Lack of effective interaction between the authorities, the operator and the public in the promotion of projects, as well as involvement of independent organizations or experts affiliated with Rosatom in carrying out independent public examinations.
- Absence of an integrated environmental monitoring independent of operators from radiation facilities in the region of the proposed location for the liquid radioactive waste

27.December 2016 a license was received for the construction of a radioactive waste disposal facility. The national operator for radioactive waste management was told to have a high readiness to start construction.

The current situation however, is that construction of the underground laboratory (burial ground) in Krasnoyarsk is postponed until 2021. The official reason given is lack of money. This is not official information, but information from local environmentalists that we have not been able to confirm so far. Officially, the construction of ground facilities of the future laboratory will start in 2018, according to a statement from the national operator in late 2017[42]. According to our information, the construction did indeed start in spring 2018.

[40] Chapter 7.2 in in Decommission Network 2017: Вывод из эксплуатации Российских АЭС, обращение с ОЯТ и РАО в 2016 г. (English translation: Decommissioning of Russian power plants, handling of radioactive waste and spent nuclear fuel in 2016.) Available in Russian language at: http://rusecounion.ru/sites/default/files/inline/files/2%20Status2016_decom-rw-snf-Russia_RUS_0.pdf

[41] Chapter 7.1 in Decommission Network 2017: Вывод из эксплуатации Российских АЭС, обращение с ОЯТ и РАО в 2016 г. (English translation: Decommissioning of Russian power plants, handling of radioactive waste and spent nuclear fuel in 2016.) Available in Russian language at: http://rusecounion.ru/sites/default/files/inline/files/2%20Status2016_decom-rw-snf-Russia_RUS_0.pdf

[42] Source: https://ria.ru/atomtec/20171204/1510161362.html

Underground research laboratory for radioactive waste

Along with the disposal facility for radioactive waste, an underground research laboratory will be built in Zelesnogorsk. According to the licenses received, this is a point of disposal of radioactive waste. The first stage is the construction of an underground laboratory.

The laboratory has a license for subsoil exploration, but construction has not started yet. In addition to the license for the laboratory itself, a license for subsoil use is needed. This license is also obtained.

8. Spent nuclear fuel

Spent nuclear fuel in Russia

The problem of accumulated spent nuclear fuel, including foreign SNF, has not been solved at an acceptable technological and ecological level, not only in Russia, but throughout the world.

Russia has accumulated about 22 thousand tons of spent nuclear fuel (SNF), more precisely 22 437 tons according to the last official report about 2016[43]. Annually about 650 tons are added to this volume.

Most of the SNF is stored in the storage pools on-site at nuclear power plant, in the Mayak storage facility in Ozersk (Chelyabinsk region), in the wet and dry storage facilities of the Mining and Chemical Combine in Zheleznogorsk (the Krasnoyarsk Territory) and some other places. We have not found information on how much waste is stored at Mayak, how much at Zhelesnogorsk and how much is stored on-site at the nuclear power plants.

Both Chelyabinsk region and Krasnoyarsk territory annually receives a significant amount of spent nuclear fuel for storage and processing from the European part of Russia, and even other countries. Spent fuel assemblies have been imported to Russia from Uzbekistan, Latvia, Kazakhstan, Czech Republic, Bulgaria, Hungary, Romania, Libya, Ukraine, Poland, Serbia and Belarus.

Rosatom's policy on handling spent nuclear fuel

Rosatom continues the policy of importing spent nuclear fuel from abroad and reprocessing spent nuclear fuel. The production capacity for reprocessing of spent nuclear fuel is increasing. A new line is built in the "Mayak" facility. In addition, new facilities for reprocessing is planned in the city of Zheleznogorsk Krasnoyarsk Region.

To date, the GHK (Zeleznogorsk) has launched a new center for reprocessing SNF. This is an experimental center where it is planned to process 5 tons per year. In the future, it is planned to build new center-2 with a capacity of 250 tons per year.

PA Mayak (ZATO Ozersk, Chelyabinsk region) and the Mining and Chemical Combine (ZATO Zheleznogorsk, Krasnoyarsk Krai) have key roles in the development of a closed nuclear fuel cycle. Mayak was a pioneer of SNF reprocessing programs, having mastered this technology about 40 years

[43] Source: http://www.rosatom.ru/upload/iblock/d9a/d9a7d8a9569667eb38bcfc153a7016fe.pdf

ago, there are plans to increase the existing SNF reprocessing volumes by an order of magnitude. For this, SNF from traditional NPPs with thermal neutron reactors will be supplied for reprocessing to extract nuclear materials. Later, there is plans to produce fresh nuclear fuel for fast neutron reactors of the type BN-800 from these materials. In addition, work is under way to create a mixed uranium-plutonium fuel (remix fuel) for VVER-type thermal neutron reactors.

Under these large-scale tasks, the following technological facilities laid in the basis of the closed nuclear fuel cycle have already been put into operation and will be built in the near future (all located in Zhelesnogorsk):

- A federal complex of "wet" and "dry" SNF storage facilities from VVER-1000 and RBMK-1000 reactors. The construction of the complex was completed in December 2015. This allows to reload SNF from the pool of "wet" storage in the "dry" storage part of the WWER-1000 spent nuclear fuel, and also to ensure the reception of all RBMK fuel from Russian NPPs, up to the final stop and withdrawal of all reactors of this type from operation. The first load of SNF of the Leningrad NPP arrived at the MCC in April 2012.
- An experimental and demonstration center for reprocessing SNF (processing capacity 250 tons per year). In 2015, the first stage was commissioned. Commissioning of the second stage is planned to be carried out in 2018. By 2022, based on the results of the studies at the UDC, initial data should be given based on which will be accepted. Decision on the construction of a full-scale SNF reprocessing plant - RT-2 plant (processing capacity of 1500 tons per year)
- Production of uranium-plutonium fuel for the fourth power unit of the Beloyarsk nuclear power plant (BN-800 reactor) and a nuclear power plant with two BN-800 power units in China. In the context of SNNTs, this will allow the use of plutonium in the nuclear fuel cycle. The production was created on the basis of the radiochemical plant of the Mining Chemical Combine, where weapons-grade plutonium was previously separated[44]
- Complex for management of radioactive waste. It includes facilities for storage and processing of radioactive waste with further disposal of RW. For these purposes, the city of Zheleznogorskty is planning to construct three "repositories": one federal disposal site for radioactive waste of 1st and 2nd class (which will be active for tens and hundreds of thousands of years) and two regional disposal sites for radioactive waste of 3 and 4 classes (the period of activity is up to 300 years)

About 650 tons of SNF are produced annually at Russian nuclear power plants. At the same time, slightly more than 10% of the spent nuclear fuel produced is re-processed, although reprocessing is the chosen Russian policy on how to deal with spent nuclear fuel.

When being re-rocessed, the amount of radioactive waste increases by a thousand-fold in comparison with the volume of SNF. Most countries have left the strategy of reprocessing, but France and Russia still relies on the method, with the aim to obtain a so-called "closed circle".

Russian regulatory documents in the field of SNF management do not comply with the principles of equal environmental safety and protection of future generations adopted in the world, in particular the "Declaration on Environment and Development" (Rio de Janeiro, 1992).

[44] Source: http://www.sibghk.ru/company.html

The Mayak facilities

The structure of PO Mayak includes reactor, radiochemical, chemical-metallurgical, radioisotope and instrument-making industries. The company's activities are directed toward the implementation of the defense order, the processing of irradiated nuclear fuel from nuclear reactors, the production of radioactive isotopes and the disposal of radioactive waste.

During the work on RT-1, fuel was supplied not only by Russian, but also by foreign nuclear power plants: Paks - Hungary, Loviisa - Finland, Nord and Greisfald - Germany, Kozloduy - Bulgaria, Dukovany and "Rzhezh" - Czech Republic, "Bohunice" - Slovakia, "Rivne" - Ukraine.

A total of 54 radioactive waste storages with a total volume of $4{,}06 \times 10^8$ cubic meters are located on the territory of the industrial site of PO Mayak.

We know that spent nuclear fuel is recycled in Mayak, but how much and where the spent fuel comes from, we do not know. At the end of 2016, the company Mayak built a new spent nuclear fuel reception center. Now the company can reprocess any type of spent fuel, including from RBMK reactors. This means that also spent fuel from Leningrad nuclear power plant is reprocessed.

Mayak has already processed defect spent fuel assemblies of RBMK-1000 reactors, in which leakage is broken.

In autumn 2017, foreign and Russian media was discussing a possible accident at the Mayak facility in September 2017. It is plausible that ruthenium-106 could enter the air from the operation of the new reprocessing line in Mayak. The vitrification furnace is part of the RT-1/ plant 235 irradiated fuel reprocessing (from nuclear power plants) in Mayak, and the new furnace has shown some problems[45].

This story is interesting - and upsetting - as an example on how Russian nuclear authorities deal with facts:

Information was first published by French scientists on 4. October 2017. IRSN, the French Institute for Radiation Protection and Nuclear Safety, reported a detection of ruthenium-106 in eastern and south-eastern Europe. 8. October the German Ministry of Nuclear Safety announced that ruthenium-106 was found throughout Europe, and that it was thought that its source would be in the south of the Urals. 11. October Rosatom and the Chelyabinsk Region Authority announced that they are monitoring the situation of the nuclear facilities and that there have been no incidents or accidents[46].

The Minister of Public Security of the Chelyabinsk region, Evgeniy Savchenko, noted that claims of contamination was suspiciously connected with the 60 years anniversary of the Mayak accident of 29.September 1957, and that the news on the alleged releases could be a political trick launched to receive secret data on the factory, like industrial espionage. After first claiming that there was no ruthenium, the authority of the Chelyabinsk region changes its position 19. October and announced that "on 25 September, traces of ruthenium 106 were found in the region, which are 200 times below the allowed limits. The origin of this ruthenium is unknown"[47].

[45] Source: http://www.atomic-energy.ru/SMI/2016/10/28/69941
[46] Source: https://www.kommersant.ru/doc/3435048
[47] Source: https://www.kommersant.ru/doc/3442811 via Andrey Oszharovsky.

Russian authorities continued to deny any accidents, and apart from that, refused to comment. Independent Russian media has covered the issue with questions from environmentalists. Finally, in the middle of November 2017, the Federal Service for Hydrometeorology and Environmental Monitoring published information on the releases of ruthenium-106 in the rubric "emergency, extremely high and high pollution of the environment".

The facilities at Zheleznogorsk

We don't know how much spent nuclear fuel is shipped to Krasnoyarsk territory, as the information about the quantity of spent nuclear fuel is secret.

Zheleznogorsk has a large storage facility for spent nuclear fuel, with wet storage for reactors VVER-1000 and dry storage for reactors RBMK-1000. There is also an experienced demonstration center for spent nuclear fuel reprocessing. Information on how this center works is missing. In November 2017, the processing of the first spent nuclear fuel for reactors VVER-1000 began. For this experimental small scale "dry technology"[48] it is used spent fuel assemblies produced on Balakovo NPP in 1994 (23 years ago). There is no liquid radioactive waste. After the extraction of U235 and PU239, the future MOX fuel for fast neutron reactors (Breeders) and the so-called REMIX fuel for VVER reactors will be refined in the future.

It is expected that the pilot demonstration center of reprocessing of VVER reactor will work on an industrial scale after 2020, and in 2021 the Mining and Chemical Combine (MCC) expects to reprocess dozens of tons of spent fuel from VVER-1000 reactors, informed Petr Gavrilov, the MCC General Director.

So, according Rosatom plans, the reprocessing plant RT-2 on MCC will provide a closing of the nuclear fuel cycle of VVER-1000 reactors with the help of breeder reactors after 20121.

9. Energy efficiency and alternative energy

Status for energy efficiency

Russia has the world's largest potential for energy efficiency. Thus, energy efficiency could be considered an energy source. Investments in energy efficiency is more economic than building new power plants. More efficient use of energy resources gives less environmental impact and contribute to modernization of the Russian economy.

In 2009, the Federal Law on Energy Conservation was adopted, and the State program of energy conservation and energy efficiency for the period up to 2020 has been implemented since 2010. The energy efficiency measures planned within the framework of the state program shall, by 2020, save 1.124 billion tons of oil equivalents (toe) of primary energy, 330 billion cubic meters of natural gas, 63 TWh of electricity, 1550 million giga-calories (Gcal) of heat, and 17 million tons of oil products.

[48] https://ria.ru/atomtec/20171120/1509165493.html

The expected energy saving only of electricity within the state program (63 TWh) is equal to the total combined output from the biggest nuclear power plant (Leningrad produces 28 TWh per year each) and the the biggest thermal power station Surgut GRES (up to 39 billion kWh per year).

However, there are no clear plans for energy efficiency in Russia. After 5 years of the State Program for Energy Efficiency 2020, the federal funding almost disappeared. In 2011-2013 federal funding was annually 7 billion RUB (around 230 million USD). Since then state funding has stopped. During COP23 in November 2017 the representative of Ministry of Economic Development informed that Ministry of Economy and Ministry of Energy plan to resume the activities according to EE Program. So far, no further information has been published.

It is established a Center for Energy Efficiency in every region. The centers are working more or less actively with funding from the regional budget. In Moscow, St.Petersburg and some oil-rich regions as Khanty-Mancy (Yugra) and Tumen' they are quite active, in other regions almost invisible.

Since 2013, the international energy efficiency and energy saving forum (ENES) has every year organized a competition of advanced energy efficiency and energy efficiency project. There are some difference year by year. The competition includes various nominations, such as energy efficiency project in business companies, energy efficiency projects of city service companies and energy efficiency education.

There are initiatives in the regions related to energy service contracts, for instance to improve energy efficiency in state buildings and about street lighting. The energy efficiency center selects the most prepared organization with more promised conditions (high payback) and invest to energy efficiency measures. The scale is nevertheless very limited. In St.Petersburg 4 schools are done, 3-4 more in line.

The progress is in energy efficiency are not impressive. At the Climate Summit of the Cities in Moscow August 2017 it was underlined that this is a big gap in Russian energy policy: The gap between the huge energy efficiency potential and needed measures with obviously positive effect on one hand – and on the other hand an orientation to support fossil fuel and nuclear sector while neglecting energy efficiency.

On the other hand, the new policy on regulation of CO_2 emission gives some motivation to companies and cities/regions to think about energy efficiency. For now, it is a system for regional reporting on CO_2 emission, established in spring 2017. Only about 10 regions of 87 have reported, but the Ministry for Nature Use has a task to activate this work. Payments for emissions is not in place as there are still a fighting between various business interests.

Energy efficiency in Murmansk region

In Murmansk the regional development strategy to 2025, issued in 2013, mention the importance of energy efficiency but without any specific projects.

In 2010 the town of Apatity, south of Murmansk, had an energy efficiency program for several years. In this program two houses were modernized. The project was suspended in 2014 because of lack of money – all sources of finance support from federal, regional and municipal authorities was canceled. The economic recessions meant that public spending for energy efficiency was no longer given priority, even if the project would save money in the long run.

Renewable energy developments

In 2016 the installed power of renewable energy (big hydro excluded) was 0,4 % of total installed power of electricity in Russia (0,9 GW of 243,2 GW). In practice, renewable energy production was 0,2 %. The General Scheme for Energy Development includes a scenario of renewable energy grows. But this doesn't necessarily mean in will be implemented.

The new General Scheme of Energy Development includes a scenario with 9 GW renewable energy to 2035. The governmental tendency is very clear – support to big companies with state participation and state corporations.

A development this year is a new legislative kit facilitating micro generation of renewable energy. The State Order is done, but corresponding governmental regulation is still not completed. Once adopted it will help individual owners of renewable energy installations to connect to the grid, and make renewable energy more attractive and more easily managed.

For solar (PV) state investment support is granted to Renova 440 MW and Solar Systems 80 MW. Some of the projects done in 2016 and 2017 include:

- September 2016 Altai PV station 5 MWp
- December 2016 Bashkortostan – second step of PV station, up to 35 MWp, it should be 90 MWp to 2020.
- First half of 2017 – modernization of Novocheboksarsk enterprice produsing PV modules, to increase power, and increase efficiency by 20%.

For wind-energy this includes Rosatom (360 MW), Fortum (6 installation with total amount 1000 MW), ENEL Russia (two windparks totally 291,06 MW). In 2016 3 wind projects in Adygeya and 22 in Krasnodar regions (South) were selected, with start of operation in 2019-2020. In 2017 among others four wind projects selected for Murmansk region by Fortum. In addition to Murmansk, there are plans to build a wind farm in the Rostov region. According to the press service of *Enel Russia*, the total investment required for the construction of two wind farms will be around € 405 million. The equipment for future projects will be delivered by *Siemens Gamesa*, the world's largest manufacturer of wind turbines. It will be produced on the territory of the Russian Federation[49].
In addition, Karelia and China agreed to construct a wind station by 2020, China will invest 1,5 billion USD. For small hydro support is given to Rusgidro two objects 24,9 MW each.

Renewable energy in Murmansk region

In Murmansk region, between 2012 and 2015 combined wind-solar-diesel power stations were installed in four faraway settlements of the Tersky district of Murmansk region. In 2016 another three settlements of the district were connected to a similar power supply system.

Future plans are construction of a peat boiler plant in Umba, the use of solar energy in combination with a diesel engine in the center of the Kola Peninsula - in the villages Krasnoshchelye, Kanevka, Sosnovka[50].

[49] Source: https://www.murman.ru/news/2017/11/21/0813

[50] Source: http://www.mvestnik.ru/eco/veter-veter-ty-moguch/

It is planned a wind farm near the settlements of Teriberka and Misty, along the road Teriberka-Tymanny. The land has been rented since 2008. The wind park is expected to be launched by the end of 2021. The wind park will consist of 3 MW turbines, and the total installed capacity of the wind farm will 201 MW. The summer 2017 a company Enel Russia won the tender to construct the farm. The wind farm in the Murmansk region will produce up to 700 million kilowatt hours a year[51].

At a round table of the Kola NPP on 17. November 2017, the director of the Omelchuk station said, that Rosatom has an idea to buy out hydroelectric power plants from TGK-1 and thereby get a monopoly on electricity generation. Rosatom also plans to buy new energy generation in the future, for example, wind power, and thereby create a common energy company. If Rosatom in the future will control a bigger share of the electricity production, it might get a close-to-monopoly-situation in Murmansk. It is a possibility that Rosatom wants to start in the Murmansk region as a pilot project, and then spread the experience to other regions.

10. Legislative changes

In 2017, there has been changes in the law on decommissioning, and on the law on nuclear development. There have been no changes lately in the laws on radioactive waste or spent nuclear fuel.

Changes in the legislation of decommissioning

On 10. January 2017, Rostechnadzor of Russia adopted new decommissioning rules. For the first time, there were officially two scenarios for the decommission: immediate decommission and deferred decommissioning.

The Law "On the Use of Atomic Energy" stipulates that the procedure and measures to ensure the decommissioning of nuclear facilities and storage facilities should be provided throughout the life cycle of such facilities, beginning with its design. The law provides for the development of appropriate rules and regulations.

At present, a system of federal norms and rules has been developed and is functioning, including 89 documents that establish security requirements for nuclear facilities and activities in the field of nuclear energy. These norms and rules were adopted by Gosatomnadzor of Russia, and then by its receiver Rostekhnadzor of Russia. To date, regulations have been developed for the safe decommissioning of nuclear fuel cycle facilities (NP-057-04), nuclear power installations of ships (NP-037-02), research nuclear facilities (NP-028-01), industrial reactors (NP- 007-98) and others.

In general, the rules for decommissioning of such nuclear installations and storage facilities are enshrined in the General Provisions for the Safety of Nuclear Power Plants (NP-001-15) and the Safety Rules for decommissioning a nuclear power plant unit (NP-012-16, approved by the Rostekhnadzor Order from 10/01/2017 № 5). In addition, the content of the decommissioning program for the nuclear power plant block is contained in the Safety Manual RB-013-2000 "Requirements for the maintenance of the decommissioning program for the nuclear power plant unit" (approved by the Resolution of the Federal Nuclear Surveillance Agency No. 13 of November 4, 2000).

[51] Source: http://nord-news.ru/news/2017/10/07/?newsid=96916

Rules NP-012-16 are the first in Russia, which consider several options for decommissioning nuclear power plants. These rules also established the need to develop this concept for all power units within two years after the entry into force of these rules, no later than February 22, 2019.

To date, two scenarios for the decommissioning of nuclear power plants are normatively fixed. It is either the liquidation of a nuclear power plant block or the disposal of a nuclear power plant block. The first option (liquidation of a nuclear power plant unit) is realized by the method "Immediate liquidation of a nuclear power plant unit" or by the method "Deferred liquidation of a nuclear power plant unit".

Law for the support of nuclear development

Late in 2017, in 31.12.2017, the Federal Law "On the State Atomic Energy Corporation" Rosatom " (No. 317-FZ of December 1, 2007), was updated. These laws are expanding the powers of Rosatom's Supervisory Council, remove Rosatom from the control of the Government of the Russian Federation and strengthen Rosatom's monopoly in closed nuclear cities (ZATO).

Federal Law of December 25, 2014 No. 473-FZ "On the territories of advanced social and economic development in the Russian Federation" was adopted. This law this law led to a change in other laws: 03.07.2016 No.250-FZ, 03.07.2016 FZ, 05.12.2017 No. 371-FZ and 29.12.2017 N 455-FZ .

The Law 473-FZ "On the territories of advanced social and economic development in the Russian Federation", regulates cities with one large industrial enterprise, in other words single industry towns The purpose of the law is to diversify the economy of these cities, to promote other enterprises in the cities. The government suggests in these cities to establish a preferential tax regime to attract investment in various enterprises. Therefore, this law works in closed nuclear cities, and also in other territories. It is a universal law, not only for the nuclear field.

But for 10 single nuclear industry towns (ZATO), where Rosatom exclusively makes decisions, and Rosatom itself is managed not by the Government of Russia, but by the Supervisory Council headed by the former head of Rosatom (Kirienko), this means that such decisions actually stimulate investments in the further development of nuclear technologies, and not the diversification of the economy of the ZATO. The ZATO will continue to function not like a part of the regional location, but like a part of the Kremlin, without transparency and democratically principles in decision making process.

All 10 Closed Administrative-Territorial Formations (CATF) of Rosatom will receive the status of Territories of Advance Development (TAD)[52]. This means new economic privileges for development of nuclear technologies. By April 2018, 3 ZATOs already received this status: ZATO Ozersk, ZATO Snezinsk (Chelyabinsk region)[53] and ZATO Zheleznogorsk (Krasnoyarsk Territory)[54].

After the above-mentioned change in 2017, it is envisaged that the Rosatom Supervisory Council will have the authority to approve the program of Rosatom's activities, including within the framework of participation in the management of the territories leading social and economic development in ZATO.

[52] http://www.atomeks.ru/mediafiles/u/files/Atomex_2016/materials/4/Aliev.pdf .
[53] http://government.ru/docs/31292/
[54] http://zato.tv/news/8405

Rosatom is given the authority to issue permits to organizations for the construction and commissioning of nuclear facilities, regardless of the affiliation of these organizations to the state corporation."Rosatom" will issue permits for the construction of capital construction projects and commissioning of its facilities, "daughters" and "granddaughters". This means that the Russian government has been removed from the administration of the State Corporation Rosatom.

For the closed nuclear cities (officially "close administrative-territorial entities" - ZATO) this means that Rosatom now controls construction and reconstruction of the facilities. In these 20 closed nuclear communities live 1,5 million people, 1% of Russia's population.

The changes in the law means that the regions where the closed nuclear cities are located will in fact have less opportunities than before to influence the activities of Rosatom in the closed city (ZATO). However, it should be noted that there are other procedures for the influence of local authorities on the construction of new facilities, for example the Environmental Impact Assessment (EIA) procedure.

Moreover, president Putin appointed Sergey Kiriyenko, First Deputy Head of the Presidential Administration of Russia, who was previously the head of Rosatom, as the Chairperson of the Supervisory Board of Rosatom.

11. Conclusion

Starting in 2016 and continued in 2017, we have seen some progress in the planning of decommissioning of Russian nuclear power plants. For the first time, not only the timing of the final stop of the Leningrad nuclear power plant was publicly discussed, but also attraction of new business for the development of the site in question, as the decommission end-stage has been decided to be "brown field", meaning that it is not released without restrictions with potential to become park or kindergarten but for industrial purposes. In 2017, new rules on decommissioning was adopted, making a clear distinction between possible end stages.

At the same time, these discussions were superficial, all interested parties were not involved, but only the operator of the station and the executive power of the Leningrad region represented by the vice-governor. So far, no legislative basis has been created at the regional level to ensure deeper involvement of the region, local authorities, as well as the public concerned in planning and monitoring the decommissioning of Leningrad nuclear power plant.

Whereas Leningrad power plant's first unit will be closed in December 2018 and the second unit in 2020, the first units of Kola nuclear power plant will most likely run for 60 years, twice the original lifetime. After the closure of the first reactor at Leningrad, some years will be needed for planning of decommissioning. Several questions are unanswered, amoung them how to deal with the graphite.

The amount of spent nuclear fuel generated by Russian NPPs is still many times greater than the mass of spent nuclear fuel being reprocessed. However, we don't recommend it to be increased. Reprocessing of spent nuclear fuel generates formation of liquid radioactive waste, which is thousands of times greater than the amount of spent nuclear fuel being reprocessed. Thus, it is not really "reprocessing" of spent nuclear fuel, which solves the problem of the safety of nature, but the transformation of one problem into another.

In 2017 the transport of spent nuclear fuel from nuclear power plants from the European part to closed administrative territorial units of the Urals and Siberian regions has continued. This has been going on without public discussions, without taking into account the inhabitants of these places, and was accompanied by a deterioration in the socio-ecological situation, which caused many thousands of protests.

The first Russian storage facility was put into operation in Novouralsk in 2016.
The media reported on the refusal of RW to build a repository of radioactive waste on the shores of the Gulf of Finland near St. Petersburg and the beginning of research in the less populated northern territories of Northwest Russia. Thus, during the promotion of the storage facility project, not only economic but also social and environmental criteria were considered when choosing the location of its deployment.

For the last years the state bodies of Russia have put heavy pressure on civil society involved in promoting the safe decommissioning of nuclear power plants and the treatment of radioactive waste and spent nuclear fuel. Non-governmental organizations arguing for local and regional involvement in decision-making on the future of old nuclear reactors, have been labelled foreign agents.

12. References

For chapters 3, 4, 5, 7 and 8, you can find more information in
Decommission Network 2017: Вывод из эксплуатации Российских АЭС, обращение с ОЯТ и РАО в 2016 г. (English translation: Decommissioning of Russian power plants, handling of radioactive waste and spent nuclear fuel in 2016.)
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For chapters 7 and 8, you can find more information in
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For chapter 6, you can find more information in
Naturvernforbundet 2017: How to pay? Financing decommissioning of nuclear power plants
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