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Nuclear Means Clean

The last month saw three major events for Rosatom in the back-end segment. First, Rosatom fuel division TVEL won a contract for bringing a mothballed uranium mine in Tajikistan to a safe state. Second, TVEL's subsidiary Angarsk Electrolysis Chemical Plant received an automatic sorting line for radioactive loose materials. Third, TVEL took part in an IAEA seminar on decommissioning of small nuclear facilities.

TVEL Fuel Company is Rosatom's subsidiary responsible for the development and fabrication of nuclear fuel. In 2019, the company became a nuclear industry integrator for decommissioning and radioactive waste management projects, technology and solutions.

Safe Taboshar

Taboshar, one of the early Soviet uranium mining sites, will be TVEL's first nuclear legacy management project in the CIS countries. It will be carried out by the Central Design and Technology Institute (CPTI). As part of TVEL, CPTI functions as one of its competence centers for nuclear decommissioning.

The former mining site includes four tailings pads, Workshop 3 tailings storage facility, and a low-grade ore storage facility. In 1973–1975, all the pads were mothballed, and their

surface and slopes were covered with soil. By contrast, heap-like tailings at Workshop 3 reach up to 70 meters and covering an area of 3 hectares while the low-grade ore storage facility has not been rehabilitated yet. Their surface and slopes are not protected against rain and wind, and radioactive materials are spread with airborne dust. There are dirt roads laid long ago and grazing lands all around, so the site requires rehabilitation.

By now, the company has conducted comprehensive engineering and topographic surveys, updated geological and hydrological parameters of the site, and prepared project documents and cost estimates.

"We will have to pull down the dilapidated low-grade ore plant, remove contaminated soil and replace it with clean one, reinforce the tailings storage slopes, cover up the surface of the tailings storage facility and install upper protection barriers, rehabilitate lower sections of the slopes, and install drainage and monitoring systems," says CPTI General Director Mikhail Tarasov.

Contaminated areas were also found around the tailings storage facility. Radioactive soil will be moved to the tailings storage and covered up there. Clean soil for backfilling will be sourced from a number of mining sites in the region as specified in the project documents. The rehabilitation project is planned to be completed next year.

Separation of contaminated soils

The Angarsk Electrolysis Chemical Plant received FREMES (Free Release Measurement System) line for the separation of loose materials. It will be used in decommissioning operations at obsolete gaseous diffusion enrichment facilities (uranium is enriched using a gas centrifuge enrichment process).

It is assumed that the total amount of waste, which is estimated at 85,000 tons, will decrease 80% thanks to waste separation. The separation line was first tested in a rehabilitation project at FBFC International's fuel fabrication facility in Belgium. It processed over 45,000 tons of soils over 2.5 year, having reduced the amount of waste to be dumped significantly.

The line developed by TVEL engineers consists of three modules. The first module separates solid waste by sieving. Larger pieces are sent to crushing, while smaller pieces of up to 20 mm in diameter are fed to the second module. This is where the system analyzes their level of radioactivity and applies a predefined algorithm to divide the waste into three flows to be sent to the third module consisting of cascading belt conveyors and packaging machines. The first flow is a clean material; its radioactivity is less than one tenth of the regulated limit. The second flow contains a slightly contaminated material, from one tenth of the regulated safety limit and up to the safety threshold, that is treated before further use.

Contaminated material in the third flow, which is radioactive above the regulated limit, is cleaned up or classified as radioactive waste and sent to storage.

The plant is capable of separating up to 10 tons of loose materials per hour. It is expected to be in use at the Angarsk Electrolysis Chemical Plant for the next five to eight years. **"We expand our capabilities in nuclear legacy management and decommissioning thanks to FREMES technology and new competencies acquired by our staff,"** project manager Igor Khisamutdinov says.

Attention to small nuclear facilities

TVEL took part in the Fifth Technical Meeting on the International Project on Decommissioning of Small Medical, Industrial and Research Facilities (MIRDEC). Led by the IAEA, the project was launched in the summer of 2018.

Although such facilities are usually low-power (up to 1 MW), the challenge is serious. If we take research reactors alone, there are more than 150 facilities worldwide either decommissioned or in the process of decommissioning; 20 reactors more are suspended or shut down and need decommissioning; another 45 reactors have been in operation for over 40 years. Apart from research reactors, there are a hard-to-estimate number of radiation sources, both secret and known to public, linear accelerators and other sources of ionizing radiation, and many of them require decommissioning.

The meeting featured reports on decommissioning of small nuclear facilities

in the member states of the project, as well as expert discussions on the relevant topics, including sources of finance, relationships with regulating authorities, and disposal of decommissioned radiation sources used in medical applications.

Yulia Gorlova, Head of International Business Development at TVEL's department for decommissioning programs, presented a report on the best Russian practices in decommissioning of research reactors, citing RFT and MR reactors at Kurchatov Institute as an example: RFT was the world's first loop-type channel reactor for material studies, while MR was a multi-loop channel-type open pool reactor. Those reactors had somewhat more power and formally do not fit into the small facility category but their decommissioning is relevant in terms of challenges faced and therefore worth considering.

"Small nuclear facilities and reactors are often located in urban areas, while medical facilities are most often dismantled in the medical centers that continue their routine operations. This imposes more restrictions on the work to be done and makes it more difficult. It is not unusual that such facilities are installed in relatively small spaces, there is no standard equipment

for decontamination, dismantling and disposal, and many more aspects need to be taken into account. All those factors make it necessary to prepare detailed decommissioning plans," Yulia Gorlova pointed out.

Rosatom has a wealth of experience in back-end management. In 2008–2015, the company carried out 37 projects at seven sites as part of the first Nuclear and Radiation Safety national program. In total, 57 facilities were decommissioned, with another 13 prepared for decommissioning. At present, the company is involved in the projects provided for in the second Nuclear and Radiation Safety program covering 2016–2020 and a period until 2030.

Rosatom also targets international markets, offering its decommissioning and radioactive waste management services.

Kazakhstan Interested

Kazakhstan is interested in the construction of a nuclear power plant and considers the possibility of partnership with Rosatom. National authorities visited the Akkuyu NPP and had a meeting with Rosatom Director General Alexey Likhachev. In addition, a branch of Russia's National Nuclear Research University will open in Almaty, country's largest city.

Little bit of history

Kazakhstan is not a nuclear industry newcomer. Back in Soviet times, its Semipalatinsk test site was a part of the USSR atomic project. It is here that the first Soviet atomic bomb was tested in 1949.

In July 1973, the world's first commercial fast neutron reactor BN-350 was put in operation in the city of Aktau (then Shevchenko). What made it different from other reactors was its dual purpose: the plant generated

electric power and desalinated water, while remaining heat was supplied to local housing. BN-350 was shut down in March 1998; the decision to mothball the plant was made in April 1999.

Kazakhstan's National Nuclear Center includes the Institute of Atomic Energy, Institute of Radiation Safety and Ecology, Institute of Geophysical Research, and Baikal Enterprise (providing maintenance, repairs, security and transportation services). Kazakhstan operates two research reactors, three test stands and a tokamak, with the latter used to stage experiments and conduct tests on structural materials and designs. In May 2022, the National Nuclear Center celebrated its 30th anniversary.

Since 2009, Kazakhstan has been the world's largest uranium producer, the country plays an essential role in the global nuclear industry. In 2021, it accounted for 46% of global uranium output. In 2021, state-owned uranium miner Kazatomprom produced 11,858 tons of uranium (24% of the total market), according to the company's report.

Since the 2000s, Kazakhstan has been examining the possibility of building a nuclear power plant. The project has been advancing in starts and stops being suspended several times for economic reasons and pushback from the people.

Today, Kazakhstan's interest in the construction of a nuclear power plant is growing again. **"I think it is time to consider this matter pointedly because Kazakhstan needs a nuclear station,"** President Kassym-Jomart Tokayev said at the Eastern Economic Forum in September 2021. Several days before he had ordered to study the possibility of building a nuclear power

plant in Kazakhstan in view of a looming power shortage in the region. **"We already see the first signs of power shortages in Kazakhstan. <…> This is the reason why we will have to decide on the nuclear plant construction looking forward,"** the president of Kazakhstan said at a meeting with financial industry representatives in November 2021. In early June, the government of Kazakhstan announced that a potential site for the future nuclear power plant had been selected — near the village of Ulken in the Almaty region.

Rosatom and Kazakhstan

In late May, Rosatom Director General Alexey Likhachev had a meeting with Kazakhstan's Prime Minister Alikhan Smailov. **"The parties had a broad discussion regarding cooperation in the energy sector, including expansion of joint uranium mining projects,"** Rosatom's press release read.

Uranium One, a mining subsidiary of Rosatom, has been operating in Kazakhstan as Kazatomprom's partner for many years. Kazatomprom and Uranium One's subsidiaries have set up five joint ventures engaged in uranium mining: Karatau, Khorasan-U (with Energy Asia Holdings Ltd

as the third partner), Akbastau, Zarechnoe (with the Kara-Balta Mining Plant as the third partner), and the Southern Mining and Chemical Company. Those companies produced a little more than 8,660 tons of uranium in 2021, according to the Kazatomprom's annual report.

"The Russian party confirmed its interest in continuing investments in Kazakhstan's uranium mining industry to strengthen energy security of the two countries," the press release read.

Rosatom and Kazatomprom also cooperate in the nuclear fuel segment through the Uranium Enrichment Center (UEC). It was founded in 2006, and Kazatomprom had held a 50% stake in it until March 2020. The Kazakhstan company sold its stake, except for one share, to the second shareholder TVEL (Rosatom's fuel division). As the parties agreed, the remaining share gives the company access to uranium enrichment services. In 2021, UEC started regular deliveries of low-enriched uranium to Ulba-TVS, a joint venture between Kazakhstan and China General Nuclear Power Corporation (CGNPC) manufacturing square-lattice fuel assemblies for PWRs.

Russia has repeatedly expressed its readiness to build a nuclear power plant in Kazakhstan. President Vladimir Putin suggested Rosatom's involvement back in 2019. **"Taking into account the necessity of building the first nuclear power plant in Kazakhstan, I should say that Rosatom is ready to take part in this large-scale project. Our readiness goes beyond providing project finance on favorable terms and extends to training local staff and engaging local companies in the construction project,"** Russia's Ambassador to Kazakhstan Alexey Borodavkin said when speaking at a seminar dedicated to the anniversary of the National Nuclear Center in late May.

Kazakhstan authorities already know how Russian-designed nuclear power plants are built. On May 9, Kazakhstan's delegation headed by Minister of Energy Bolat Akchulakov visited a construction site of the Akkuyu nuclear power plant in Turkey. Today, it is the world's largest nuclear construction site with four VVER-1200 reactor units being built simultaneously. Rosatom's subsidiary Akkuyu Nükleer provides engineering and construction services and will operate and maintain the plant under the BOO (Build–Own–Operate) model.

The guests from Kazakhstan visited a sea cargo terminal Vostochny (Russian for 'Eastern') and a pump station at Unit 1 and went up to the site's highest point with a scenic view of the reactors under construction. Akkuyu Nükleer CEO Anastasia Zoteeva told the guests about the Turkish project and its specifics, and Rusatom International Network President Vadim Titov spoke about the best practices in public communications.

In addition, Al-Farabi Kazakh National University (Almaty) will open a branch of the National Nuclear Research University (MEPhI) to train students in nuclear energy, pharmaceutics, medicine and economics. The corresponding agreement was signed on June 1 between the universities in the presence of the President of Kazakhstan, Kassym-Jomart Tokayev. MEPhI is Rosatom's core university offering degrees in nuclear professions.

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Harnessing Wind

By entering the wind power segment, Rosatom widens its offer to the clean energy market. Along with large and small nuclear power plants, the Russian nuclear corporation builds wind farms. In five years, Rosatom's wind power division has constructed Russia's largest pool of wind farms with a total installed capacity of 720 MW. The company builds wind farms in Russia and plans to export the technology.

Wind power is a relatively new business for the Russian nuclear corporation. Its subsidiary NovaWind, a holding company for the wind power division, was incorporated in September 2017. At present, the division consists of VetroOGK, VetroOGK-2, VetroOGK-3 and AtomEnergoPromSbyt. The first three companies engage in the construction, maintenance and operation of wind farms while the fourth supplies power to industrial consumers and provides power storage and management services.

In May, Rosatom obtained a construction permit for the Kuzminskaya wind farm in the Stavropol Krai (Southern Russia). With a total power capacity of 160 MW, it will have 64 wind turbines 2.5 MW each. It is not the first wind farm to be built by Rosaton there with another four wind parks already operating in the region (for details, see Rosatom Wind Farms below).

Also in the Stavropol Krai, the company is building a 60 MW Berestovskaya wind farm.

ROSATOM DIVISIONS

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Rosatom wind farms

Republic of Adygea:
- Adygea Wind Farm (150 MW)

Stavropol Krai:
- Kochubeevskaya Wind Farm (210 MW)
- Karmalinovskaya Wind Farm (60 MW)
- Bondarevskaya Wind Farm (120 MW)
- Medvezhenskaya Wind Farm (60 MW)

Rostov Region:
- Marchenkovskaya Wind Farm (120 MW)

The construction permit for this wind farm was obtained in June 2021.

The aggregated power capacity of the wind farms constructed, under construction and to be constructed by the wind power division amounts to 1.7 GW. The capacity in operation stands at 720 MW.

Producing locally

Apart from building wind parks, NovaWind manufactures key systems and components for wind turbines. The factory is based in Volgodonsk (Russia) and produces generators, nacelles, hubs, and tower base platforms. Its annual production capacity is 120 wind turbine sets, with 68% of components manufactured locally. The plan is to increase local content to 80–85% in the future. Blades are another component, which production is likely to begin soon in Russia. NovaWind holds talks with Umatex (Rosatom's composite materials division we wrote about in this year's first issue) on the possibility of producing turbine blades locally. The wind farms commissioned in 2021 are built using components manufactured at NovaWind's factory. NovaWind also has software programs for wind turbine operation and control.

Green certificates

Clean wind power is in market demand. Russian and international companies sign contracts directly with AtomEnergoPromSbyt to receive electricity from wind farms and reduce their carbon footprint. A recent example is a contract made in January with Russian Delo Group. The contract provides for the supply of wind power to major container and grain terminals on the Azov Sea and Black Sea coasts.

Export potential

NovaWind and Rosatom top managers have announced plans to enter international markets. **"Having accumulated valuable competencies, it would be unreasonable to use them in the domestic market only,"** Kirill Komarov, Rosatom first deputy CEO said last February when signing a wind farm finance agreement with Gazprombank.

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Rosatom Director General Alexey Likhachev confirmed that the company was ready to go international. **"[As for wind power] we focus mainly on exports. And many countries — our neighbors such as Kazakhstan, Uzbekistan and Armenia and more remote ones such as Vietnam — place orders with us,"** he said.

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Facts & Figures

> 540 thousand MWh
Aggregated power output by Rosatom's wind farms in Q1 2022

125%
Year-on-year increase in power generated by Rosatom's wind farms

> 2 million MWh
Total amount of electricity produced by Rosatom's wind farms

TRENDS

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Cheap Energy No More

With sanctions imposed on the Russian energy sector and soaring power prices in Europe, one of the key questions faced by decision-makers is how to reduce dependency on hydrocarbons. The answer seems to lie with the so-called alternative energy, but the raw materials it uses also demonstrate a dramatic increase in prices, and no one is certain what to do.

There have been only two solutions developed over the last 50 years to overcome an energy crisis. The first is energy saving, or consumption reduction. The other is transition to alternative energy sources.

In this context, alternatives should be interpreted broadly, both as alternative suppliers and other available sources of energy.

The current energy crisis is not an exception. In the International Energy Agency's (the IEA) 10-Point Plan to Reduce the European Union's Reliance on Russian Natural Gas, six out of ten proposals provide for the diversification of energy sources, and another two pertain to energy saving.

To replace energy imports from Russia, the IEA proposes **to replace Russian supplies with gas from alternative sources, accelerate the deployment of new wind and solar projects, maximize generation from existing dispatchable low-emissions sources: bioenergy and nuclear, speed up the replacement of gas boilers with heat**

pumps, and **step up efforts to diversify and decarbonize sources of power system flexibility**.

How workable are the IEA proposals?

Replace Russia

The plan was published on March 7. By early June, the European Union had introduced six sanction packages. The last one provides for a ban on the purchase of crude oil (with six months' delay) and oil products (with eight months' delay). This seems to be a direct implementation of one of the proposals. Indeed, oil imports from Russia are planned to be replaced with supplies from long-standing oil exporters (with fresh news coming that French Minister of Finance Bruno Le Maire held talks with the UAE) and sanctioned Venezuela and Iran. **"The US may allow more sanctioned Iranian oil onto global markets even without a revival of the 2015 nuclear accord, according to the biggest independent crude trader,"** Bloomberg writes quoting Mike Muller, the head of the Asian division of the world's largest oil trader Vitol.

But the thing is that smaller oil exporters, such as Iran or Venezuela, had less finance to invest in their economies (the oil sector included) due to the sanctions imposed so it will not be easy for them to quickly increase oil output. We may assume, therefore, that it will be extremely costly, if at all possible, to replace oil imports from Russia, the world's second largest oil supplier.

Although adopted, the sixth package of EU sanctions contains certain exceptions: the ban extends to seaborne oil only while supply via the Druzhba pipeline will continue. Special exceptions were made for Bulgaria, the Czech Republic, and Croatia.

There is a growing outcry from European politicians and economists of all sorts that the sanctions destroy Europe's economy more than that of Russia. It is overwhelmingly a matter of price, not supply. **"The embargo will reduce Russia's income from oil in the long term, but European companies and consumers will suffer more from high and potentially growing oil prices. Inflationary pressure will persist,"** says Guntram Wolff, Director of Brussels-based economic think tank Bruegel. He believes that **"Europeans will face hard times"**.

"Before we pull out of supply contracts [with Russia — ed's note], we need to secure supplies. This applies mostly to oil and, of course, gas," Minister President of Saxony Michael Kretschmer said commenting on the sanctions imposed by the EU and German Federal Government on Russian coal and oil.

Gas is truly an 'of course' thing: although prepared to consider an embargo on crude oil and oil products, Europe does not want to

include gas in it. Evidently, no country can replace Russia in this segment even if the USA and Qatar ramp up LNG supply to Europe.

Expensive metals

The IEA's second proposal provides for the construction of more renewable capacity. There is another challenge, though: prices for the metals that are used to build renewable energy generators, storage batteries and grids are growing, too. Lithium, nickel, platinum group metals, particularly palladium, aluminum and copper cause the greatest concern with the IEA.

Their prices have been on the rise for more than a year. Global economic recovery after the coronavirus pandemic, lifted restrictions and pent-up demand gave the first — and also the strongest — inflationary push. Concerns about the stability of metal supplies from Russia provided another stimulus, pushing the prices further up. The price of nickel made the highest leap, having risen from a little more than USD 29,000 per metric ton on Friday, March 4, 2022 to USD 50,300 per ton on Monday, March 7. On March 8, the price shot upward to USD 100,000 per ton, so that nickel trading was suspended and trades were canceled.

Copper, aluminum, palladium and iron ore exhibited similar price hikes in March, while lithium simply continued its growth observed in February. **"Prices of many minerals and metals that are essential for clean energy technologies have recently soared due to a combination of rising demand, disrupted supply chains and concerns around tightening supply. The prices of lithium and cobalt more than doubled in 2021, and those for copper, nickel and aluminum all rose by around 25% to 40%,"** says the IEA report published on May 18, 2022.

The trends look alarming: **"The price of lithium has increased an astonishing two-and-a-half times since the start of the year. The prices of nickel and aluminum — for which Russia is a key supplier — have also kept rising, driven in part by Russia's invasion of Ukraine. For most minerals and metals that are vital to the clean energy transition, the price increases since 2021 exceed by a wide margin the largest annual increases seen in the 2010s."**

The forecast is no less uncomfortable: **"The price trends have continued into 2022."**

However, if we take a look at the price charts for the last few months, we will see that the prices of metals have flattened and even decreased to the levels recorded in the autumn of 2021 and winter of 2022. So, it is difficult to predict whether the upward trend in prices will persist and, if it does, what will fuel the growth. Looking at the price evolution, we can assume that the panic over potential supply disruptions has subsided.

There is also another point to mention: in March, the price of gold, which has always

been perceived by investors as a safe haven, broke through the psychologically important level of USD 2,000 per ounce, then fell below it in April and went further down to less than USD 1,900 in May. It seems there is no panic in the investment community, which feeds off, among other things, political information. The crisis intensity seems to ease, and investors' focus of attention shifts over to other financial instruments.

Both manufacturers, from Russia included, and consumers are equally interested in supplies, so everyone is trying to find a way out of the situation in which businesses have found themselves thanks to politicians. The last few months showed clearly, with facts and examples, that the bogeyman of political dependency on commercial supplies is a straw man brought to light by the politicians themselves. The reality shows that even a strong dependency on large metal supplies does not result in a political dependency of the buyer on the seller. This became clear in the 1950–1960s and then in the 1980s on the back of panic-mongering in connection with hydrocarbon supplies from the USSR (we wrote about it in our issue #4). There was also a panic whipped up around the supply of rare-earth metals from China. By various estimates, the country accounts for about 60% to 70% of global supply of these metals. This matter was raised repeatedly in the 2010s and is not forgotten now. Rumor had it that rare-earth metals from China could be banned, but there is no information that those threats have ever been made real.

We know from experience that production disruptions are caused by artificial political barriers on the consumer's side. Here is an example: in late December 2020, the US imposed sanctions on Russia's largest titanium producer VSMPO-AVISMA but stroke it off the sanctions list in less than a month because Boeing needs titanium. In February, Boeing suspended titanium purchases, referring to the accumulated reserves and diversification of suppliers. In early June, WSJ published an article about a 10-day suspension in the production of Boeing 737 MAX, with supply disruptions named to be the main cause of the suspension.

Therefore, production costs of batteries, solar panels and wind turbines are indeed growing, but the main driver behind this growth is not supply disruptions, which have been largely minimized. Much more important is, first, a global inflation in the metals segment on the back of post-pandemic recovery and, second, a politically driven growth in demand. The proposal to accelerate deployment of new wind and solar capacity made by the IEA in March means indirect stimulation of demand for metals and, as a result, price growth mentioned by the IEA in May.

The IEA has a plan on how to curb the growth in production costs of sustainable sources of power: **"Higher commodity prices will not always rule out further cost reductions**

for clean energy technologies, but only if there is a redoubling of efforts to reduce costs via technology innovation, efficiency improvements and economies of scale. Companies will also have to pay more attention to managing price risks along the value chain. An extension of existing incentive schemes could be considered to avoid consumers turning their back on clean energy technologies."

Russian atom is not a dependency

We should take note of the last sentence in this suggestion. For the IEA, clean energy technologies finally mean not only renewable energy sources, but also nuclear. And one of the points in its 10-point plan provides for the maximization of nuclear generation.

It should be remembered that Rosatom is a global leader in the construction of nuclear power plants abroad. The Russian nuclear corporation is building 24 power reactors in nine countries. Rosatom boasts extensive expertise in the construction and operation of various reactor designs and also the world's most solid experience in the construction and operation of fast neutron reactors. So, if we talk about maximization of nuclear generation, Rosatom is the best choice as a company that builds power reactors cost-effectively and in reasonable time.

As we can say from many examples of partnerships with Russia across a wide range of supplies, business with Russians does bring benefits. Working with Rosatom is advantageous and does not lead to any political dependency. Doesn't sound convincing? Take a look at the policies pursued by the Czech Republic in which Russia built six power reactors and to which it continues to supply nuclear fuel, or Finland in which Russia built two power units and planned to build one more. Hanhikivi was a worthwhile project for Finland. Fennovoima's executives even expressed their regret in public statements: **"Unfortunately, the termination of the EPC contract is estimated to have a significant employee impact in Fennovoima and is expected to impact also the supply chain companies and Pyhäjoki region,"** says Fennovoima's CEO Joachim Specht. **"The decision to terminate the EPC contract with RAOS Project is not made lightly,"** Esa Härmälä, Chairman of the Board, points out.

Nuclear energy is a contribution to the energy security of any country. It helps mitigate supply risks and become more self-sufficient in electric power. Unlike oil and gas prices, the price of uranium fuel is much less volatile, according to statistics.

Numerous studies underline that no 'dependency' problems have a place in nuclear energy, and no supplier cannot afford leveraging its market position to exert political influence. History does not know examples of arm twisting with the use of nuclear energy. NL

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