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Monitored this issue:

Russian grip on EU nuclear power

This article is based on a report by Patricia Lorenz called "Russian grip on EU nuclear power" written for The Vienna Ombudsoffice for Environmental Protection.[1]

Introduction

When Russia invaded Ukraine in February of 2022, it quickly made other European countries reconsider their relationship with their Russian energy supply imports and their Russian energy dependency. Members of the European Parliament demanded a full embargo on Russian oil, coal, gas and nuclear fuel on april 7th[2].

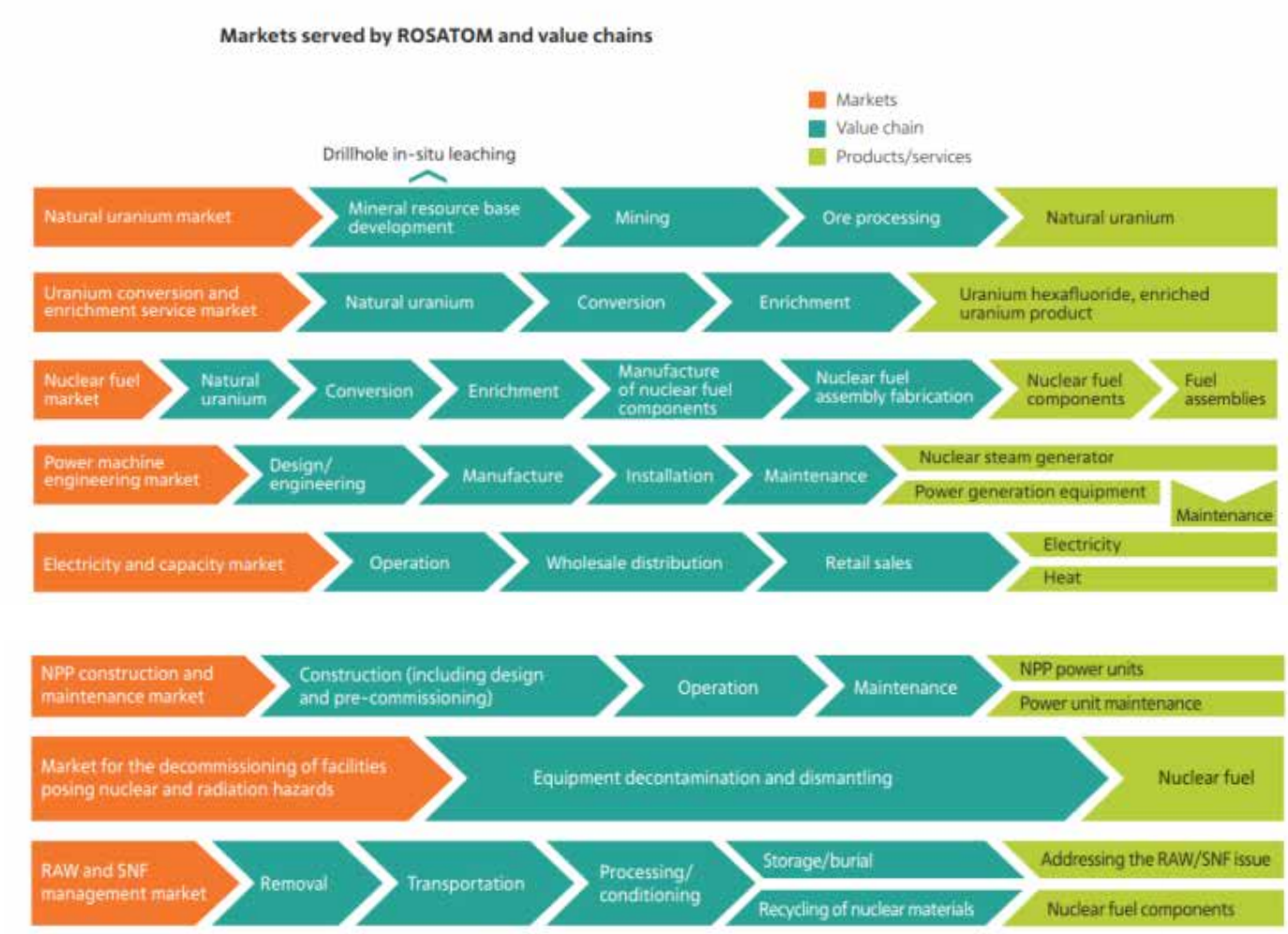
Regarding gas it has been difficult for the EU to make headway as several countries, particularly Germany and Austria, are very dependent on Russian imports to keep the lights on. With regards to oil the EU has been more successful. A ban on crude oil and refined petroleum products was adopted by the Council on june 3rd[3].

Nuclear power has stayed somewhat out of the limelight though. A quarter of European energy is produced by nuclear power plants and the nuclear power industry in Europe is heavily dependent on Russian imports, expertise, maintenance and operation. This is all through Rosatom, a state-owned Russian enterprise that is the market leader in the 500bn nuclear power industry. This article will explore Rosatom, its ties with the EU and her member states and whether it can be easily replaced.

Rosatom

Rosatom Holding was created by Vladimir Putin in 2007. It is an economic as well as political power to reckon with. According to Rosatom's website, the corporation includes about 300 enterprises and organizations employing a total workforce of more than 290,000[4]. The following scheme shows that through its subsidiaries Rosatom covers the complete "nuclear fuel cycle" of the nuclear industry, from mining and enrichment to construction, maintenance and decommission:

Figure 1: Markets served by ROSATOM and value chains[5]



1. https://www.laka.org/docu/boeken/pdf/2-34-6-50-04.pdf#page=2
2. https://www.europarl.europa.eu/news/en/press-room/20220401IPR26524/meps-demand-full-embargo-on-russian-imports-of-oil-coal-nuclear-fuel-and-gas
3. https://www.consilium.europa.eu/en/press/press-releases/2022/06/03/russia-s-aggression-against-ukraine-eu-adopts-sixth-package-of-sanctions/
4. https://rosatom.ru/en/about-us/
5. Rosatom 2020 Annual Report.

Rosatom and lobbying

In a recent report, Greenpeace has accused Rosatom of extensive lobbying in the EU for favorable legislation. A big part of this was apparently lobbying for the inclusion of nuclear energy in the EU taxonomy policy for labeling green investments[6].

Fuel

Rosatom now produces nearly 20 percent of the world's nuclear fuel — providing an important revenue stream for Moscow, just like fossil fuels. According to its 2020 Annual Report, Rosatom produced over 1,000 tons of heavy metal (tHM) of nuclear fuel and 7,100 tons of uranium. The Rosatom subsidiary that is responsible for all of its fuel business is called TVEL.

TVEL is the supplier of nuclear fuel for the VVER reactor series, where all Russian designed reactors come from. They use different fuel than Western design nuclear power plants, thus creating severe dependency for those countries still operating the nuclear power plants they built in Communist times. The situation for the older VVER-440 units is different from the larger and newer VVER-1000 series, because no Western supplier can provide fuel for the smaller plants at the moment.

Westinghouse may develop VVER-440 fuel. In 2021, a contract was signed between Energoatom and Westinghouse for the development and delivery of licensing documentation for fuel assemblies fitting VVER440 reactors. The first reload of Westinghouse fuel in a Ukrainian VVER-440 nuclear fuel is expected at Rovno-2 in 2024, according to Energoatom. This, of course, may change due to the current war situation; with respect to other VVER-440 operators, it is the question of whether it is commercially and technically viable for Westinghouse to produce fuel for a few VVER-440 reactors needing fuel with different characteristics.

Some countries (Ukraine, Bulgaria, Czech Republic) already started switching to Western suppliers, but Westinghouse is the only one already supplying VVER-1000 fuel assemblies. On top of likely technical problems with the replacement fuel which have occurred in the past decades it is clear that Westinghouse will not be able to handle the large number of new customers asking for fuel – Westinghouse will first need to create new production capacities. Short-term solutions are not likely, while some EU leaders started calling for an embargo also on nuclear fuel from Russian state companies.

Czech Republic

The Czech Republic intends to steer away from any Russian involvement, as evidenced by their public tender for a new nuclear plant that does not allow Russian, or Chinese, bids. Since the beginning of the war in Ukraine, for the third time a nuclear fuel delivery has been flown into the Czech Republic. This was so urgent that, in the midst of the war in Ukraine, an exemption to the ban on flights for Russian aircraft into the airspace of the European Union had to be granted. ČEZ, the operator of both Temelín and Dukovany plants, explained that this was the last of the planned deliveries. ČEZ also informed the public that Temelín currently has sufficient fuel stored for two years and Dukovany for three. Their contract with TVEL expires in 2 years and they do not intend to renew.

Ukraine

With its fleet of 13 VVER-1000 and 2 VVER-440 units, Ukraine has consistently led the way in trying to diversify its TVEL fuel and demonstrates the realistic options available in complex conditions. Development of the first Westinghouse VVER-1000 fuel for delivery to Ukraine started in 2001. However, after several technical difficulties they had to revert back to TVEL fuel deliveries. After the 2014 annexation of Crimea, Ukraine restarted their fuel diversification. Westinghouse has been able to deliver an improved design – the Robust Westinghouse Fuel Assembly (RWFA). The change to Westinghouse fuel is a slow one though. Per a 2018 contract, it was decided that TVEL will continue to supply 9 of 15 Ukrainian plants. It will only be in 2025 that for example the Rivne-3 will be able to operate entirely on American nuclear fuel.

Ukraine also intends to receive VVER 440-fuel from the US company. In 2021, a contract was signed between Energoatom and Westinghouse for the development and delivery of licensing documentation for fuel assemblies fitting VVER-440 reactors. The first reload of Westinghouse fuel in a Ukrainian VVER-440 nuclear fuel is expected at Rovno-2 in 2024, according to Energoatom. However, it was already expected for 2022.

Bulgaria

Bulgaria has two VVER-1000 units operating at the Kozloduj sites. Bulgaria started preparing for the switch three years ago. According to experts in Bulgaria, the new supply by Westinghouse will come through, but the necessary tests took 2-3 years and the new fuel still needs a permit for commissioning. In early 2021 a contract was signed between the Bulgarian government and Westinghouse for a safety assessment of Westinghouse nuclear fuel as a supplement to Russian-sourced fuel for the 1,000-MW Kozloduy-5. However, TVEL is contracted to supply Kozloduy-5 and -6 until 2025.

Finland

After the invasion of Ukraine it was reported that Finland has decided to kick Rosatom out of the construction of their new Hanhikivi NPP. For now it seems though, as expressed by Finland's NPP operator Fortum on March 25 at the Fortum AGM37, that they intend to stay with TVEL (Rosatom company) as foreseen in the contracts until 2027 and 2030.

6. https://www.greenpeace.de/publikationen/20220517-greenpeace-report-russland-taxonomie.pdf

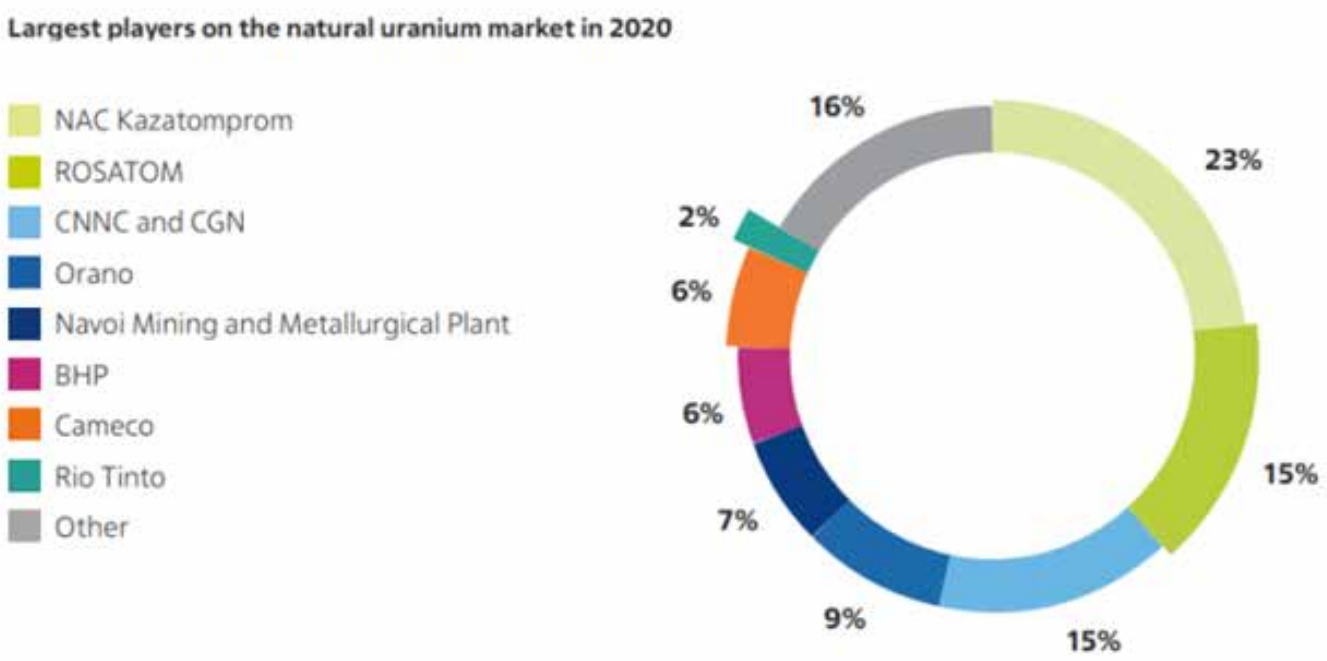


Figure 2: : Largest players on the natural uranium market in 2020[7].

Slovakia

Slovakia is a good example of total dependence. Currently, Slovakia's utility Slovenské elektrárne is the operator of four units of VVER-440 reactors, delivering over 50 % of Slovak power. This reactor type is operated with fuel which only the Russian company TVEL can deliver. Slovakia ignored the warning from EU institutions which kept asking for alternative fuel suppliers. Instead, Slovakia continued with the construction of two additional VVER-440 units (Mochovce 3 & 4). Slovakia is very silent when it comes to efforts to find other suppliers of nuclear fuel. The reasons might be that no alternative suppliers exist for those VVER 440 units, and the existing infrastructure for licensing new fuel – Nuclear Regulator and TSO – is not very capable. Consequently, it might prolong the time needed in order to use new fuel up to ten years. It is fair to assume that Slovakia is most likely lobbying the other member states and the EU Commission hard to keep fuel from Russia coming in, despite the ongoing war, war crimes and the crimes against humanity committed by the Russian army in Ukraine.

Hungary

Hungary seems to hold on to Rosatom in its new VVER-1200 Paks-2 project, which was scheduled to be operational in 2025, but is now looking at a 2030 start. There are plans to extend the lifetime of their 4 older VVER-440 reactors, which will continue to be supplied by TVEL.

Replacing Rosatom in mining and conversion

To understand why Russia's nuclear fuel deliveries to European countries cannot be simply replaced by importing Australian uranium, for example, it is necessary to understand that fuel is specific for reactor types and the different production phases are available only on a limited scale in certain countries, and there can be bottlenecks.

About 40% of uranium imported in the EU stem from Rosatom's mine or from Kazakhstan, which is politically considered an ally of Russia. Some of the mines in Kazakhstan are owned or co-owned by Russian companies.

Europe's last uranium mine in Rožná in the Czech Republic closed in 2017. However, the government reserved the option of reopening other mines, such as Brzkov. Brzkov is said to contain 3000-4000 tU around 300 m deep; state company Diamo said it would take six to seven years to commission the mine; local resistance is high. In Spain, the Salamanca project was under preparation and could produce 4.4 million pounds (Mlbs) of uranium concentrate annually for 14 years. But this was also recently canceled. Similarly, the Kvanefjeld mining project didn't start after the Greenland Parliament approved a bill prohibiting uranium exploration and mining in 2021.

Uranium price plays a minor role for the operator of a nuclear power plant, but it is decisive when opening or enlarging a uranium mine. An example here is the US, where a dramatic decline in uranium production from 2016 to 2018 was due to low market prices. At the same time, US utilities started importing cheaper uranium from Rosatom; by March 2022 the dependency was so high that they lobbied hard to prevent the White House from banning the import; this may well be overturned.

Conversion and enrichment

Western uranium converters and enrichers are facing an explosion in demand from nuclear fuel buyers preparing for a possible cutoff from Russian nuclear fuel. However, new additional capacities are needed and those are a long-term project. Some observers pointed out at the beginning of April 2022 that for many companies uncertainties remain, because if the war ends suddenly and Russian nuclear fuel never stopped entering the EU or the US, the newly build-up capacities for mining, converting and enriching would have been in vain.

7. UxC, Company reports

Outlook on Alternatives for New Reactors

Russia's Rosatom with its many subsidiaries was the market leader in the nuclear industry. Russia was not only constructing nuclear power plants at home, but also successfully completed its NPP projects (Astravets-1/ Belarussia) abroad, certainly with fewer delays and cost overruns compared to its competitors. Russia has dominated the nuclear export market since 2009 and was preparing new contracts in many countries. Following its attack on Ukraine and resultant sanctions, Finland has canceled its contract with Rosatom. Hungary and Turkey have not shown that they plan to terminate their contracts with Rosatom regarding their prospective projects.

At the moment there are 4 other countries that have reactors that might be exported, but each of them have their own problems.

EPR/France

The French nuclear industry, usually understood as a powerful branch, is vastly overrated. The issue here is the potential of the French nuclear industry to replace the new reactors which were previously, or might have been, delivered by Rosatom in Russia. The only European reactor on the market, developed by state owned energy company EDF, is the EPR-1600 MW, which 20 years ago was called the flagship of the nuclear renaissance. This Generation III+ reactor, however, is infamously troubled, notorious for its cost overruns and delays at Flamanville 3 in France and Olkiluoto 3 in Finland.

Two key problems stand in the way of an export offensive: manufacturing capacity and the EPR's design deficiencies which became evident once the first EPR started operating in China. This might be a major design failure which affects all EPR reactors and as of yet this has not been resolved.

Any new projects will involve an evolved version of the EPR, called the EPR2, which is supposed to be cheaper and easier to build. French president Macron announced plans to build at least 6, and maybe 8 more, EPR2 reactors that are supposed to become operational in 2035[8]. EDF has submitted a preliminary, non-binding offer to the Polish government for the construction of four to six EPR nuclear power plants in Poland at two or three different locations. It is also hoping to build six EPRs at the Jaitapur site in Maharashtra state, Western India. All of this adds up to a potential total of 26 new EDR-2 reactors.

It is safe to doubt the ability of France to go from managing the construction of 4 EPRs in the past 15 years to this potential of 26. Especially considering that EDF has to maintain France's many own, and quite old, plants, adding pressure on the existing lack of skilled workforce and other nuclear industry infrastructure. The EDR2 reactor of course has not been tested yet, but its design might contain flaws as well. France and EDF might be able to replace Rosatom, but as of yet they have to answer a lot of difficult questions.

US/Westinghouse

Another option is Westinghouse's new reactor type, the AP 1000. It has been advertised to have new passive safety features, meant to withstand Fukushima-type events. This, however, could lead to a time-consuming licensing process, because European regulators lack experience and legal provision for this reactor type with more passive safety features.

Westinghouse promised to beat this trend because of their expectation that "plant costs and construction schedules benefit directly from the great simplifications provided by the design" and because of the adoption of "modular construction techniques". Westinghouse projected that the AP1000 reactor would have "an accelerated construction time period of approximately 36 months, from the pouring of first concrete to the loading of fuel". All of these projections have gone spectacularly wrong in both China, with the Sanmen and Haiyang projects, and especially with projects in the United States. The modular construction methods only had the effect of shifting some of the problems from the building site to the factory, found the World Nuclear Report in 2017.

On top of technical issues, many observers doubt Westinghouse's abilities as a reactor supplier. Westinghouse filed for bankruptcy reorganisation in 2017, driven by liabilities related to the two US projects, and new owner Brookfield Business Partners has said the company wanted to remain a reactor supplier but not get involved in being the construction contractor on nuclear plant projects.

China

China has been developing its own nuclear industry and exporting its energy technologies is definitely part of the Belt and Road Initiative. The answer to the question whether China will replace Rosatom in providing nuclear reactors in Europa is however a short one. European countries will simply have too many security concerns to allow a Chinese enterprise to control such an import feature of their energy infrastructure. The Czech Republic has recently in the same vein excluded both Russia and China from its tender for a new nuclear power plant.

Korea Hydro and Nuclear Power (KHNP)

South Korean energy company Korea Hydro and Nuclear Power (KHNP) has confirmed it intends to take part in the Czech Republic's tender process. Its flagship export technology is the 1,345 MW APR-1400 pressurized water reactor design, so far deployed overseas only at the United Arab Emirates' Barakah nuclear power station. Domestically, KHNP operates the APR-1400 at Shin-Kori-3 and 4 and is building more units at ShinHanul-1 and 2 and Shin-Kori-5 and 6. However, since 2009, when South Korea won this contract thus beating France, South Korea has not won a single reactor export contract, but more importantly, the APR-1400 is currently not recognized as a Gen III+ reactor in Europe.

Conclusion

Russia's state owned energy company Rosatom has been integral to the European nuclear industry. Now Russia has invaded Ukraine, it has become a top priority for the EU to reduce its Russian energy dependence. It will not be easy for Europe's nuclear power plants to phase out Russian

8. https://www.politico.eu/article/france-to-build-6-new-nuclear-reactors/

involvement, especially if it has to be done quickly.

Replacing Rosatom as fuel supplier seems to be the hardest task. Regarding the fuel for the VVER-1000 series reactors, replacing them might be doable, as American company Westinghouse already produces this kind of fuel for some plants. The big problem will be the fuel for the older VVER-440 reactors, as no company except for Rosatom currently has the expertise to produce it. There are plans for this, but they might take years.

For both Uranium mining as well as uranium conversion, the same thing can be said. The exclusion of Rosatom leaves few other options and these alternatives will need to kick their production into overdrive to meet demand. There are many uncertainties for these companies though; their newly build-up capacities for mining, converting and enriching will have been in vain if, for instance, the war ends and Europe and the US never stop importing nuclear fuel.

Possible alternative vendors for new reactors are very limited. On top of the usual construction time and cost overruns, both the French EPR and the US AP-1000 have encountered several design failures. The South 6 Korean APR-1400 is not recognized as a Gen III+ reactor in Europe. Chinese reactors are excluded for security reasons.

NUCLEAR NEWS

World Nuclear Power Status

Number of Reactors
(as of October 2022)

Source: https://www.worldnuclearreport.org/

Finland, New delays Olkiluoto-3

Finland can't catch a break with Olkiluoto 3. After 13 years of delays, the long awaited commissioning of the nuclear power plant was postponed again after large cracks were found in all four of the reactor's feedwater pumps. The cracks were first discovered in August, but not made public by the operator TVO until October. So far, the operator has no explanation for the occurrence of the cracks, that measure a few centimeters each. It is for now unclear how the damage will impact the scheduled commissioning of the plant, Reuters reports.

In neighbouring Sweden, experts are alarmed by the news.. *"They are an essential part of the nuclear power plant, it is not possible to run a power plant without pumps. When it comes to such large cracks, it is a serious mistake,"* said the nuclear scientist Peter Lund to Swedish Yle.

World Nuclear news reports that the feedwater pumps are Olkiluoto 3's largest pumps and are used to pump water from the feedwater tank into the steam generators. The pumps at OL3 have been designed for the plant unit's operations and are larger in size.

OL3 attained first criticality on 21 December 2021 and was connected to the grid on 12 March. The 1600 MWe pressurised water reactor is currently in an ongoing test production phase. It was operated at full capacity for the first time in late-September.

"The schedule for continuing the test production programme will be updated once the reasons for the damage and the repair method have been confirmed," TVO said.

Sources: Reuters, Word Nuclear News, Sweden Postsen

Belgium mothballs first reactor

In the midst of an ongoing debate on the closure of Belgiums nuclear reactors, Doel 3 was taken off grid in september. The decision was made in 2003 to close all reactors after 40 years of operation. Doel 3 was connected to the grid in 1982 and is the first reactor to be decommissioned. Tihange2 will follow early 2023.

The current reactor fleet is plagued by technical problems. Doel 3 was one the "cracked reactors" and has been the subject of a heated nuclear security debate. The decommissioning of the plant will take at least 18 years and a billion Euro's.

There are growing concerns about electricity supply in Belgium, that is heavily dependant on nuclear power and has been reluctant to invest in renewable energy. After the Russian invasion in Ukraine followed by soaring energy prices, the Belgian government decided to extend the lifetime of Tihange3 and Doel3 with ten years. The other three reactors will be taken off the grid in 2025.

In Germany, the debate on lifetime extension of nuclear reactors has also flared up after the Ukraine invasion, with a different outcome. The German government decided to postphone the mothballing of the two last reactors in the country for a few months. However, the operators of the plants will have to keep the reactors on stand-by, only to be activated in case of electricity shortages. This also means they will have to ration the remaining nuclear fuel until spring. The nuclear phase-out will be completed in april 2023.

Sources: De Volkskrant, World Nuclear News