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New Nuclear Technologies: Problems and Prospects of Their International Legal Regulation

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Abstract. The article is devoted to practical and legal aspects of small modular reactors (SMRs). Their technology combines safety and a variety of flexibilities, such as reasonable costs, longer terms of operation without refueling and mobility. SMRs can be used locally in remote areas with severe climatic conditions, such as Arctic region. SMRs have great export potential. The question arises how SMRs fit into rules of International Law?
The research was based on the legal analysis on SMRs' application in the system of national and international legal regulations – nuclear, maritime, environmental and tort law. The analysis showed that there are several gaps and grey areas in SMRs' export scenarios implementation, which are described below.

Keywords: new nuclear technologies, international legal regulation, small modular nuclear power plants, application in the Arctic, cross-border operation.

Research area: law.

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Новые ядерные технологии: проблемы и перспективы международно-правового регулирования

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Аннотация. Статья посвящена практическим и правовым аспектам использования малых модульных АЭС. Технология малых модульных атомных реакторов (ММР) совмещает в себе необходимый уровень безопасности и ряд преимуществ, таких как доступная стоимость, длительный срок эксплуатации без перезагрузки ядерного топлива, мобильность и доступность к отдаленным территориям. Малые АЭС могут использоваться в труднодоступных районах с суровыми климатическими условиями, например в Арктике. ММР обладают серьезным экспортным потенциалом. Основным вопросом остается – насколько действующие международно-правовые нормы применимы к регулированию трансграничной эксплуатации малых модульных атомных электростанций.
Исследование основано на правовом анализе национальных и международных правовых документов в областях ядерного, морского, природоохранного и деликтного права на предмет их применимости к регулированию процесса эксплуатации малых модульных АЭС. Результаты проведенного правового анализа продемонстрировали, что существуют определенные пробелы и серые зоны в сферах эксплуатации ММР, описанные ниже.

Ключевые слова: новые ядерные технологии, международно-правовое регулирование, малые модульные атомные электростанции, применение в Арктике, трансграничная эксплуатация.

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Introduction

World economy forecasts confirm that energy consumption will continue to grow in the coming decades. The largest part of fuels for power plants is still carbons, which account for nearly two-thirds of global greenhouse gas emissions[1]. At the same time, most countries are determined to become carbon-free by the middle of the 21st century. In accordance with the EU long-term Strategy 2050, the countries of the European Union aim to become completely climate-neutral by 2050[2]. The COVID pandemic pushed decision-makers to prioritize green recoveries over unsustainable strategies[3].

[1] A Small Source of a Large Energy. Tass News Agency. Available at: https://tass.ru/spec/asmm (accessed April 30, 2022)

[2] 2050 long-term Strategy. European Commission official website. Available at: https://ec.europa.eu/clima/eu-action/climate-strategies-targets/2050-long-term-strategy_en (accessed April 30, 2022)

[3] Transitions to low carbon electricity systems: Key economic and investments trends. IAEA official website. Available at: https://www.iaea.org/sites/default/files/21/06/transitions-to-low-carbon-electricity-systems-changing-course-in-a-post-pandemic-world.pdf (accessed April 30, 2022)

To achieve this goal nuclear energy can play an indispensable role. Today, nuclear power generates ~10–11 % of the world's electricity. It already "provides more than a quarter of the world's clean power". The International Atomic Energy Organization (IAEA) and other international centers have recently examined this issue in several reports in connection with the climate change. The Agency contends that "nuclear energy provides access to clean, reliable and affordable energy, mitigating the negative impacts of climate change. It is a significant part of the world energy mix and its use is expected to grow in the coming decades"[4]. In 2021 the IAEA released a Report ahead of COP26 Climate Summit on Nuclear Energy for a Net Zero World[5]. The Report highlights nuclear power's crucial role in achieving the goals of the Paris Agreement[6] and Agenda 2030 for Sustainable Development[7] by displacing coal and other fossil fuels, enabling the further deployment of renewable energy[8].

Globally, more than 400 nuclear reactors are in operation in 30 countries nowadays[9]. Although some countries, like Germany, decided to phase out their nuclear reactors, more than other 30 countries are considering options to obtain nuclear power plants (NPP)[10]. Some of these countries are current leaders in NPPs' construction, such as China, France, Russia and the USA[11]. Other countries are fostering their first NPPs. These are – Belarus, Turkey, Bangladesh and the UAE[12].

Most of the current NPPs are the so-called high-energy reactors. Their energy output is around 700–1000 MW(e). They are imperative either for countries with a lack of fossils or in need of energy independence. Generally, they are used in industrialized regions with high energy demand especially for metallurgical, shipbuilding, machinery, automobile and other heavy manufacturing productions. Obviously, NPPs construction and maintenance is rather expensive. It requires trained local personnel, developed material and legal infrastructure.

In the meantime, the world nuclear industry is on the verge of transformation and transition to some new innovative technologies.

In order to make a significant boost in the global nuclear energy, the IAEA and nuclear producers are searching for cutting-edge technologies. One of the options is the development of fast-neutron reactors which generate more fissile material than they consume and can burn the radioactive waste. Those reactors work as a closed fuel cycle and thus support long-term nuclear power development and decrease the nuclear waste burden[13]. Still, such modern technologies are mostly under development and are costly as well. It is only Russia that operates one industrial Fast Reactor with 2 units (BN-600 and BN-800) at the Beloyarsk nuclear power plant in the Sverdlovsk region[14].

[4] Nuclear energy, safe use of nuclear power. IAEA official website. Available at: https://www.iaea.org/newscenter/news/iaea-at-cop26-how-nuclear-power-and-technologies-can-help-tackle-climate-change (accessed April 30, 2022)

[5] IAEA Report on Nuclear Energy for a Net Zero World. IAEA official website. Available at: https://www.iaea.org/sites/default/files/21/10/nuclear-energy-for-a-net-zero-world.pdf (accessed April 30, 2022)

[6] Paris Agreement 2015. UN official website. Available at: https://www.un.org/en/climatechange/paris-agreement (accessed April 30, 2022)

[7] Transforming our world: the 2030 Agenda for Sustainable Development. UN official website. Available at: https://sdgs.un.org/2030agenda (accessed April 30, 2022)

[8] IAEA Releases Report on Nuclear Energy for a Net Zero World Ahead of COP26 Climate Summit. IAEA official website. Available at: https://www.iaea.org/newscenter/pressreleases/iaea-releases-report-on-nuclear-energy-for-a-net-zero-world-ahead-of-cop26-climate-summit (accessed April 30, 2022)

[9] Nuclear power reactors. IAEA official website. Available at: https://www.iaea.org/topics/nuclear-power-reactorshttps://www.iaea.org/topics/nuclear-power-reactors (accessed April 30, 2022)

[10] Advanced Reactors Information System (ARIS). IAEA official website. Available at: https://www.iaea.org/resources/databases/advanced-reactors-information-system-aris (accessed April 30, 2022)

[11] Operational § Long-Term Shutdown Reactors. Power Reactor Informational System. IAEA official website. Available at: https://pris.iaea.org/PRIS/WorldStatistics/OperationalReactorsByCountry.aspx (accessed April 30, 2022)

[12] Plans For New Reactors Worldwide. World Nuclear Association official website. Available at: https://www.world-nuclear.org/information-library/current-and-future-generation/plans-for-new-reactors-worldwide.aspx (accessed April 30, 2022)

[13] Fast-Neutron Reactors. IAEA official website. Available at: https://www.iaea.org/topics/fast-reactors (accessed April 30, 2022)

[14] Modern Reactors of Russian Design. Rosatom official website. Available at: https://www.rosatom.ru/en/rosatom-group/engineering-and-construction/modern-reactors-of-russian-design/ (accessed April 30, 2022)

There is another affordable technology which combines the required safety and such flexibilities as reasonable costs, longer terms of operation without refueling, mobility and easy access to remote territories. These advantages are associated with small modular reactors (SMRs)[15].

Theoretical framework. SMRs as a New Trend in the Global Nuclear Energy Market

Small SMRs are actual nuclear reactors which use nuclear fission to generate electricity or to create heat and desalinate water[16]. Their power output is less than 300 megawatts (MWe) which is about one-third of a generating capacity of traditional high-energy nuclear power reactors. They are fully factory produced and loaded with fuel. They could be factory-assembled in different modules and delivered as a unit to the customer on a turnkey basis. They are so compact that could be transported by railways or even in trucks.

Larger SMRs (more than 300 MWe) are designed primarily for on-grid power generation in order to replace oil and coal power plants. Smaller SMRs, in their turn, could create an alternative to diesel generation in remote communities and at mining sites.

SMRs definitely offer savings in cost and construction time. The OECD Nuclear Energy Agency notes that a rapid SMR uptake could help to avoid 15Gt of carbon emissions by 2050[17]. As for safety, the IAEA experts explain that SMRs rely on reactor's passive safety systems. It means that in case of emergency no human or external intervention is needed to shut down the reactor, and that provides increased safety margins.

Although SMR is a new nuclear technology that is not directly associated with conventional nuclear plants, it offers the operational flexibility that large reactors do not have[18]. Additionally, SMRs may require less frequent refueling in comparison to 1–2 years for conventional plants.

Currently there are more than 70 SMR designs under development in 17 countries[19]. They can be classified by a number of ways depending on the type of the reactor, its technology, fuel forms and licensing readiness levels. Thus, in accordance with the OECD-NEA Report "Small Modular Reactors: Challenges and Opportunities", most SMR concepts can be grouped into five main categories. They include: single-unit LWR-SMRs; multi-module LWR-SMRs; mobile/transportable SMRs; generation IV SMRs; micro modular reactors (MMRs)[20].

Actually, the world's first floating SMR unit is already in operation in Russia (more details below)[21]. Other SMRs are at the stage of construction or licensing in such countries as Argentina, Canada, China, Russia, Republic of Korea and the USA[22]. The OECD Nuclear Energy Agency predicts that SMRs are expected to massively enter the global market in the next decade[23].

[15] Small Modular Reactors. IAEA official website. Available at: https://www.iaea.org/topics/small-modular-reactors (accessed April 30, 2022)

[16] FNPP Akademik Lomonosov. Rosatom official website. Available at: http://fnpp.info (accessed April 30, 2022)

[17] Small Modular Reactors. OECD Nuclear Energy Agency Report. 2021. Official NEA OECD website. Available at: https://www.oecd-nea.org/upload/docs/application/pdf/2021–10/small_modular_reactors_cop26_flyer.pdf (accessed April 30, 2022)

[18] Cunningham, N. (2012). Small Modular Reactors: A Possible Path Forward for Nuclear Power, *In American Security* Project. Available at: https://www.americansecurityproject.org/ASP%20Reports/Ref%200087 %20-%20Small%20Modular%20Reactors.pdf (accessed April 30, 2022)

[19] IAEA Presents New Platform on Small Modular Reactors and Their Applications. Available at: https://www.iaea.org/newscenter/news/iaea-presents-new-platform-on-small-modular-reactors-and-their-applications (accessed April 30, 2022)

[20] Small Modular Reactors: Challenges and Opportunities. OECD Nuclear Energy Agency Report. 2021. Available at: https://oecd-nea.org/upload/docs/application/pdf/2021–03/7560_smr_report.pdf (accessed April 30, 2022)

[21] About. FNPP Akademik Lomonosov. Rosatom official website. Available at: http://www.fnpp.info/about (accessed April 30, 2022)

[22] Liou, J. (2021) What are Small Modular Reactors (SMRs)? IAEA official website. Available at: https://www.iaea.org/newscenter/news/what-are-small-modular-reactors-smrs (accessed April 30, 2022)

[23] Small Modular Reactors. OECD Nuclear Energy Agency Report. 2021. Available at: https://www.oecd-nea.org/upload/docs/application/pdf/2021–10/small_modular_reactors_cop26_flyer.pdf (accessed April 30, 2022)

Statement of the problem

Globally, the implementation of new nuclear technologies needs changes in political, economical and legal regulation. At the moment the governmental support of the SMRs in the countries developing SMR's technology is targeted at providing long-term political, financial, infrastructural and, especially, international regulatory support[24].

To encourage and to coordinate studies on SMRs, the IAEA has published several reports[25] and established expert groups – the Platform on SMRs and their Applications, the Technical Working Group on Small and Medium Sized or Modular Reactors (TWG-SMR) and the SMR Regulators' Forum[26]. In March 2022 the IAEA launched the "Nuclear Harmonization and Standardization Initiative" bringing together policy makers, regulators, designers, vendors and operators to develop common regulatory and industrial approaches to SMRs[27].

The IAEA hosts technical meetings, produces scientific and technical publications and facilitates research projects. The IAEA coordinates such efforts to encourage the development of a variety of SMRs and to identify advanced technologies in order to ensure the competitiveness and reliable operation of such reactors through research, technology development and innovation[28].

Such reports mainly depict technology roadmaps for implementing SMR technology. They focus on current status of deployment, nuclear power infrastructure and prospects for technologies.

As we see, at the moment, the IAEA's focus on SMRs is technologically oriented. Still, the closer the entry of SMRs at the global market, the more practical issues require clarity and guidance in their international legal regulation. These include trans-boundary transportation issues; ownership in export scenarios; nuclear liability and nuclear insurance; licensing; applicability of the IAEA safeguards, etc. Primarily, a large amount of unclear issues and legal gaps surrounds the operation of floating or other transportable nuclear power plants.

Discussion

Russia and SMRs. Focus on Arctic regions

Today, the only case of operational SMRs is attributed to Russia where the world's first floating nuclear power unit (FNPU) "Akademik Lomonosov" is in operation since May 2020 in Pevek, Chukotka, the most distant Russian port in the Eastern Arctic. It is a non-propelled barge with two nuclear reactors with the power capacity of 35 MW each. The combined 70 MW is enough to provide electricity and heat for a city with 100.000 inhabitants. To compare: the total population of Chukotka region is about 50.000 people[29].

SMRs are in special demand in Russia's Arctic regions, especially in hard-to-reach places of industrial or geological development. Russian SMRs are based on the RITM-type reactors which have been successfully used for decades in the icebreaker fleet[30]. Consequently,

[24] Small Modular Reactors: Challenges and Opportunities. OECD Nuclear Energy Agency Report. 2021. Available at: https://oecd-nea.org/upload/docs/application/pdf/2021–03/7560_smr_report.pdf (accessed April 30, 2022)

[25] See, for example, Technology Roadmap for Small Modular Reactor Deployment. 2021; Benefits and Challenges of Small Modular Fast Reactors 2021; Considerations for Environmental Impact Assessment for Small Modular Reactors 2020. Available at: https://www.iaea.org/publications/14861/technology-roadmap-for-small-modular-reactor-deployment (accessed April 30, 2022)

[26] The IAEA Platform on SMRs and their Applications. Available at: https://www.iaea.org/about/organizational-structure/department-of-nuclear-energy/webinars/nuclear-energy-side-events-at-the-65th-iaea-general-conference/the-iaea-platform-on-smrs-and-their-applications;

Technical Working Group on Small and Medium Sized or Modular Reactors (TWG-SMR). Available at: https://www.iaea.org/topics/small-modular-reactors/technical-working-group-on-small-and-medium-sized-or-modular-reactors-twg-smr;

Small Modular Reactor (SMR) Regulators' Forum. Available at: https://www.iaea.org/topics/small-modular-reactors/smr-regulators-forum (accessed April 30, 2022)

[27] Accelerating SMR Deployment: New IAEA Initiative on Regulatory and Industrial Harmonization. 01 Apr 2022. Available at: https://www.iaea.org/newscenter/news/accelerating-smr-deployment-new-iaea-initiative-on-regulatory-and-industrial-harmonization (accessed April 30, 2022)

[28] Small modular reactors. IAEA official website. Available at: https://www.iaea.org/ru/temy/malye-modulnye-reaktory (accessed April 30, 2022)

[29] Rosenergoatom official website. Floating Nuclear Power Unit. Available at: https://www.rosenergoatom.ru/stations_projects/sayt-pates/ (accessed April 30, 2022)

[30] Born in the Arctic. Rusatom Overseas official website. Available at: https://rusatom-overseas.com/smr/rodom-iz-

there is already a long-term experience of using such nuclear reactors in harsh conditions of the Arctic region. There are also plans to build a ground-based NPP with a small modular RITM-200 reactor in Yakutia. The projected SMR will have such benefits as its compactness and modularity, shortened construction period, high safety standards, and service life of at least 60 years. It is expected that it will reduce the cost of electricity in the region by almost twice. The construction of the SMR will provide a stable and clean energy supply for the development project of the Kyuchus gold deposit in Yakutia[31].

Russia has a number of other major projects in the Arctic related to mineral resources, especially, gas and oil. One of the main projects is the Prirazlomnoye oil and gas extraction platform on the Arctic shelf[32]. Its infrastructure needs heat and electricity. Accordingly, a SMR seems to be the best option for that project.

Financial support for such SMRs is envisaged in the Russian Government's Goals of National Development in 2021–2024[33].

Basically, SMRs become advantageous for Russia in many ways. They are useful for distant regional energy supply; for airports and seaports infrastructure; for meteorological and hydrological stations, for water desalination and hydrogen production[34].

In addition, SMRs have great export potential. At the EXPO-2020 in Dubai Russia presented different types of SMRs[35]. Rosatom and the Energy Ministry of the Kyrgyz Republic have signed there a Memorandum of Understanding on cooperation on SMR nuclear power plants[36]. Rosatom and the United Arab Emirates agreed to create a working group to study the possibility of operating SMR nuclear power plants in the UAE[37].

SRMs in the Framework of National Law

Obviously, it is an issue of crucial importance to regulate legally all possible aspects of nuclear power plant's lifecycle.

As for the national legal regulation of SMRs, in most countries there are special laws on the use of nuclear energy including operations of nuclear power plants.

Russia as the current leader in FNPUs can be taken as an example. There is a national legal regime that includes federal laws and government decrees to regulate the use of nuclear energy. Implementation of these norms is monitored by the Russian regulator, which reports to the Russian Government. Such norms are in conformity with the international nuclear safety and security conventions.

However, in addition to the Federal laws[38], which stipulate the special order of mandatory accounting of nuclear energy sources as well as the mandatory state monitoring of nuclear facilities, some amendments have been made in Russian national laws to accommodate "Akademik Lomonosov" exploitation, especially its design features. Federal Rules and Regulations in the Field of Nuclear Energy Use[39] and Fed-

arktiki/ (accessed April 30, 2022)

[31] By 2028, a low-power nuclear power plant will be built in Yakutia. December 24, 2020. Rosatom official website. Available at: https://rosatom.ru/journalist/news/k-2028-godu-v-yakutii-budet-postroena-atomnaya-stantsiya-maloy-moshchnosti/?sphrase_id=2660993 (accessed April 30, 2022)

[32] Prirazlomnoye project. Gazpromneft official website. Available at: https://shelf.gazprom-neft.com/business/ (accessed April 30, 2022)

[33] Plan_po_dostizheniyu_nacionalnyh_celey_razvitiya_do_2024g.pdf (economy.gov.ru). Available at: https://www.economy.gov.ru/material/file/ffccd6ed40dbd803eedd11bc-8c9f7571/Plan_po_dostizheniyu_nacionalnyh_celey_razvitiya_do_2024g.pdf (accessed April 30, 2022)

[34] SMRs: scientific problems and ways for solutions. Scientific session "Science for nuclear energy". Available at: http://nsrus.ru/files/65NP/ppt/du-2706/Solovjov.pdf (accessed April 30, 2022)

[35] Rosatom presents full Small Modular Reactors product line at EXPO-2020. Rosatom official website. Available at: https://rosatom-mena.com/press-centre/news/rosatom-presents-full-small-modular-reactors-product-line-at-expo-2020-/ (accessed April 30, 2022)

[36] Rosatom and Kyrgyzstan agree to cooperate on SMR NPP construction. Rosatom official website. Available at: https://www.rosatom.ru/en/press-centre/news/rosatom-and-kyrgyzstan-agree-to-cooperate-on-smr-npp-construction/ (accessed April 30, 2022)

[37] Atomic-Energy.ru. Rosatom and the United Arab Emirates agreed to create a working group to study the possibility of using small nuclear power plants in the UAE. Available at: https://www.atomic-energy.ru/news/2022/02/02/121537 (accessed April 30, 2022)

[38] Federal Law of the Russian Federation of November 21, 1995 № 170 – FZ About use of atomic energy. Available at: https://oecd-nea.org/law/legislation/russ-fed-law170-nov1995-en.pdf (accessed April 30, 2022)

[39] Federal Norms and Regulations in the Field of Nuclear Energy Use. General Provisions for the Safety of Ships and Other

eral Standards and Rules in the Field of Atomic Energy Use[40] have been amended.

Each state which would operate SMRs on its own territory and under its jurisdiction should estimate the effectiveness of its national legislation and update it if needed.

However in case of export scenario of SMRs, certain international legal gaps or legal grey areas still exist and need to be mitigated.

SMRs' compatibility with the norms of the International Law

The 1994 Convention on Nuclear Safety[41] obliges the States Parties to abide by certain safety regulations for site selection, design, construction and operation of nuclear facilities. However, its regulations are applicable to land-based stations only. In accordance with the definition of Article 2 (i), a nuclear installation "means for each Contracting Party any land-based civil nuclear power plant under its jurisdiction…"[42]. Thus, formally it does not cover floating NPUs.

The 1982 UN Convention of the Law of the Sea[43], the 1974 International Convention for the Safety of Life at Sea[44], some other maritime agreements contain provisions on nuclear powered ships. Yet, the FNPU "Akademik Lomonosov" is not a ship but a non self-propelled barge. In its export scenario a legal ambiguity will arise.

In case of a SMR trans-boundary transportation additional legal issues arise in connection with the interactions between the transit and the host states on such issues as civil liability of nuclear damage, physical protection of the reactor loaded with nuclear fuel during transportation, as well as counter-terrorism measures.

Another key issue is the application to SRMs of nuclear non-proliferation safeguards. In most options a SMR will be exported to a host state on a turn-key basis. It will be loaded with fuel and operated by the vendor's personnel. The host state will have the only duty to connect electric grids and other infrastructure to the SMR and to guard the facility. It is not clear how the host state will report to the IAEA on the issue of safeguards if the SMR operates as a "black-box" technology without access to it of the local personnel. The IAEA already admits that there are "gaps in the understanding of international safeguards requirements among designers and vendors"[45].

Finally, it should be noted that many developing countries interested in obtaining SMR are not State Parties to most of the basic nuclear safety and security conventions. It would create certain difficulties in resolving such issues as SMRs nuclear security including their armed personnel protection, handling of radioactive waste, nuclear liability and others.

Results

Despite the current legal gaps and some other uncertainties regarding transboundary SMR transportation and operation, their long-term economic, technological and trade benefits are obvious. At the moment it is difficult to predict when and at what scale transfers of such technologies will happen and what will be their preferable models. That is why it would be premature now to start with amending basic instruments of the international nuclear law.

At the beginning it seems to be more prudent to start with the conclusion of bilateral intergovernmental agreements between

Floats with Nuclear Reactors. Available at: https://www.russiangost.com/p-220938-np-022–17.aspx (accessed April 30, 2022)

[40] Federal Standards and Rules in the Field of Atomic Energy Use. Available at: https://www.russiangost.com/p-220941-np-029–17.aspx (accessed April 30, 2022)

[41] Convention on Nuclear Safety 1994. IAEA official website. Available at: https://www.iaea.org/topics/nuclear-safety-conventions/convention-nuclear-safety (accessed April 30, 2022)

[42] Article 2. Definitions. Convention of Nuclear Safety 1994 full text. Available at: https://www.iaea.org/sites/default/files/infcirc449.pdf (accessed April 30, 2022)

[43] UN Convention on the Law of the Sea 1982. UN official website. Available at: https://www.un.org/depts/los/convention_agreements/convention_overview_convention.htm (accessed April 30, 2022)

[44] International Convention for the Safety of Life at Sea (SOLAS) 1974. IMO official website. Available at: https://www.imo.org/en/About/Conventions/Pages/International-Convention-for-the-Safety-of-Life-at-Sea-(SOLAS),-1974.aspx (accessed April 30, 2022)

[45] Safeguarding the Nuclear Future: Small Modular Reactors. 23 Sep 2021. Official site of the IAEA. Available at: https://www.iaea.org/newscenter/news/safeguarding-the-nuclear-future-small-modular-reactors (accessed April 30, 2022)

the exporting/vendor state and the host state. Such an agreement shall contain a mechanism to regulate all related technical and legal issues of the SMR transboundary operational life-cycle. In particular, it should contain obligations on part of the exporter: on the type of FNPU and the time for its delivery; on the responsibility of the operator of the SMR for the implementation of the agreement, including its delivery, operation, maintenance, safety and return to the manufacturer after the end of the SMR life cycle. The obligations of the host state should include: site allocation; provision of electrical grid, water and other infrastructure supplies; external physical protection of the SMR by armed personnel and other nuclear security arrangements. The agreement should also include financial, information sharing and nuclear liability commitments. In addition, it should anticipate a mechanism for the application of nuclear safeguards arrangements with the IAEA, including procedures of inspections of the SMR by the IAEA personnel.

At the international level, especially at the IAEA, much can be done.

In addition to the above mentioned IAEA's working groups on technical SRM's issues it is important to create a corresponding group on legal issues. The IAEA already admits such demand. Rafael Grossi, Director-General of the IAEA, notes that "new technologies represent another important cross-cutting area of nuclear law, specifically with the introduction of advanced reactors including SMRs and transportable nuclear power plants" which need to be accommodated[46].

A related issue is licensing of SMR's. Its regulations and requirements shall be approved by national laws. However, taking into an account that laws and legal regulations on licensing differ from country to country, it would be important to implement recommendations for unified standards of SMRs' licensing[47].

Finally, it would be accurate to update the first fundamental international study on the topic performed by the IAEA in 2013 "Legal and Institutional Issues of Transportable Nuclear Power Plants: A Preliminary Study". It highlighted potential benefits of transportable nuclear power plants, analyzed related potential legal and institutional issues, exposed challenges for their deployment, and outlined pathways for resolution of the identified issues in the short and long terms[48]. However, since then the situation with SMRs development, innovation and implementation has radically changed. It would be advisable to set up a working group of international experts who shall prepare a new report taking into account the current situation and perspectives of SMRs implementation.

To sum up, SMRs are becoming a forward-looking trend in the global advancement of nuclear technologies. More and more countries develop SMRs' concepts and technologies or show interest in purchasing SMRs.

In parallel to the development of these technologies, a step by step legal regulation is needed to address gaps and "grey areas" which still exist, especially, at the junction of national and international legal norms applicable to SMRs.

It is recommended that the IAEA plays a leading role in arranging and coordinating this process.

[46] Grossi, R.M. (2022). Nuclear Law: The Global Debate. In: Nuclear Law. T.M.C. Asser Press, The Hague. https://doi.org/10.1007/978–94–6265–495–2_1 Available at: https://link.springer.com/chapter/10.1007/978–94–6265–495–2_1 (accessed April 30, 2022)

[47] Facilitating International Licensing of Small Modular Reactors. World Nuclear Association official website. Available at: http://www.world-nuclear.org/uploadedFiles/org/WNA/Publications/Working_Group_Reports/REPORT_Facilitating_Intl_Licensing_of_SMRs.pdf (accessed April 30, 2022)

[48] Legal and Institutional Issues of Transportable Nuclear Power Plants: A Preliminary Study. IAEA official website. Available at: https://www.iaea.org/publications/10516/legal-and-institutional-issues-of-transportable-nuclear-power-plants-a-preliminary-study (accessed April 30, 2022)

References

Accelerating SMR Deployment: New IAEA Initiative on Regulatory and Industrial Harmonization. 01 Apr 2022. IAEA official website. DOI: https://www.iaea.org/newscenter/news/accelerating-smr-deployment-new-iaea-initiative-on-regulatory-and-industrial-harmonization

Advanced Reactors Information System (ARIS). IAEA official website. DOI: https://www.iaea.org/resources/databases/advanced-reactors-information-system-aris

A Small Source of a Large Energy. Tass News Agency. DOI: https://tass.ru/spec/asmm

Atomic-Energy.ru. Rosatom and the United Arab Emirates agreed to create a working group to study the possibility of using small nuclear power plants in the UAE. DOI: https://www.atomic-energy.ru/news/2022/02/02/121537

Born in the Arctic. Rusatom Overseas official website. DOI: https://rusatom-overseas.com/smr/rodom-iz-arktiki/

By 2028, a low-power nuclear power plant will be built in Yakutia. December 24, 2020. Rosatom official website. DOI: https://rosatom.ru/journalist/news/k-2028-godu-v-yakutii-budet-postroena-atomnaya-stantsiya-maloy-moshchnosti/?sphrase_id=2660993

Convention on Nuclear Safety 1994. IAEA official website. DOI: https://www.iaea.org/topics/nuclear-safety-conventions/convention-nuclear-safety

Cunningham, N. (2012). Small Modular Reactors: A Possible Path Forward for Nuclear Power, *In American Security* Project. DOI: https://www.americansecurityproject.org/ASP%20Reports/Ref%20 0087 %20-%20Small%20Modular%20Reactors.pdf

Facilitating International Licensing of Small Modular Reactors. World Nuclear Association official website. DOI: http://www.world-nuclear.org/uploadedFiles/org/WNA/Publications/Working_Group_Reports/REPORT_Facilitating_Intl_Licensing_of_SMRs.pdf

Fast-Neutron Reactors. IAEA official website. DOI: https://www.iaea.org/topics/fast-reactors

Federal Law of the Russian Federation of November 21, 1995 № 170 – FZ About use of atomic energy. DOI: https://oecd-nea.org/law/legislation/russ-fed-law170-nov1995-en.pdf

Grossi, R.M. (2022). Nuclear Law: The Global Debate. In: Nuclear Law. T.M.C. Asser Press, The Hague. DOI: https://doi.org/10.1007/978–94–6265–495–2_1

IAEA Presents New Platform on Small Modular Reactors and Their Applications. DOI: https://www.iaea.org/newscenter/news/iaea-presents-new-platform-on-small-modular-reactors-and-their-applications

IAEA Releases Report on Nuclear Energy for a Net Zero World Ahead of COP26 Climate Summit. IAEA official website. DOI: https://www.iaea.org/newscenter/pressreleases/iaea-releases-report-on-nuclear-energy-for-a-net-zero-world-ahead-of-cop26-climate-summit

IAEA Report on Nuclear Energy for a Net Zero World. IAEA official website. DOI: https://www.iaea.org/sites/default/files/21/10/nuclear-energy-for-a-net-zero-world.pdf

International Convention for the Safety of Life at Sea (SOLAS) 1974. IMO official website. DOI: https://www.imo.org/en/About/Conventions/Pages/International-Convention-for-the-Safety-of-Life-at-Sea-(SOLAS),-1974.aspx

Legal and Institutional Issues of Transportable Nuclear Power Plants: A Preliminary Study. IAEA official website. DOI: https://www.iaea.org/publications/10516/legal-and-institutional-issues-of-transportable-nuclear-power-plants-a-preliminary-study

Liou, J. (2021) What are Small Modular Reactors (SMRs)? IAEA official website. DOI: https://www.iaea.org/newscenter/news/what-are-small-modular-reactors-smrs

2050 long-term Strategy. European Commission official website. DOI: https://ec.europa.eu/clima/eu-action/climate-strategies-targets/2050-long-term-strategy_en

Modern Reactors of Russian Design. Rosatom official website. DOI: https://www.rosatom.ru/en/rosatom-group/engineering-and-construction/modern-reactors-of-russian-design/

Nuclear energy, safe use of nuclear power. IAEA official website. DOI: https://www.iaea.org/newscenter/news/iaea-at-cop26-how-nuclear-power-and-technologies-can-help-tackle-climate-change

Operational § Long-Term Shutdown Reactors. Power Reactor Informational System. IAEA official website. DOI: https://pris.iaea.org/PRIS/WorldStatistics/OperationalReactorsByCountry.aspx

Paris Agreement 2015. UN official website. DOI: https://www.un.org/en/climatechange/paris-agreement

Plan_po_dostizheniyu_nacionalnyh_celey_razvitiya_do_2024g.pdf (economy.gov.ru). DOI: https://www.economy.gov.ru/material/file/ffccd6ed40dbd803eedd11bc8c9f7571/Plan_po_dostizheniyu_nacionalnyh_celey_razvitiya_do_2024g.pdf

Plans For New Reactors Worldwide. World Nuclear Association official website. DOI: https://www.world-nuclear.org/information-library/current-and-future-generation/plans-for-new-reactors-worldwide.aspx

Rosatom and Kyrgyzstan agree to cooperate on SMR NPP construction. Rosatom official website. DOI: https://www.rosatom.ru/en/press-centre/news/rosatom-and-kyrgyzstan-agree-to-cooperate-on-smr-npp-construction/

Rosatom presents full Small Modular Reactors product line at EXPO-2020. Rosatom official website. DOI: https://rosatom-mena.com/press-centre/news/rosatom-presents-full-small-modular-reactors-product-line-at-expo-2020-/

Safeguarding the Nuclear Future: Small Modular Reactors. 23 Sep 2021. Official site of the IAEA. DOI: https://www.iaea.org/newscenter/news/safeguarding-the-nuclear-future-small-modular-reactors

Small Modular Reactors: Challenges and Opportunities. OECD Nuclear Energy Agency Report. 2021. DOI: https://oecd-nea.org/upload/docs/application/pdf/2021–03/7560_smr_report.pdf

Small modular reactors. IAEA official website. DOI: https://www.iaea.org/ru/temy/malye-modulnye-reaktory

Small Modular Reactors. OECD Nuclear Energy Agency Report. 2021. Official NEA OECD website. DOI: https://www.oecd-nea.org/upload/docs/application/pdf/2021–10/small_modular_reactors_cop26_flyer.pdf

Small Modular Reactor (SMR) Regulators' Forum. DOI: https://www.iaea.org/topics/small-modular-reactors/smr-regulators-forum

SMRs: scientific problems and ways for solutions. Scientific session "Science for nuclear energy". DOI: http://nsrus.ru/files/65NP/ppt/du-2706/Solovjov.pdf

Technical Working Group on Small and Medium Sized or Modular Reactors (TWG-SMR). DOI: https://www.iaea.org/topics/small-modular-reactors/technical-working-group-on-small-and-medium-sized-or-modular-reactors-twg-smr

Technology Roadmap for Small Modular Reactor Deployment. 2021; Benefits and Challenges of Small Modular Fast Reactors 2021; Considerations for Environmental Impact Assessment for Small Modular Reactors 2020. DOI: https://www.iaea.org/publications/14861/technology-roadmap-for-small-modular-reactor-deployment

The IAEA Platform on SMRs and their Applications. DOI: https://www.iaea.org/about/organizational-structure/department-of-nuclear-energy/webinars/nuclear-energy-side-events-at-the-65th-iaea-general-conference/the-iaea-platform-on-smrs-and-their-applications

Transforming our world: the 2030 Agenda for Sustainable Development. UN official website. DOI: https://sdgs.un.org/2030agenda

Transitions to low carbon electricity systems: Key economic and investments trends. IAEA official website. DOI: https://www.iaea.org/sites/default/files/21/06/transitions-to-low-carbon-electricity-systems-changing-course-in-a-post-pandemic-world.pdf

UN Convention on the Law of the Sea 1982. UN official website. DOI: https://www.un.org/depts/los/convention_agreements/convention_overview_convention.htm