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EXPO 2020: Week of Success

Rosatom Week — a series of events organized by the Russian nuclear corporation at EXPO 2020 in Dubai — was great success. These are not empty words but a concrete result: Rusatom Overseas signed four documents related to small modular reactor (SMR) NPPs. Rosatom also held sessions on new materials and wind power, organized virtual tours to Russian nuclear stations, and presented its achievements in digitalization and opportunities of the Northern Sea Route. This article will provide you with more details.

SMRs

Small nuclear power plants are Rosatom's key product in the domestic and international markets. The world's only floating NPP Akademik Lomonosov was put into operation in the Russian region of Chukotka in December 2019. Documents were signed to begin construction of four floating power units with two RITM-200 reactors each to supply power to Baimsky GOK, a mining and processing plant that will develop one of Russia's largest gold deposits, which is also situated in Chukotka. In addition, work started in Yakutia (another Russian region) to build an SMR NPP with a RITM-200N reactor ('N' in its name stands for 'onshore'). This NPP will supply power to the Kyuchus gold mine and nearby towns.

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On the SMR Day, Rosatom and Russian gold miner Seligdar holding a mining license for Kyuchus, signed an agreement for electric power and capacity of the yet-to-be-built small nuclear power plant.

In addition, Rosatom and the Armenian NPP signed a memorandum of understanding to establish the prospects of cooperation in the construction of Russian-designed nuclear power reactors in the Republic of Armenia. **"The Armenian Nuclear Power Plant produces around 40% of the electric power generated in the country and has been a clean and reliable source of power since 1977. After its service life is over, we would like to continue having nuclear in our energy mix. With this in mind, we are considering Russian technologies as they are the most advanced in the world,"** CEO of the Armenian NPP, Eduard Martirosyan, said during the signing ceremony.

Kyrgyzstan is another country to sign a memorandum of understanding with Rosatom. Reflecting the interest of this Central Asian country in nuclear energy, the document provides for cooperation in the construction of small nuclear power plants with RITM-200N reactors. The memorandum also sets the ground for assistance in the development of nuclear infrastructure in Kyrgyzstan and joint advanced training programs for researchers and engineers engaged in peaceful uses of nuclear energy.

The Philippines and Rosatom signed a joint plan and terms of reference for the SMR project feasibility study. This is the second step towards a small nuclear power plant in the country. The first step was made in 2019 when the parties signed a memorandum of intent to carry out a feasibility study.

Sergey Ryzhov, Chairman of the Board at Seligdar, spoke about the advantages of nuclear over other sources of power. First, nuclear power is reliable and does not depend on the weather. Second, the price of electricity is lower. It has always been high in Yakutia because it is very costly to deliver energy sources (primarily diesel fuel) to remote northern communities. Third, tariff rates are predictable for the entire period of the deposit development. Fourth, nuclear has little carbon footprint. Fifth, the modular design of a small nuclear power plant makes it easy to scale up the plant's capacity and develop production and infrastructure in the region.

Rosatom holds talks on SMRs with over a dozen countries. The anchor design is a two-unit — onshore or offshore — plant featuring RITM-200 reactors with the capacity of 105–107 MW. The design options vary, however, ranging from 1–2 MW micro reactors to 300 MW nuclear power plants.

Composite materials

Apart from the SMR Day, Rosatom also held a session on composite materials. Hydrogen economy is an emerging market for composites. Tanks made of carbon fiber reinforced with composite materials are

stronger and three to four times lighter than steel tanks, so they are better suited to transporting hydrogen, says Luca Burelli, Sales Manager at Faber Industrie Sp A. But to make composite tanks a mainstream product, the price of carbon fiber composites should fall from the current EUR 20–22 to EUR 13 per kilogram.

Composite materials are confidently entering the transportation industry. They reduce the number of components and assemblies, increase structural rigidity and strength and, most importantly, reduce the product weight. The smaller the weight, the less fuel is consumed, so the composite vehicles are more cost efficient and eco-friendlier. Umatex, a vertically integrated manufacturer of composite materials and Rosatom's subsidiary, supplied its products for the wing panels, center sections, high-lift devices and tail assembly of Russia's latest medium-range MC-21–300 airliner. Italian manufacturers have been purchasing Umatex composites for several years. Umatex carbon fabrics are certified to be used in the production of yachts by the Italian company Salorenzo at its shipyards in the cities of Massa and Ameglia. Prepregs are used to manufacture car accessories and high-speed motorbikes.

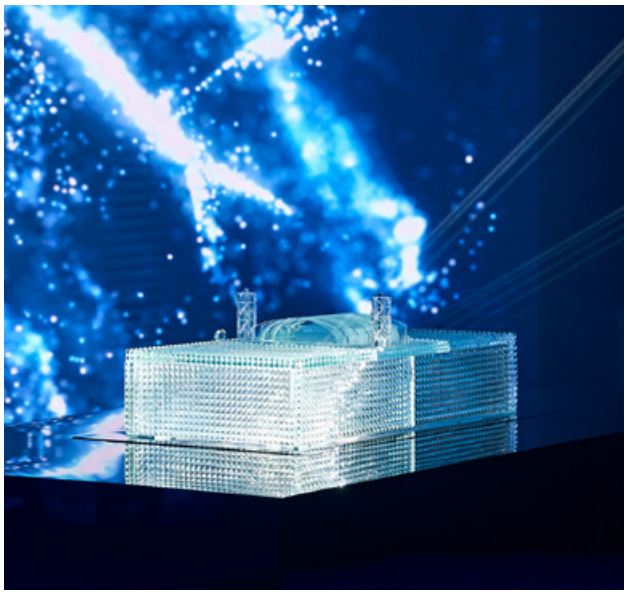
Wind power

NovaWind (Rosatom's wind power division) has acquired competencies at home and is entering the international markets with export-oriented products. In Russia, the company is to commission wind parks with the total capacity of 1.7 GW and holds talks with Southeast Asian countries, primarily Vietnam. The Balkans are another region of focus. Kazakhstan, Belarus, Armenia and Uzbekistan are also of interest for NovaWind.

Digital solutions

Rosatom acquires competencies and develops products in such areas as digital maintenance of nuclear construction projects, mathematical modeling of complex systems, artificial intelligence and cyber security. In particular, the Russian nuclear corporation joins forces with technology companies that have made much progress in cyber security to develop IT solutions that will mitigate unacceptable risks for the government, such as transportation havoc, blackout or disclosure of medical data.

According to the Bank of Russia, exports of Russian IT solutions keep growing and exceeded USD 6 billion in 2021. The same figure quoted by industry association is nearly two times higher, says Maksim Parshin, Deputy Minister of Digital Development, Communications and Mass Media. **"Our domestic software register includes almost 13,000 products, and many of them are truly competitive and globally efficient. We should promote these products in the global market in association with our partners — in partnership with Rosatom."**



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Virtual tours

RosEnergoAtom (part of Rosatom) organized a series of virtual technical tours to the Beloyarsk and Novovoronezh nuclear power plants, and to the Akademik Lomonosov floating NPP. The visitors to EXPO 2020 Dubai were lucky — apart from following the ordinary tour route, they had a chance to 'enter' the restricted access zones and see how the VVER-1200 power reactor and BN-800 fast neutron reactor halls look from inside, and also take a look at the facilities of the world's only floating nuclear power plant.

You can find more about the development of the Northern Sea Route and its presentation at Rosatom's Week in another article of this issue.

NovaWind consolidates Rosatom's wind generation assets and is responsible for the delivery of its wind power strategy.

Umatex is a Rosatom subsidiary and Russia's largest manufacturer of carbon fiber and composite materials. The company comprises several production facilities in Russia and two trading firms in the Czech Republic and China.

Rusatom Overseas is a Rosatom company responsible for promoting integrated solutions for the construction of nuclear power plants and nuclear science and technology centers worldwide. Rusatom Overseas expands the network of international partnerships, acting as a link between the customer countries and Rosatom's companies.

Fuel Cycle Closing Soon

Rosatom made another step towards closing the nuclear fuel cycle as more MOX fuel assemblies were loaded into the BN-800 reactor core at Beloyarsk Unit 4 during scheduled maintenance operations. MOX fuel makes 60% of the total core now. In late January 2022, the reactor unit was brought back to full capacity.

Russia was the first country to begin, and is continuing, extensive work to 'close' the nuclear fuel cycle by using fast neutron reactors. The Russian acronym BN-800 stands for a '800 MW sodium-cooled fast-neutron' reactor. Launched in December 2015, the reactor has served to gain extensive experience in using MOX fuel, as well as handling and processing irradiated assemblies that contain the same type of nuclear fuel.

MOX means 'mixed oxide'. Plutonium oxide is the first component of the fuel mixture. MOX fuel is made of low-level plutonium

obtained by reprocessing spent nuclear fuel from sodium-cooled fast neutron reactors and high-level plutonium extracted from the nuclear fuel irradiated in VVER-type reactors. High-level plutonium differs from low-level plutonium in its isotope content. For example, high-level plutonium has a larger share of even-numbered isotopes, which are formed in power reactors (VVER and RBMK-type reactors) and can be burnt in fast neutron reactors.

The second component of the fuel mixture is depleted uranium obtained at the enrichment stage. And yes, it is the uranium many consider to be a 'waste'. By creating MOX fuel, Rosatom demonstrates that the 'waste' is feedstock for a new-generation fuel.

The pilot assemblies containing MOX fuel were produced at the Research Institute of Atomic Reactors (RIAR, part of Rosatom) and loaded into the reactor during the first fueling in 2015. Commercial fabrication of MOX fuel started in late 2018; the first batch of serial MOX fuel assemblies was loaded into the BN-800 core in early 2020. One of the most reputable industry media, POWER Magazine, ranked this event among the Top-12 events of the year. During the scheduled maintenance at the beginning of 2021, the reactor was for the first time ever refueled with MOX fuel only, with 160 MOX assemblies loaded into the core.

In general, migration to the core consisting of only MOX fuel assemblies is quite a simple procedure. Refueling operations are performed in accordance with the standard pattern: a third of all fuel assemblies are replaced during each refueling outage. It is planned that the reactor core will be filled with MOX fuel only by the end of the current year.

Fuel fabrication and reactor operation are both totally safe. Following the reactor sustainability assessment by the International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO) in 2012, the MOX-fueled BN-800 design was found to meet the Generation III+ reactor requirements. All the fuel fabrication operations involving high-level plutonium are fully automated. Refueling mechanisms of the BN-800 reactor are also automated, with manual operations minimized.

What is special about the BN-800 design is that the reactor core is surrounded by the breeding zone filled with fertile material (depleted uranium). When irradiated, depleted uranium in that zone turns into nuclear material that can be fabricated into nuclear fuel. This is the essence of the 'closed' nuclear fuel cycle — maximizing the use of natural uranium while minimizing waste. Since natural uranium contains less than 1% of U-235, the inclusion of depleted uranium into the nuclear fuel cycle might increase tens of times the amount of fuel obtained from a single portion of natural uranium.

Along with implementing the closed nuclear fuel cycle based on sodium-cooled fast reactors, Rosatom is the first in the world to

attempt closing the cycle with the use of lead-cooled fast reactors. This project is called Proryv (Russian for “Breakthrough”).

As part of Proryv, Rosatom builds a BREST-type reactor with the capacity of 300 MW and a fuel fabrication and refabrication unit. The BREST-300 reactor will use a new — mixed uranium-plutonium nitride (MUPN) — fuel. As the name suggests, it contains not oxides but nitrides of uranium and plutonium. MUPN fuel is denser than MOX fuel, so it has better plutonium breeding parameters. Researchers test the new fuel and study its performance.

Finally, Rosatom works on the design of a more powerful sodium-cooled fast neutron reactor BN-1200. Last September, three technical councils had a joint meeting to assess the upgraded reactor design BN-1200M (‘M’ stands for ‘upgraded’ or ‘improved’) in the light of the Proryv Project. The design was approved.

The purpose of BN-1200 is to make the closed nuclear fuel cycle a cost-efficient and commercially viable option and enable the migration to the so-called two-component nuclear energy generation scheme. It assumes that VVER and BN-type reactors — the two components of the energy system — will operate in a single process chain. At present, researchers choose an optimal ratio of the fast and thermal reactors.

New design solutions and the latest engineering technology will make the BN-1200 reactor cost-efficient. In particular, the new design provides for the same size of the reactor pressure vessel as BN-800 has, but the reactor will be more powerful. Shorter pipelines and upgraded equipment will make the new reactor less steel-intensive, with more improvements on the list.

Much has already been done for BN-1200 during the construction of BN-800, such as auxiliary pipelines, grid connections and even RPV assembly parts (unlike VVER, BN reactor pressure vessels are not delivered from the plant but assembled right on the construction site).

The new reactor will be constructed by 2035, according to the press service of the Beloyarsk NPP. NL

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In Charge of Northern Sea Route

The Northern Sea Route Directorate stands apart among Rosatom's divisions. Its task is to develop the high-latitude transit corridor between Europe and Asia. The new route is necessary to mitigate maritime traffic risks and offer freight carriers an alternative.

A short way to help

Redirecting some of the cargo traffic to the Northern Sea Route will increase reliability of the global trade flows, Rosatom believes.

The need for a new maritime route, which would supplement the existing corridors, was made clear after several factors — quarantine restrictions in Chinese ports in February and an accident in the Suez Canal in March — came into play in the first half of 2021.

Speaking at the EXPO 2020 session entitled Supply Chain Resilience. Economic Corridor Via the NSR As a New Opportunity For Global Trade, Rosatom's Deputy Director General for Corporate Development and International Business Kirill Komarov noted that the rate of change in maritime supply chains in the last two years was higher than over the past twenty years: **"We have to understand the threats and possibilities this creates because sea logistics costs used to be considered an ordinary thing — if you have to transfer goods from one city to another you just need to pay for it. Now**

we begin managing risks, and tomorrow we will understand that the professional management of logistics and selection of correct solutions could affect the price significantly."

Rosatom realizes the NSR is not a competitor or an alternative to Suez, but a transport corridor with its own niche, opportunities and advantages. Other market players are of the same opinion. **"We see the northern transit corridor as being a viable alternative to the southern transit corridor in terms of servicing the Asia-Europe trade route. And as DP World, we play a major part in the southern trade route and globally through our ports in India, Africa, as well as Saudi Arabia. And we would very much like to be a dominant player together with our partner Rosatom in the northern transit corridor,"** Raj Jit Singh Wallia, Deputy Chief Financial Officer at DP World, said when speaking at the session. Last year, this world leader in global supply chain solutions and the Russian nuclear corporation signed an agreement to pilot container freight traffic on the NSR.

"What the northern route needs to do is to target appropriate customers, target appropriate types of products to ensure that at the end of the day the value chains are taking the full advantage of the benefits this route obviously has," said Paul Holthus, Founding President and CEO of the World Ocean Council.

The NSR grows in popularity with the global market players. In 2021, 86 ships, including 75 foreign-flag vessels, sailed that route to transport over 2 million tons of freight. In 2020, cargo transit on the NSR reached 1.3 million tons.

Access to the NSR becomes easier

In order to make the NSR more attractive to freight carriers, the NSR Directorate works to make it navigable all year round. The Directorate commissions the construction of new icebreakers, improves navigation and infrastructure, builds new terminals and organizes container traffic.

The NSR navigation window is expanding. For example, the Arctic LNG carrier Christophe de Margerie was the first to follow the Northern Sea Route eastwards in January–February 2021. Before that, liquefied natural gas had never been transported on the NSR so late in winter — its delivery to China usually took more than a month with gas carriers sailing through the Suez Canal and Strait of Malacca. The Northern Sea Route is almost a third faster so the decision was made to give it a try. No icebreaker escort was needed when Christophe de Margerie sailed eastwards. When traveling back, the LNG carrier was escorted by the 50 Let Pobedy icebreaker. Both voyages were successful.

In the winter-spring navigation of 2021–2022, the nuclear fleet is gaining more

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operating experience in the eastern section of the Northern Sea Route. In mid-December of 2021, Arktika, the lead Project 22220 nuclear icebreaker, escorted a ship convoy to Pevek (Chukotka). In January and February, Arktika continued its work in the eastern section of the NSR, escorting vessels from Russia's Arctic ports to the Pacific Ocean and back. The navigation in the eastern NSR section used to finish in November. The year-round navigation on the NSR is expected to begin by 2030s.

In late January, Sibir (Siberia), first serial icebreaker of the Project 22220 design, joined the nuclear icebreaker fleet. Right after hoisting the colors, she set off on her first commercial voyage to the Yenisei Gulf and returned as soon as early February.

Rosatom will receive another three Project 22220 icebreakers in the next four years. Ural will be put into operation by the end of this year to be followed by Yakutia in 2024 and Chukotka in 2026. All the icebreakers are built at the Baltic Shipyard; the work is fully on track. Another icebreaker, Rossiya, is under construction at the Zvezda Shipyard. This one is built to Project 15010 (Lider-class) design and will be commissioned in 2027.

The NSR Directorate conducts offshore surveys along the Northern Sea Route to increase the number of recommended waterways. Last year, it completed a bathymetric survey covering 41,500 square kilometers and installed buoys with automatic identification systems. The Directorate is also developing a single

platform for NSR digital services. The platform will integrate digital systems and databases to ensure navigation safety and provide dispatching services on the Northern Sea Route.

New terminal will be built to enable container traffic. Andrey Severilov, Chairman of the Board at Russia's largest private logistics company FESCO, said at EXPO in Dubai that the container terminal agreed with Rosatom would be ready by 2025. The terminal will include a berth and a transshipment yard for intermodal containers at the commercial port of Vladivostok. Necessary permits have been obtained; site surveys and engineering design are underway. As for the western end of the NSR, a logistics hub is planned to be built on the western coast of the Kola Gulf. **"A new stage of international transit will begin in 2025 — the western endpoint of the corridor will be situated in the Murmansk Region, near Murmansk,"** Rosatom's special envoy Vladimir Panov said at a meeting with the Governor of Murmansk Region, Andrey Chibis.

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Recognition in Europe

The European Commission adopted (with some reservations) an act amending the EU Taxonomy to include natural gas and nuclear energy. Nevertheless, this is an important step towards the worldwide recognition of nuclear energy as a safe and sustainable power source. This issue was raised to the political level in, perhaps, the last region where the development of nuclear generation was slowed down because of the position of certain countries.

What happened

On February 2, 2022, the European Commission approved a complementary delegated act that amended the EU Taxonomy and included the natural gas and nuclear energy-related activities into it.

The EU Taxonomy is a list of economic activities and technical screening criteria for investors to identify whether certain activities are sustainable or not. The first version of the Taxonomy included neither natural gas nor nuclear energy. The gas-related economic activities were blamed for carbon dioxide emissions, while the nuclear sector was said — often quite vaguely — to be liable for hazardous waste.

However, as time passed by, the attitude of politicians and the general public towards nuclear energy began to change. The key argument in favor of nuclear generation is its carbon-free nature. The fact that nuclear stations produce less emissions than any other source of electricity, including renewables, was confirmed by the UNECE. **"A UNECE technology brief notes the potential role of nuclear power — which currently provides 20% of electricity generated in the region and 43% of low-carbon generation — to decarbonize the energy system and energy intensive industries, as part of a broader portfolio alongside deploying other sustainable low- or zero-carbon technologies,"** the UNECE Climate Action brochure says.

Publication of the final version of the Complementary Delegated Act was preceded by numerous consultations and extensive research. First, the Joint Research Centre (JRC), the European Commission's science and knowledge service, prepared a technical assessment of nuclear energy (see the JRC Findings for details). Then the JRC report was reviewed by radiation protection and waste management experts who generally agreed with the findings of the report while making some observations. In particular, uranium mining and milling activities were not included in the Delegated Act. It should be said, however, that the uranium industry in the EU will not be affected since there are almost no uranium mining operations in Europe.

The document says the Commission rejected some of the criticism of the natural gas and nuclear sectors as it seemed inconsistent with the provisions of the Taxonomy Regulation.

The draft Delegated Act was sent out to the EU Member States on the last day of 2021. Comments could be filed back until January 21, 2022. During the next two weeks, the document was refined and finalized.

What will happen next

On February 2, the document was submitted to the European Parliament and Council of the European Union for consideration. It cannot be amended at this stage but only adopted or rejected in its entirety. The European lawmakers now have four months to discuss the amendments. If necessary, the time period can be extended to six months. That is, the deadline for taking the final decision is August 2, 2022.

For the amendments to come into force, they need to be adopted by two institutions. The European Parliament makes decisions by simple majority. In the Council, it will be enough if more than 28% of the Member States or the Member States representing more than 35% of the population vote for the decision. It is only Austria and Luxembourg that are against the amendments for now. Since the amendments include gas in the Taxonomy, Germany will not vote against them as it considers the inclusion of natural gas a true victory. It is not surprising,

though — Germany benefits most from the distribution of pipeline gas in Europe.

If the document is adopted, the amendments will come into force on January 1, 2023.

What is in the document

The Taxonomy will include three groups of activities related to nuclear energy. The first group comprises research and development of advanced nuclear reactor technologies that would minimize the production of high-level radioactive waste. The second group incorporates construction and safe operation of new nuclear installations using best available technologies to generate power and heat and produce hydrogen. Third, this is production of electricity at the existing nuclear power plants.

The technical screening criteria related to the nuclear sector should reflect the highest standards of nuclear safety, radiation protection and radioactive waste management throughout the life cycle of each nuclear installation. This refers to the application of the defense-in-depth principle and an effective safety culture to minimize the impact of extreme hazards. Service life extension projects should also meet the highest safety standards.

Starting from 2025, the European Commission will review technical parameters for the best available technology at least once every ten years.

Another technical screening criterion is the use of the so-called accident-tolerant fuel from 2025. It should be certified and approved by the national regulator of the country that plans to launch the relevant project.

The Taxonomy will also include technical screening criteria for nuclear reactors that use closed fuel cycles or self-breeding fuels that minimize the production of high-level radioactive waste. The proposed amendments to the Taxonomy refer such amendments to Generation IV.

Investments in the development of the closed fuel cycle and self-breeding fuel should be subject to technical assessments. The European Commission should be informed of them and give its approval.

The technical screening criteria for nuclear projects also provide that certain financial resources should be in place to finance radioactive waste management and decommissioning programs. It is also required that waste generators should bear responsibility for managing waste and that radioactive waste should not be exported to third countries for disposal. It is assumed that placing radioactive waste into disposal facilities in the EU Member States is acceptable provided there is an agreement to this effect.

The Member States should include planning and implementation of disposal options in their national policies, as well as develop and operate disposal facilities by 2050. They also have to report regularly on the sufficiency of financial resources and the progress in building disposal facilities.

Transparency of information is another requirement. To make information comparable, a special template was developed to include project performance indicators.

According to a press release by the World Nuclear Association, the inclusion of nuclear energy into the EU Taxonomy is a **"very welcome development that will help assure institutional investors that nuclear power projects are aligned with the EU sustainability goals."**

"The adoption of this CDA is a hugely important milestone that the international financial community cannot afford to ignore. Nuclear energy is essential for the low-carbon energy transition and will be part of the EU future energy landscape for many decades to come," WNA Director General Sama Bilbao y León was quoted in the press release as saying.

Rosatom regarded the event as the most logical outcome. **"When climatic goals become more complex, it is hardly possible to ignore the already existing low-carbon technologies, especially when the UNECE calls nuclear energy a source with the lowest CO2 emissions across the life cycle,"** says a press release published by the Russian nuclear corporation.

Controversial requirements

Some of the technical screening criteria, however, do not allow nuclear projects to be recognized as sustainable and therefore restrict investments in them. For instance, life extensions of the existing nuclear reactor meet the criteria of the Taxonomy only if such extension projects are approved no later than 2040. New capacities should be put on the plan before 2045. It is absolutely unclear why those time limits were chosen.

No less unclear is the requirement to use accident-tolerant fuel only. **"These requirements go beyond existing national and European nuclear regulation and will be challenging, and in some cases impossible, to implement,"** the WNA press release says. **"In reality, the existing EU regulations that govern all aspects of nuclear energy generation, including the long-term management of used nuclear fuel and radioactive waste, are more than sufficient to ensure the safe and environmentally sustainable operation of nuclear facilities,"** Sama Bilbao y León is sure.

The World Nuclear Association hopes that the criteria will be adjusted upon revision in accordance with the latest scientific data. This is a task for the future, though. Rosatom believes that the near-future priority for

the entire nuclear community should be a detailed analysis of the amendments to the Taxonomy and preparation of documents for the official qualification of the projects, which will start in 2023.

"It is definitely important for us that Europe will continue using this [nuclear — RN] technology. Nuclear ideas should exist at different venues," Rosatom Director General Alexey Likhachev said when speaking at the Gaidar Forum in January 2022. Rosatom has joint projects with France and Germany in research and development, decommissioning and other fields. **"At COP-26, we witnessed a small but true revolution. Until then nuclear technology had been more of an outcast technology in the UN programs. After COP-26, people started talking about what nuclear energy and on what terms should be included in, roughly speaking, the global taxonomy,"** Alexey Likhachev said.

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JRC findings

1. Nuclear energy can make a substantial contribution to the climate change mitigation objective and meanwhile does not do significant harm to the other four environmental objectives of the Taxonomy Regulation provided that it meets the proposed technical screening criteria;

2. Deep geological repositories can be considered — at the state of today's knowledge — appropriate and safe means of isolating spent fuel and other high-level radioactive waste from the biosphere for very long time scales and the necessary technologies are now available;

3. Where and when the environmental impacts are potentially harmful, appropriate measures to prevent the impacts or to mitigate their consequences can be implemented using existing technology; and

4. Compliance with the provisions of the Euratom legislation and licensing processes provides sufficient confidence that the impact of the nuclear energy full lifecycle, including the back end of the nuclear fuel cycle, on humans and the environment remains below harmful levels