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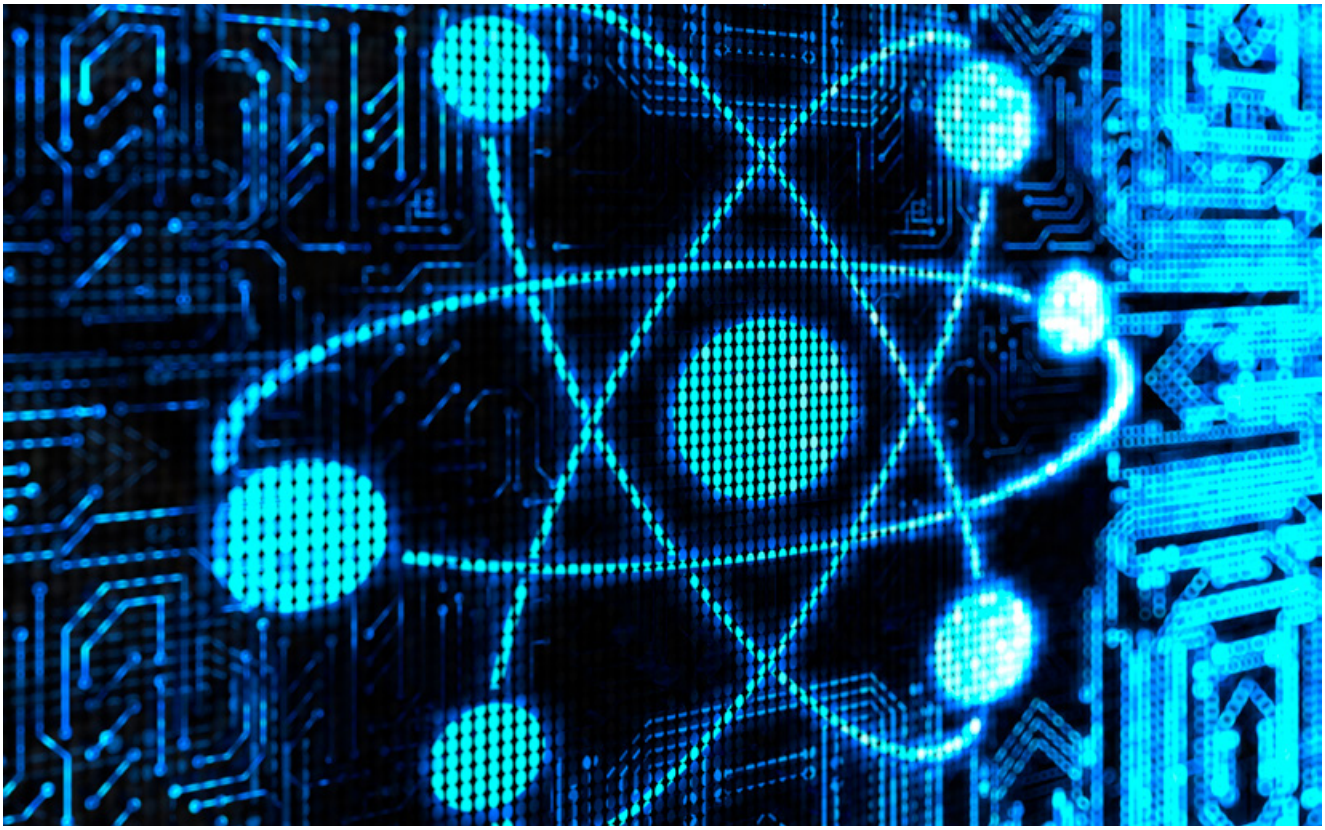

Quantum Breakthrough

Having presented its quantum computing development roadmap to the government, Rosatom concentrates efforts in quantum technology. A recently established management office for quantum computing projects will bring together researchers and developers to create different physical implementations of quantum processors.

Rosatom follows the government-approved Quantum Computing Roadmap in its efforts to develop a quantum processor. It was prepared as part of the wider reaching Quantum Technology Roadmap (see Quantum Technology in Russia for details - RN) and presented to the Russian government in December. More than 100 experts took part in the development of the Quantum Computing Roadmap.

It was Rosatom's initiative to prepare roadmaps for seven end-to-end digital technologies, and Quantum Technology was one of them. It provides for the development of three technology applications, including quantum computing, quantum communications quantum sensors and metrology. The budget of the program is RUB 51.1 billion, including RUB 8.7 billion to be contributed by private companies. Russia must not delay investments in quantum technology, the roadmap says.

The research and development work will be focused on exploring a number of possible physical implementations of quantum computers and simulators, including:

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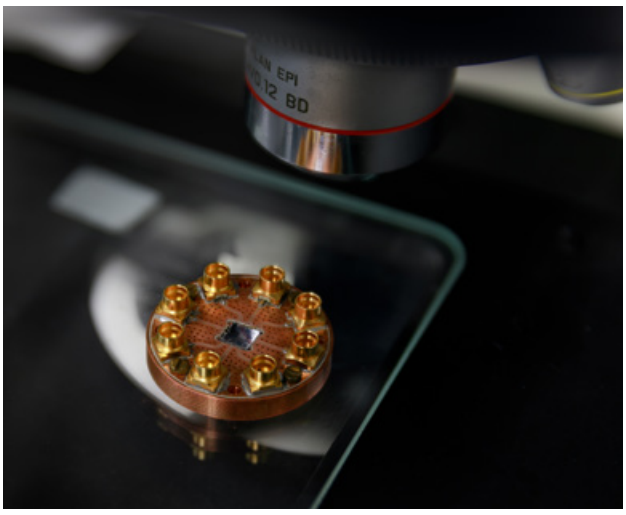
- Semiconductors
- Neutral atoms
- Trapped ions
- Linear optics and integrated photonics
- Polariton condensates
- Dopant atoms and silicon quantum dots

Other areas of research and development comprise quantum error correction schemes, cloud-based quantum computing platform and simulator, and quantum algorithms.

Such a wide range of activities is attributable to the fact that it is not clear yet what physical implementation (superconductors, atoms, ions or anything else) will be used to build the first generation of quantum computers.

Rosatom has established a project management office that will coordinate research activities in quantum computing, involving a number of Rosatom Group companies engaged in the development and production of I&C systems for nuclear power plants. Dukhov Automatics Research Institute (VNIIA) will be responsible for superconductor-related research, while Rusatom Automated Control Systems (RASU) will deal with research in trapped and dopant ions. Rosatom's quantum projects will also involve experts and researchers from the Russian Quantum Center (RQC), Skolkovo Institute of Science and Technology (Skoltech), other research institutes and universities. For example, hardware for the trapped-ion quantum computing solutions will be produced by teams from RQC and the Russian Academy of Sciences Lebedev Physical Institute (LPI RAS), while software for this experiment will be developed at Skoltech and Russian Academy of Sciences Valiev Institute of Physics and Technology (FTI RAS).



Experiments will be partly staged in existing laboratories. For instance, experiments on superconducting quantum computing will be carried out using cryogenic equipment in the laboratories of the National University of Science and Technology (MISIS), Moscow Institute of Physics and Technology (MIPT), RQC, VNIIA, and Bauman Moscow State Technical University (Bauman MSTU). RQC also hosts laboratories involved in other areas of quantum research. New laboratories provided for in the roadmap will be also scattered across a number of sites.

Sources of finance for the Quantum Technology Roadmap are mixed and include grants, subsidies, and other funds. Allocation of the funds has already begun. In a press release published in January, RASU confirmed that its consortium with RQC had been awarded a RUB 300 million 3-year grant from the Russian Venture Company for the development of quantum technology.

"Our goal is to create a prototype of an ion-based quantum computer and provide a cloud access to it. It will be a platform that will enable users to run quantum algorithms by accessing the computer

over the Internet. We will also attempt to find solutions for optimization and management tasks that are of interest for Rusatom Automated Control Systems," says Prof. Alexey Fedorov, Team Lead for Trapped Ion Quantum Computers and Simulators.

Quantum computing targets for Russian-designed quantum processors (from the Quantum Technology Roadmap)

Item	2019	2021	2024
Number of qubits in a superconductor-based quantum computer	2	5-10	30-50
Number of qubits in a neutral atom quantum computer	10	50	100
Number of qubits in an ion-based quantum computer	1	5	55
Number of channels in a photonic quantum computer	10	50	100
Number of particles in a polariton-based quantum computer/ simulator	50	100	1000
Number of experiments on the cloud-based quantum platform	0	20	10000

Quantum processors are capable of making calculations much faster than the most powerful upercomputers existing today. This super high computational speed is required to solve tasks in cybersecurity, artificial intelligence, development of new materials and new means of energy storage.

Russia needs quantum technology to keep pace with other developed countries and maintain its national security and technological independence.

Commercial use of quantum computing is far ahead, but it has been demonstrated that a quantum computer having several dozens of qubits can make calculations that cannot be made by a supercomputer with the same or at least comparable speed.

Rosatom Unites Engineering Designers

Rosatom mergers its three engineering design subsidiaries into the united design institute, aiming at higher quality of design services and timely delivery of orders.

After the merger is completed, all engineering design companies of Rosatom Group will act as a single team and follow uniform production standards.

How the institute is formed

The institute will comprise three of Rosatom's engineering design organizations located

in Nizhny Novgorod, Moscow and Saint Petersburg. Each of them has its own established practices and expertise, which will be adjusted where necessary and harmonized. The new institute will have uniform standards for staff qualifications, infrastructure and IT systems.

Atomstroyexport (an engineering subsidiary of Rosatom, ASE) Vice President Ruben Topchiyan was appointed Director of the the united design institute - he will hold two positions concurrently. Directors of individual design institutes became first deputies to the institute Director. After the reorganization, they will be able to focus on performance targets without being distracted by auxiliary functions, which used to consume much time and effort.

Along with changes in the organizational structure, quality is also expected to improve. The work will be centered on eleven projects included in the VVER-based NPP Design Improvement program (see the Projects of the Program table below).

New generation of managers

It is important that changes are initiated from inside, rather than forced upon employees

by the top management. The transformation program involves a total of 279 employees, including 23 top-level officers and 61 mid-level managers. Working jointly with heads of production and functional units, they participate in project meetings, accumulate information and acquire engineering design and project management competencies. According to Andrey Vilyaev, Director for the institute Development Program and Manager of the BOO (Build - Own - Operate) Project Management Office at ASE Engineering Company, these are the people who will become highly qualified engineers and managers and improve efficiency of production processes as heads of particular functions in the organization. He said, **“For example, our employees had a chance to work closely with the Finnish regulator, one of the most demanding regulators in the world, on the Hanhikivi project. Thanks to the new experience, they learned a new approach to design and project management. We have a totally new generation of employees who have been promoted to management positions.”**

Process already underway

During 2019, design processes in all three design institutes were analyzed carefully and discussed in details. The discussion resulted in a comprehensive plan approved by all the stakeholders on how these processes could be transformed to become more efficient.

In 2020, the plan will be implemented step by step. For example, there will be a new approach to preparing project network diagrams. They used to be prepared for individual projects only, but now they are made for each project, each business unit and the institute in general. Reporting forms

will be standardized, too. Uniform reports are necessary to have a bird's eye view of the work scope at a particular time, as well as its detailed representation.

Network diagrams will be integrated with resource profiles, which show the number of design engineers and their specialization, current and expected availability, and standard workload. This is a full-fledged management tool that allows managers to proactively respond to changes in the workload of employees and make the right decisions. For instance, the institute can re-train its employees for a similar profession or position, hire new engineers or review the project schedule and adjust it, if possible. This approach engages employees from all three institutes and allows them to work on any project, making the process more efficient. **"If there is a shortage of electrical engineers in Moscow, we see whether we can engage engineers from Saint Petersburg,"** Andrey Vilyaev explains.

Since project network diagrams and resource plans are optimized, project cost estimates become more accurate. From now on, project budgets are based on updated information and new economic planning rules.

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Those design projects that have reached an advanced stage will use a limited scope of new rules and methods – improved practices will be integrated into the existing processes as carefully as possible. Construction of a nuclear power plant in Uzbekistan will be the first project to pilot the full range of new practices. NL

Projects of the Program

- Standardization and harmonization
- Data structures and libraries
- Integration of IT systems
- Engineering design methodology
- Design tools and customer relationship management systems
- Quality management
- Requirement, configuration and change management
- Project time management, project scheduling/planning and reporting
- Resource management
- Financial planning and reporting
- Efficiency improvements in the translation of project documents

Going Green

Europe is discussing criteria of sustainability for various industries. Providing funding for the development of nuclear depends on whether it is considered sustainable.

Sustainable finance for nuclear projects was one of the key topics at the Annual Nuclear Conference 2020 held by Swedish research institute Energiforsk. The conference brought together energy strategy experts from European countries, representatives of public organizations, the IAEA and nuclear station operators to discuss the role of nuclear power in the region. Speaking at the conference, Polina Lion, Rosatom Chief Sustainability Officer, told the audience how the Russian nuclear corporation dealt with the requirements and limitations imposed by financial organizations.

One of the problems discussed at the conference is a limited risk appetite that is a level of risk that a bank is prepared to accept in making investments into large-scale projects, including nuclear construction.

As international practice shows, commercial metrics alone do not make much sense for nuclear power plants. Every nuclear construction project costs many billions of dollars and is intended for more than half a century of reliable service. Taking into account construction, possible service life extension and decommissioning, the time horizon of the project can reach up to 100 years. The benefits of a nuclear project are not measured only in money earned from the power generation, but in economic development stimulated by reliable power supply, better education, science and technology, and improved quality of life. These benefits are hard to express in terms of measurable income.

Philosophy and practices of commercial banks are different: they usually expect a quick return on investment, so it is not a regular thing for them to provide multi-billion finance for technology-intensive projects with long payback periods.

A common ground does exist, though. Having respect for the position of commercial banks, Rosatom assumes that a complex nuclear construction project can be first distributed into several "building blocks", such as electrical machinery, I&C systems, work done by local subcontractors, etc. Second, the financial model of such projects may involve export agencies, which support exports of value-added products, particularly high-tech products, and insure exporters against commercial risks. In Russia, it is the Russian Agency for Export Credit and Investment Insurance (EXIAR). Similar agencies exist in other countries, and they work with customers planning to build a nuclear power plant.

Nuclear seeks inclusion into development banks' mandates

It seems logical that nuclear power plants as infrastructure projects contributing to the development of national economies and well-being of people should be financed by development banks, such as the World Bank and its regional divisions or the Asian Infrastructure Investment Bank founded at the initiative of China. These banks finance construction of large ports, technically challenging bridges and highways that cost many billions of dollars and have long payback periods (or sometimes bring no return at all).

However, mandates of development banks (documents defining the scope of industries

and projects they are willing to finance) often specify that nuclear power projects are not considered as investment targets. Things sometimes goes against logic, for example, earlier Rosatom Newsletter wrote that the African Development Bank was ready to finance biomass energy projects (carbon-intensive projects), but was unwilling to finance nuclear power plants.

One might wonder why this happens. It is safe to assume that people are afraid of nuclear power. It was repeatedly mentioned at the Energiforsk's Conference that people were not informed about the advantages of atomic energy.

Public opinion surveys confirm this point of view. According to a poll conducted by France-based Orano Group last June, 69% of respondents are sure that nuclear power plants emit greenhouse gases. Even less is known about applications of nuclear energy or multi-level protection and safety systems.

Large power plants are far from being the only application of nuclear technology. Another good example are nuclear science and technology centers offered by Rosatom. They include a research reactor, different laboratories and multi-purpose irradiation facilities. For example, such facilities

could be used to disinfect grain, fruit and vegetables. Since irradiated agricultural produce has a longer shelf life, this improves yield (seeds do not rot, have better storage life and higher germination) and supports exports (irradiated products meet safety requirements for imported foods). Research reactors could also be used to produce medical isotopes for diagnostics and cancer treatment. Construction and operation of a nuclear science and technology center helps train local staff and educate students in nuclear physics, material science and other fields of fundamental and applied physics. This knowledge and expertise will later contribute to the development of the national nuclear infrastructure and prepare the country for the potential construction of a nuclear power plant. Finally, a nuclear science and technology center helps raise public awareness of nuclear technology and give local researchers first-hand experience.

It turned out, though, that international development banks are not willing to finance any projects involving nuclear technology, not just nuclear power plants. Is this a game over? Or is it possible to convince banks otherwise?

It seems that a more detailed description of finance requirements for nuclear projects

could be a solution to the problem. A positive example here is a new wording that, despite Germany's nuclear power phase-out, was included into the mandate of Euler Hermes, one of the world's largest export agencies specializing in export credit insurance. Now it reads, **"In line with previous practice, Hermes Cover is not available for the delivery of goods and services for nuclear power stations. This basic exclusion does not apply to transactions whose purpose is to enhance the safety of existing facilities or are required for the shutdown, dismantling and disposal of nuclear power stations. Likewise, goods and services not related to commercial electricity production, e.g. research reactors and nuclear medicine equipment, are exempt from this exclusion."** It should be noted that Euler Hermes is wholly owned by German Allianz SE.

"Explaining benefits of nuclear technology and maintaining a dialog with development institutions will finally help make their mandates more specific," Polina Lion stressed.

Europe defines criteria for green investments

There was much work done in the European Union over the last two years to establish uniform "sustainable" finance standards for different industries and projects. This work was necessary for financial institutions to have clear differentiation criteria for which industries and projects are "green" and "sustainable" and which are not. Banks and investment funds use the criteria to make their loan portfolios as sustainable as possible – this information is regularly disclosed in sustainability reports.

TRENDS

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In December 2016, the European Commission established the EU High-Level Group (HLEG) on Sustainable Finance to help develop an overarching and comprehensive EU roadmap on the issue. On 31 January 2018, HLEG published its final report that presented the concept of sustainable finance and defined two imperatives for the EU's financial policy framework. The first imperative is to improve the contribution of finance to sustainable and inclusive growth. The second is to strengthen financial stability by incorporating environmental, social and governance (ESG) factors into investment decision-making. HLEG also made eight cross-cutting recommendations for the European financial industry to meet sustainability criteria.

In May 2018, the European Commission established the EU Technical Expert Group (TEG) on Sustainable Finance that had two tasks. The first was to establish the so-called EU sustainability taxonomy, that is a general framework for the development of an EU-wide classification system for environmentally sustainable economic activities. In June 2019, the TEG published a sustainable taxonomy report, which is being currently updated.

"The Commission will regularly update the technical screening criteria for the transition and enabling activities. By 31 December 2021, it should review the screening criteria and define criteria for when an activity has a significant negative impact on sustainability," the European Commission said in December 2019.

The TEG's second task was to develop the EU Green Bond Standard. The relevant technical report was also published in June 2019. The TEG proposed that the Commission created a voluntary, non-legislative EU Green Bond Standard **"to enhance the effectiveness,**

transparency, comparability and credibility of the green bond market and to encourage the market participants to issue and invest in EU green bonds."

By the end of 2019, the EU formulated the Green Deal concept. **"The European Green Deal is our new growth strategy. It will help us cut emissions while creating jobs,"** Ursula von der Leyen, President of the European Commission, said. The strategy sets out, **"The European Green Deal is a response to these challenges. It is a new growth strategy that aims to transform the EU into a fair and prosperous society, with a modern, resource-efficient and competitive economy where there are no net emissions of greenhouse gases in 2050 and where economic growth is decoupled from resource use."**

As part of the Green Deal, the European Commission expects to acquire at least EUR 1 trillion in sustainable investments over the next decade.

Some of this money is expected to flow in through the Just Transition Mechanism (JTM), a financing scheme for sustainability projects aimed at achieving carbon neutrality and other goals of the European Green Deal. Information about the JTM was published by

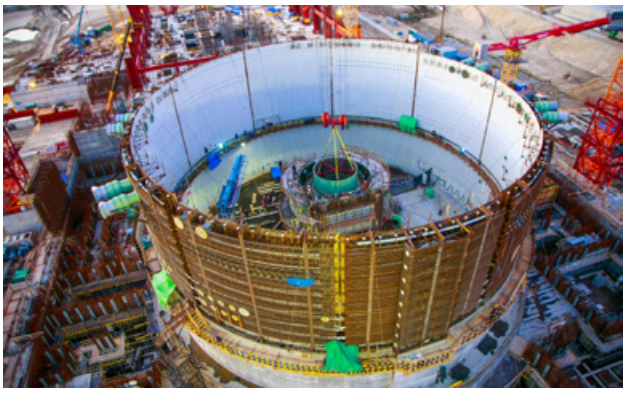
the European Commission in January 2020. The JTM provides for the mutualization of risks carried by public and private investors, technical support and advice. The Just Transition Mechanism consists of three main sources of financing:

- A new EUR 7.5 billion Just Transition Fund expected to generate at least EUR 30–50 billion of investments;
- Invest EU 'Just Transition' scheme to mobilize EUR 45 billion of investments;
- A new public sector loan facility with the EIB backed by the EU budget to mobilize EUR 25–30 billion of investments.

Every euro in the Just Transition Fund is expected to attract 1.5–3 euros from the European Social Fund and the European Regional Development Fund. Altogether, the JTM provides targeted support to help mobilize at least EUR 100 billion. The money will be used to finance employee retraining programs and projects aimed at improving access to clean, reliable and secure sources of electric power.

Reliable nuclear is in an unreliable position in Europe

Documents of the European Commission reflect a mixed attitude towards nuclear power. A perfect example is the sustainable taxonomy report published in June 2019. The section dealing with nuclear energy reads, **"Evidence on the potential substantial contribution of nuclear energy to climate mitigation objectives was extensive and clear. The potential role of nuclear energy in low carbon energy supply is well documented."** The only challenge – the absence of a final solution to the nuclear waste problem – mentioned later in the report brings the TEG to an opposite conclusion, **"Given these limitations, it was not possible for TEG, nor its members, to conclude that the nuclear energy value chain does not cause significant harm to other environmental objectives on the time scales in question. The TEG has not therefore recommended the inclusion of nuclear energy in the Taxonomy at this stage."**



In December 2019, debate sparked between the European Commission and the EU Parliament over whether gas and nuclear generation should be included into the list of sustainable sources of power. This will define which power plants are not considered sustainable in the European Union and should be discontinued. As a result, nuclear and natural gas remained on the sustainable list. **"The EU Parliament and member states had sparred over the recognition of nuclear power, and of natural gas as a "transition" source of energy. France, Britain, and Eastern EU countries—the Czech Republic, Hungary, Poland, Slovakia, Romania, Bulgaria, and Slovenia—rejected an earlier deal proposed last week that excluded nuclear power and natural gas,"** Powermag.com commented on the December debates.

The wording of the report does not fully rehabilitate nuclear or gas, but it does

not exclude them from the Green Deal or sustainable activities either, **"The text does not preclude or blacklist any specific technologies or sectors from green activities, apart from solid fossil fuels, such as coal or lignite. Gas, and nuclear energy production are not explicitly excluded from the regulation, however. These activities can potentially be labeled as an enabling or transitional activity in full respect of the "do not significant harm" principle."** However, if the emission limits set for the energy industry (100 g CO2eq per kWh to be reduced to zero by 2050) are not changed, gas power generation will not fall within the scope of sustainable activities.

"The final decision as to the "color" of nuclear energy has not been made yet and, even if made, will be non-regulatory as is the entire Taxonomy. If it is finally concluded that nuclear meets sustainability criteria, this will be good. The industry will have access to cheaper commercial finance or at least will not be refused finance for not meeting the bank's mandate. But even the status of a "transition" source of energy offers an opportunity to continue the dialog with financial institutions, which will be busy with developing their own internal rules and regulations for sustainable deals," Polina Lion explained.

Participants of Energiforsk's Conference realize this. The discussion at the Conference was centered on how the industry understands taxonomy metrics and how adequate they are for the nuclear power industry.

According to a representative of Europe's trade association for the nuclear energy industry FORATOM, TEG members working on the sustainable taxonomy were divided into two sub-groups. Some of the experts were looking for advantages of each industry and its positive impact on the environment. They evaluated carbon dioxide emissions (carbon footprint over the entire project life in particular industries). They asked matter-of-fact questions and soon draw definitive conclusions. The other expert group, which was assessing negative impacts of the nuclear energy industry on the environment, could not long reach a consensus on specific countable metrics. It was difficult for TEG members, many of whom are not experts in the nuclear industry, to remain calm and unemotional.

As for now, the government is the only reliable source of finance for the nuclear power industry all over the world. With this in mind, governments and industry organizations interested in obtaining sustainable finance should work jointly on developing criteria that would fully reflect the contribution of nuclear energy to the achievement of the UN Sustainable Development Goals. Nuclear contributes to the achievement of at least six of those, including access to clean energy, decent work and economic growth, innovations and infrastructure, sustainable consumption and production, global partnerships for sustainable development, and climate action. Considering these facts, it should be a no-brainer for the European regulators to put the nuclear industry on the sustainable list. NL

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Construction of the Rooppur NPP in Bangladesh