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Economic Problems

Hydrogen Energy: Legal Support and International Cooperation

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Abstract—The legal support and existing and potential contours and examples of international cooperation in the field of hydrogen energy are discussed. Based on study and analysis of international "hydrogen" initiatives and international organizations the activities of which partly extend to hydrogen, as well as interactions in the field of hydrogen energy within the framework of regional integration associations (BRICS, Eurasian Economic Union, Shanghai Cooperation Organization, Association of Southeast Asian Nations, Regional Comprehensive Economic Partnership, and the European Union) and individual regions, the authors note the lack of clearly defined strategies and plans, which does not contribute to the achievement of visible effects from cooperation, hinders the stability of international energy markets, and raises questions about the need to develop new rules at the international level, which should be enshrined in relevant international agreements in this area and on the creation of an international organization that would become a world center for cooperation in the field of hydrogen.

Keywords: hydrogen energy, hydrogen, renewable energy sources, energy transition, international cooperation, energy law

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INTRODUCTION

Many factors influence the development of the energy industry both in Russia and around the world, which, ultimately, is reflected in various kinds of conceptual and strategic documents adopted by both individual states and their associations (unions) and international organizations. One of the factors that determine the vector of development and technologies in the energy sector, the economic nature of decisions, and legal decisions was the discussion of climate change, which resulted in decisions related to decarbonization. This agenda eventually became global; in connection with its discussion, a new energy transition was mentioned, the content of which should be the transition from traditional technologies for the production and use of energy and energy sources to renewable ones. It should be noted that the scientific literature does not limit the energy transition only to the indicated content; the energy transition is "a more complex and integrated phenomenon, involving an increase in energy efficiency, a reduction in the extraction of natural resources, and an extension of the life cycles of basic materials (primarily due to the widespread introduction of the principles of a circular economy)" [Kodaneva, 2021].

Economic and legal decisions aimed at implementing the ideas of a new energy transition entail not only changes in the technologies used in the energy sector (which is, no doubt, positive in itself), but also create competition between traditional and new (carbon-neutral and low-carbon) energy sources and technologies, changes in the investment and energy policies of states and, accordingly, the geopolitical alignment of forces in the world, and at the same time give rise to new risks and challenges in the field of energy security: from the high financial and technological costs of energy decarbonization to serious socioeconomic and political shocks [Borovsky, 2021]. Moreover, ideas are being expressed about a "new understanding of energy security" [Farah, 2020], the hallmarks of which are a shift in priorities from ensuring supply to strengthening diversification; counteracting the negative impact of energy consumption on the environment; incorporating sustainability into energy and policy at both the national and international levels; and developing new strategies that provide a balance of sustainable, secure energy and economic development.

Part of the new agenda was the use of hydrogen and the development of hydrogen energy, as well as hydro-

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gen technologies. According to the International Energy Agency (IEA), the development of hydrogen energy is designed to help create a sustainable energy system and achieve zero emissions targets by 2050 [IEA, 2021]. However, to implement the corresponding scenarios (forecasts), it is obviously necessary to develop international cooperation in the field of hydrogen energy. In conditions when many states have already adopted national strategies for the development of hydrogen energy and in order to build an international hydrogen economy that would take into account the balance of interests of the new industry and national energy security, it seems appropriate to implement a consistent coordinated policy in this area and apply joint efforts aimed at creation of mechanisms for international legal regulation, especially in terms of ensuring security and developing a system of international standards and certification [Lizikova, 2021]. At the same time, in order to determine and set priorities in international cooperation in the field of hydrogen energy, both at this stage and in the future, a clear agreed vision of the role of hydrogen in the global energy system in 2030, 2040, and 2050 is necessary in accordance with the Paris climate agreement, which would be the basis for combining national strategies into global and regional roadmaps [Van de Graaf et al., 2020] and, ultimately, would help to minimize the risks of gaps in strategies (and, accordingly, their elimination), as well as the risks of not meeting the set goals.

The IEA roadmap [IEA, 2015], developed to identify the most important actions required in the short and long term for the successful development and implementation of hydrogen technologies in support of global goals in the field of energy and climate and an IAEA roadmap[1] informing about the commercial deployment of hydrogen production using nuclear energy can serve as tools to assess, plan, and develop state hydrogen projects. The former, which plays a key role among the priority areas of international cooperation for the development of hydrogen technologies, indicates the need to spread knowledge about hydrogen technologies between developed and developing regions, the possibility of attracting developing countries to activities aimed at deploying clean energy technologies, the autonomous implementation of innovations in the field of clean energy.

Before proceeding to the consideration of existing and potential contours and examples of international cooperation in the field of hydrogen energy, it is necessary to raise the issue of approaches to the classification of hydrogen, since for the effective development of international cooperation and the formation of legal regulation of legal relations in this area, a common understanding of the various types of hydrogen is necessary.

[1] IAEA to create roadmap for nuclear hydrogen deployment. https://www.world-nuclear-news.org/Articles/IAEA-to-create-roadmap-for-nuclear-hydrogen-deploy.

HYDROGEN CLASSIFICATION

Even though hydrogen is the most common element in the universe, it is practically never found in nature in its pure form but is isolated from other compounds. Hydrogen production methods (steam reforming of methane and natural gas, coal gasification, water electrolysis, pyrolysis, partial oxidation, biotechnologies) and the resulting carbon footprint (from the complete absence of CO_2 to the release of carbon dioxide in the same volumes as during the combustion of natural gas) – used as criteria in the classification of hydrogen by color. So, within the framework of this approach, green, yellow, turquoise, gray, blue and brown hydrogen are distinguished, where the first is the most environmentally friendly, and the last is the most unecological. The advantages and disadvantages of one or another type of hydrogen are in the focus of attention of representatives of the scientific community. Thus, the prospects for green hydrogen are noted by [Noussan et al., 2021; Kakoulakia et al., 2021], [Howarth, Jakobson, 2021] compare green and gray hydrogen from a conditional position of economic feasibility, and [Park etc., 2022] and [Alfradique etc., 2022] note that the use of blue hydrogen is difficult to justify in terms of climate.

Although widely used, this classification has drawbacks. The development of promising technologies for producing hydrogen, as noted by A. Ishkov, will lead to a multiple increase in the number of emitted hydrogen species, therefore he considers the carbon footprint classification to be more scientific. According to another argument, the classification "by color" has political meanings, and the European Union uses it mainly to achieve the goals of decarbonization [Janusz, 2021]. At the same time, the EU in the hydrogen strategy adheres to a different classification of hydrogen, subdividing it into renewable and low-carbon.

It should be noted that only 5% of the total volume of hydrogen produced can be considered a commercial product. At the present stage, there is not enough capacity to produce low-carbon hydrogen. The rate of formation of the world hydrogen market is due to both economic factors and technical difficulties in ensuring its storage, use and transportation. The technical possibilities of hydrogen transportation, the potential environmental hazard of a few derivative products, the efficiency of hydrogen use in energy-intensive industries, and other issues are the subject of independent scientific research and discussions that are beyond the scope of this article.

INTERNATIONAL "HYDROGEN" INITIATIVES

There are currently several hydrogen initiatives at the international level [Barbir, 2009; De Valladares and Jensen, 2011]. Thus, the International Association

for Hydrogen Energy (IAHE) and the IEA Cooperation Program in the field of hydrogen technologies (Hydrogen TCP/IEA Hydrogen) have been operating since the late 1970s, carrying out research, education, and information exchange between member countries.

The Hydrogen Council, a global initiative of leading companies[2] representing the entire hydrogen value chain, is focused on ensuring reliable and safe international trade in hydrogen. The International Hydrogen Fuel Cell Association (IHFCA) is positioning itself as a bridge and link for integrating resources across the entire hydrogen fuel cell manufacturing chain to address jointly the challenges facing the industry during its commercialization and creating a market environment. The International Partnership for Hydrogen and Fuel Cells in the Economy (IPHE) aims to facilitate and accelerate the transition to clean and efficient energy and mobility systems using hydrogen and fuel cell technologies in all applications and sectors by disseminating information about the benefits and challenges of adopting widespread commercial hydrogen and fuel cell technologies in the economy.

The goal of the Mission Innovation Innovation Challenge 8 (MI IC8) "Renewable and Clean Hydrogen" is to accelerate the development of the global hydrogen market by identifying and overcoming key technological barriers to gigawatt-scale production, distribution, storage, and use of hydrogen. The Clean Energy Ministerial (CEM) initiative is a high-level global forum to promote policies and programs and clean energy technologies, share best practices, and encourage the transition to a global clean energy economy. In turn, the Global Hydrogen Partnership of the United Nations Industrial Development Organization (UNIDO) has launched a global program to promote the use of green hydrogen in industry. The International Organization for Standardization (ISO) also contributes to the development of the global hydrogen energy industry, the role of which will only increase with the development of international hydrogen trade.

Other international organizations also contribute to the development of hydrogen energy. For example, the International Renewable Energy Agency (IRENA) has experience in the field of renewable energy and green hydrogen; the International Energy Agency (IEA) approaches hydrogen issues from the point of view of energy security; the International Atomic Energy Agency (IAEA) provides information on the production of nuclear hydrogen; the International Energy Forum provides a platform for dialogue between energy sellers and buyers; and the Global Energy Interconnection Development and Cooperation Organization (GEIDCO) is developing the use of new hydrogen energy storage and transfer technologies in a number of areas of development of global energy systems [Filimonov et al., 2021].

The effectiveness of the above initiatives will largely depend on the coordination of their activities aimed at avoiding duplication, as well as at the synergy of cooperation at the global and regional levels [IEA, 2021], which will strengthen the necessary connections between stakeholders and position of a particular region in a future low-carbon hydrogen landscape.

For example, the International Renewable Energy Agency and the Mission Innovation are developing a collaborative process to strengthen global renewable energy innovation efforts and accelerate innovation through more effective policies and greater cross-border cooperation. There is a clear synergy between the goals of these organizations: first, both have a common goal—to accelerate the development of solutions in the field of renewable energy sources; second, 20 of the 23 members of the Mission Innovation are also members of IRENA; and third, both play a decisive role in accelerating progress. As follows from the Letter of Intent on cooperation between the International Renewable Energy Agency and the Mission Innovation,[3] this interaction gives IRENA a unique unifying force, broad perspective, and understanding of the progress and challenges of the energy transition, while the experience, insights, networking, and organizational capabilities and data IRENA has accumulated can help the Mission Innovation meet its goal of accelerating clean energy innovation.

In turn, recognizing that energy innovation is critical to advancing the clean energy transition, reducing greenhouse gas emissions and air pollution, improving energy security, expanding energy access, and boosting economic growth brings the International Energy Agency and the Mission Innovation together. Mutually beneficial opportunities for expanding cooperation between them in areas such as

—improving data collection and reporting on public and private investment in clean energy research, development, and demonstration;

—sharing data on economic and technical improvements in clean energy technologies, identifying key long-term technological innovation gaps across sectors and technologies, and identifying measures to further scale up technology development and deployment;

—joint identification of countries interested in receiving additional support in this regard, to support them in achieving policy goals related to innovation efforts by the IEA, as well as adapting innovative ideas to the context of a particular country, are determined by the fact that the former continues to develop part-

[2] Currently, this organization includes 134 companies from around the world.

[3] Letter of Intent on Collaboration between the International Renewable Energy Agency and Mission Innovation. Malmö, Sweden, May 23, 2018. http://mission-innovation.net/wp-content/uploads/2019/02/IRENA-and-MI-letter-of-intent.pdf. Cited August 11, 2022.

nerships with key emerging economies from around the world, and the latter goes on working closely with the private sector.[4]

Public–private collaboration is critical to the acceleration of deep decarbonization, with clean hydrogen as the key, while ensuring the necessary flexibility and resilience of energy systems. Its strengthening is intended to be facilitated by cooperation between the International Renewable Energy Agency and the Hydrogen Council.[5]

With support by the International Energy Agency and the Ministerial Hydrogen Clean Energy Initiative, which promotes policies, programs, and projects that accelerate the commercialization and deployment of hydrogen fuels and technologies in all aspects of the economy, together with the International Partnership for Hydrogen and Fuel Cells in the Economy and the Mission Innovation, the ways how hydrogen can contribute to building a cleaner energy system by promoting resilience, fail safety, and energy security are highlighted.[6] The key areas of their collaboration are helping to ensure the successful introduction of hydrogen in current industrial applications, safeguarding the deployment of hydrogen technologies in transport, and studying the role of hydrogen in meeting the energy needs of the population. This work resulted in a report of global hydrogen targets by 70 national governments, published in May 2022.

LATIN AMERICA

According to the IEA [IEA, 2021], a significant role in the international quest for low-carbon hydrogen as an essential element of a global zero-emissions future is assigned to Latin America, a region that is one of the world's leaders in the use of renewable energy, which has a long-term potential for the production of large volumes of competitive low-carbon hydrogen and its export to other world markets. It is significant that, while in 2019 there were only three pilot projects to produce such hydrogen, at present, out of 25 hydrogen projects being developed in this region, several are gigawatt-scale projects aimed at exporting outside the region. The clue to their successful implementation, as well as the deployment of the production and use of hydrogen and the creation of a new industrial sector to produce high-tech equipment, is international dialogue and coordination, which are designed to ensure the strengthening of the necessary links between stakeholders and market participants, provide an opportunity to position the region in the future low-carbon hydrogen landscape, and could also help shape future hydrogen markets.

Currently, the states of Latin America are participants in several international initiatives. In turn, the Regional Hydrogen Dialogue, which focuses on common challenges and potential that can help optimize the use of public resources to develop solutions to regional energy problems and ultimately identify future regional trade opportunities, is carried out as part of clean energy technologies: the Central American Integration System (SICA), the Regional Energy Integration Commission (CIER) for Latin America and the Caribbean, the Latin American Energy Organization (OLADE), and the ambitious Renewable Energy Initiative for Latin America and the Caribbean (RELAC).

The latest, announced on December 10, 2019, during the UN COP25 conference, united 11 countries in the region in a commitment to achieve a 70% renewable energy target by 2030 and more than double the European Union's target. It has received information and financial support from the National Renewable Energy Laboratory (NREL), the Latin American Energy Organization (OLADE), the International Renewable Energy Agency (IRENA), the International Energy Agency (IEA), the Global Partnership for Low Emission Development Strategies (LEDS GP), NDC Partnership, and the World Wide Fund for Nature.

The region's potential for the export of hydrogen and products of its processing requires the establishment of a dialogue with potential importers. The development of promising areas for regional cooperation among Latin American countries, such as the decarbonization of freight transport through a combination of sustainable mobility technologies, could support pilot projects within a network that provides regional exports through the ports of the Pacific and Atlantic oceans, thus contributing to the formation of another "hydrogen bridge,"[7] connecting Latin America with Europe.

The Chile–Germany Green Hydrogen Promotion Agreement (dated June 29, 2021),[8] aimed at support-

[4] Letter of intent on cooperation between Mission Innovation and the International Energy Agency, Malmö, Sweden, May 22, 2018. http://mission-innovation.net/wp-content/uploads/2019/01/6.1.16-IEA-and-MI-letter-of-intent.pdf. Cited August 11, 2022.

[5] IRENA and Hydrogen Council forge alliance to scale up hydrogen across the energy system. https://hydrogencouncil.com/en/irena-and-hydrogen-council-forge-alliance-to-scale-up-hydrogen-across-the-energy-system/. Cited August 11, 2022.

[6] https://www.cleanenergyministerial.org/initiatives-campaigns/hydrogen-initiative/. Cited August 11, 2022.

[7] In the context of the development of hydrogen energy, the emergence of new energy superpowers is predicted [Borisov, 2022], which are technological leaders in the production and development of equipment for new energy, as well as the transformation of existing and the emergence of new trade and geopolitical alliances. As examples of such, along with the forecast of the transformation of the Middle East and North African states into exporting states and the loss of the dominant position of the current exporting states and their associations, the emerging "hydrogen bridges" North Africa–Europe and Japan–Australia are most often cited. This list can be continued.

[8] Chile and Germany sign agreement for the promotion of green hydrogen. https://www.energypartnership.cl/newsroom/chile-and-germany-sign-green-hydrogen-agreement/.

ing electrolysis projects abroad and creating a new commercial route for importing green hydrogen, and the Joint Statement by the Governments of Chile and the Netherlands on Low-Carbon Hydrogen Trade (July 2021),[9] as well as discussion processes for mutual cooperation in the field of green hydrogen between Germany and Brazil[10] and between Russia and Brazil[11] can be seen as the first steps in this direction.

Examples of other areas of cooperation regarding the development of a sustainable and affordable hydrogen supply chain, including the production of hydrogen from renewable sources, are the Argentine–Japanese[12] and Brazilian–American[13] cooperation.

BRICS

An important role in ensuring global sustainable development in terms of universal access to inexpensive, reliable, and sustainable energy sources is played not only by individual states and regions but also by integration associations of countries. Since almost all the growth in global energy demand comes from fast-growing developing economies, which also lead in terms of greenhouse gas emissions [Kovalev and Porshneva, 2021], it would be fair to assign the BRICS countries (Brazil, Russia, India, China, and South Africa) a special place in this process.

Since 2014, issues of energy cooperation have been consistently included in the BRICS agenda. However, only in October 2020 was the first comprehensive document adopted, which fixed the agreed plans for the development of the energy dialogue between the member countries of this association [Sinchuk, 2022], which does not contain any legal obligations, but supplements the existing agreements between the parties—the Roadmap of energy cooperation until 2025.[14] It envisages the following stages of energy research within the BRICS Cooperation Platform: identifying the most promising new technologies and developing mechanisms for cooperation; pinpointing needs and challenges in the field of energy security and energy development, as well as ways to increase the role of the BRICS countries in the global energy agenda; and reaching agreements on specific areas and forms of cooperation to promote the development of national energy systems and energy transition.

The roadmap includes renewable energy sources as part of sectoral cooperation. It is noted that the BRICS countries can benefit from the exchange of best practices and advanced renewable energy technologies, as well as joint analysis of the problems associated with the rapid increase in the share of renewable energy in the energy mix and the expansion of distributed generation.

Adopted at the XII BRICS Summit (Moscow, Russia) in November 2020, the Moscow Declaration[15] welcomed the approval of the roadmap and the start of practical cooperation within the BRICS Energy Research Cooperation Platform (ERCP) and also stressed the importance of international dialogue to advance the interests of the BRICS countries on a global scale by strengthening the strategic partnership.

In turn, adopted in September 2021 as part of the XIII BRICS Summit (New Delhi, India),[16] the declaration, noting the prospects of hydrogen for the energy transition of each country, the creation of reliable energy systems, and the strengthening of energy security, expanded the range of priority areas for energy cooperation.

A significant event in 2021 in this area was the holding of the Summit on Green Hydrogen Initiatives[17] with the participation of the BRICS countries, during which options for funding new green hydrogen technologies and the institutional support needed to create an ecosystem for the technology to flourish in order to better understand the hydrogen landscape from the BRICS perspective were discussed. The outcome of the summit was the conclusion that green hydrogen has always been a strategically important

[9] Joint statement of Chile and The Netherlands on collaboration in the field of green hydrogen import and export. https://www.government.nl/documents/diplomatic-statements/2021/07/01/joint-statement-of-chile-and-the-netherlands-on-collaboration-in-the-field-of-green-hydrogen-import-and-export.

[10] German–Brazilian cooperation on green hydrogen. https://www.german-energy-solutions.de/GES/Redaktion/EN/News/2022/20220525-h2-cooperation-brazil.html.

[11] Joint Statement by President of the Federative Republic of Brazil Jair Bolsonaro and President of the Russian Federation Vladimir Putin. https://www.gov.br/mre/en/contact-us/press-area/press-releases/joint-statement-by-president-of-the-federative-republic-of-brazil-jair-bolsonaro-and-president-of-the-russian-federation-vladimir-putin.

[12] Memorandum of Cooperation on Hydrogen between the Government Secretariat of Energy of the Ministry of the Treasury of the Argentine Republic and the Ministry of Economy, Trade, and Industry of Japan. https://webcache.googleusercontent.com/search?q=cache:2-D3XOhTViAJ:https://tratados.cancilleria.gob.ar/tratado_archivo.php%3Ftratados_id%3DkqWllps%3D%26tipo%3Dkg%3D%3D%26id%3Dkp6pmZY%3D%26caso%3Dpdf+&cd=1&hl=ru&ct=clnk&gl=ru&client=safari.

[13] Memorandum of Understanding Between the Department of Energy of the United States of America and the Ministry of Mines and Energy of the Federative Republic of Brazil for the Establishment of a Mechanism for Consultations on Energy Cooperation. https://www.energy.gov/sites/default/files/2014/03/f12/brazil_ us_mou_statement.pdf.

[14] Roadmap for BRICS Energy Cooperation up to 2025. https://brics-russia2020.ru/images/85/29/852976.pdf.

[15] XII BRICS Summit Moscow Declaration. https://www.gov.br/mre/en/contact-us/press-area/press-releases/xii-brics-summit-moscow-declaration.

[16] XIII BRICS Summit New Delhi Declaration. https://www.gov.br/mre/en/contact-us/press-area/press-releases/xiii-brics-summit-new-delhi-declaration.

[17] India to hold 2-day BRICS meet on Green Hydrogen initiatives. https://www.business-standard.com/article/current-affairs/india-to-hold-2-day-brics-meet-on-green-hydrogen-initiatives-121062000452_1.html.

area on the agenda of the BRICS countries. The expediency of adopting a common international standard for the safety of transporting and storing large volumes of hydrogen and the availability of an appropriate certificate of origin was also noted.

In addition, the preparation of a draft BRICS Energy Research Directory,[18] a document that plays a key role in the development of research cooperation in the field of low-carbon technologies between the member countries, as well as between academic and government circles, should also be noted.

Further promotion of cooperation in the field of "green" development was announced by China, which accepted the BRICS chairmanship for 2022 as one of the vectors for creating an accelerated BRICS path for global development [Wang, 2022]. However, the Beijing Declaration of the XIV BRICS Summit, adopted on June 23, 2022,[19] did not touch directly upon the development of hydrogen energy, emphasizing the fundamental role of energy security in achieving the Sustainable Development Goals and welcoming the achievements of the association in the energy sector. According to the document, cooperation in the BRICS Plus format will give a new impetus to strengthening international cooperation and solidarity in the implementation of the 2030 Agenda for Sustainable Development. During the summit, Iran and Argentina announced their intention to join the BRICS countries, which are actively promoting hydrogen energy.

Bilateral cooperation between the BRICS countries in the field of hydrogen energy is also being developed both within the association and with third countries. Thus, the Joint Statement following the XXI Russian–Indian Summit "Russia–India: Partnership for Peace, Progress, and Prosperity," made on December 6, 2021,[20] Memorandum of Understanding between the Ministry of Economic Development of Russia and the Ministry of Commerce of the PRC on the issue of deepening investment cooperation in the field of sustainable (green) development, signed at the Russia–China Summit in Beijing on February 4, 2022,[21] aimed at encouraging collaboration and investment in hydrogen energy projects and technologies are examples of the former, while the India–Germany partnership in the field of green hydrogen and sustainable development and the India–Denmark green partnership are examples of the latter.

Thus, despite the fact that the BRICS in the energy sector are characterized by a bilateral format of cooperation [Mastepanov, 2016], we should note the trend towards the intensification of multilateral cooperation—the adoption of the first multilateral act in the field of energy, the holding of summits on a regular basis, and the expanding agenda—which, in turn, is in the interests of the development of hydrogen energy both within the association as a whole and between its member states. After all, the "pioneers" will have an advantage in the energy transition, because governments and associations that develop innovative policies and technologies earlier than others are more likely to benefit from exports [Grigoryev, 2021]. Since all the BRICS states have potential in the field of hydrogen energy, comprehensive interaction in this area can ensure successful promotion of their interests in the conditions of the formation of a new global energy system, including their influence on the development of new regulatory procedures, terminology, and standards. The conditions for an active role in the emerging global energy management mechanisms [Fumagalli, 2020] for the BRICS are the implementation of a coordinated policy necessary to overcome the uneven pace of energy transformations in the participating countries and a course towards the introduction of new "clean" technologies, in particular, the development of hydrogen transport, hydrogen production, and the development of hydrogen technologies and the environmental transformation that accompanies it.

EURASIAN ECONOMIC UNION (EAEU)

As for another Eurasian integration association—the Eurasian Economic Union (EAEU)—it should be noted that the development of renewable energy sources was not initially reflected in the provisions of the treaty on its establishment. The situation began to change in 2018 in connection with the signing of the Declaration on the Further Development of Integration Processes within the EAEU,[22] reflecting the intention of the member states to implement joint projects in the field of green technologies, energy saving, energy efficiency, renewable energy, etc. This was reinforced in the Statement made in October 2021 by the heads of the EAEU member states,[23] according to which international exchange and nondiscriminatory use of technologies that reduce greenhouse emissions

[18] BRICS Energy Research Directory 2021. http://www.brics.utoronto.ca/docs/210902-energy-research-directory.pdf.

[19] Beijing Declaration of the XIV BRICS Summit dated June 23, 2022. http://kremlin.ru/supplement/5819.

[20] Joint Statement on the Results of the 21st Russian–Indian Summit "Russia–India: Partnership for Peace, Progress, and Prosperity." http://www.kremlin.ru/supplement/5745.

[21] Memorandum of Understanding between the Ministry of Economic Development of the Russian Federation and the Ministry of Commerce of the People's Republic of China on the issue of deepening investment cooperation in the field of sustainable (green) development. http://kremlin.ru/supplement/5769.

[22] Declaration on the Further Development of Integration Processes within the EAEU. https://docs.eaeunion.org/docs/ru-ru/01420213/ms_10122018.

[23] Statement on economic cooperation between the EAEU member states within the climate agenda, October 14, 2021. https://eec.eaeunion.org/news/zayavlenie-ob-ekonomicheskom-sotrudnichestve-gosudarstv-chlenov-%20evrazijskogo-ekonomicheskogo-soyuza-v-ramkah-klimaticheskoj-povestki/. Cited February 21, 2022.

is considered as one of the areas of economic cooperation between the EAEU member states within the framework of the climate agenda. It should be noted that the ESG agenda was included in the Strategy for the Development of Eurasian Economic Integration until 2025,[24] in accordance with which it is supposed to pool efforts to create and use new technologies and innovations, including green technologies and RES.

Amid sanctions aimed at abandoning Russian energy resources, the EAEU was faced with the urgent need to expand the strategy by giving key importance to hydrogen energy. The latter has found practical implementation in the agreement on the expediency of starting joint research in the development of projects related to hydrogen to increase the competitiveness of hydrogen energy in the EAEU countries, as well as in the creation of a working group in the field of hydrogen energy with the participation of research organizations.[25]

The formation of clusters for the testing of hydrogen technologies, cooperation with enterprises and scientific organizations to create electrolyzers and fuel cells, the adoption of technical solutions for the production of hydrogen at nuclear power plants, and hydrogen transport, as well as the development of mechanisms for financing projects in the field of hydrogen energy will become, as follows from speeches by the Minister for Industry and Agro-Industrial Complex of the Eurasian Economic Commission A. Kamalyan, concrete steps for the further development of the industry within the framework of the EAEU.[26]

Another step in developing cooperation in the field of hydrogen energy was the agreement signed on the sidelines of the St. Petersburg International Economic Forum on June 3, 2021, on the joint work of RUSNANO and the Eurasian Development Bank to implement alternative energy, high technologies, and green hydrogen projects in the EAEU countries.[27]

Note also that the EAEU, within the framework of the Greater Eurasian Partnership, is developing cooperation in this area with associations operating in the Eurasian space. In particular, the formation and implementation of energy policy in the Asia–Pacific region is one of the points of the Cooperation Program between the EAEU and the Association of Southeast Asian Nations (ASEAN) for 2020–2025, as well as an accent point of the Memorandum of Understanding between the EEC and the Secretariat of the Shanghai Cooperation Organizations (SCO).[28]

INTEGRATION ASSOCIATIONS OF THE ASIA–PACIFIC REGION

As for the development of interaction in the field of hydrogen energy within the Shanghai Cooperation Organization, in which almost all member states of the EAEU take part, in the Concept of Cooperation of the SCO Member States in the Energy Sector, adopted on August 12, 2021, the introduction of green energy and energy efficient technologies have received special attention. The Green Belt Program of the Shanghai Cooperation Organization, adopted at the anniversary SCO summit, held on September 17, 2021, is aimed at a wider introduction of resource-saving and environmentally friendly technologies.[29]

In addition, along with the SCO Energy Club, which is a platform for interaction between all interested producers and consumers of energy resources of the countries of the organization, the Working Group of the SCO member states in the field of energy was established, the purpose of which is to identify promising areas of practical cooperation.

For the ASEAN, the issues of ensuring energy security and international cooperation in the energy sector are not new [Kopylov, 2011]. The development of regional energy projects, including renewable energy, energy efficiency, and energy conservation, was also provided for by the ASEAN Action Plan in the field of energy cooperation for 2010–2015.

Currently, according to the Economic Research Institute for ASEAN and East Asia, there is a significant potential for supply and demand for hydrogen energy in East Asia. For example, since the end of 2019, Brunei has been exporting liquefied hydrogen to Japan. Singapore is also working closely with Japanese companies to explore the development of hydrogen as a new clean fuel to boost the economy and reduce carbon emissions. However, hydrogen is still not officially on the agenda of countries in the region as an alternative fuel, while the ASEAN Action Plan for Energy Cooperation 2021–2025 envisages policy measures to develop alternative technologies, such as hydrogen storage; to accelerate the energy transition in the

[24]On strategic areas for the development of Eurasian economic integration until 2025, approved by Decision No. 12 of the Supreme Eurasian Economic Council of December 12, 2020. https://docs.eaeunion.org/docs/ru-ru/01228321/err_12012021_12.

[25]The EEC considered prospects for development of hydrogen energy in the Union. https://eec.eaeunion.org/news/v-eek-rassmotreli-perspektivy-razvitiya-v-soyuze-vodorodnoj-energetiki/?sphrase_id=105167.

[26]The countries of the Eurasian "five" are developing innovative cooperation in industry. https://dknews.kz/ru/ekonomika/239913-strany-evraziyskoy-pyaterki-razvivayut-innovacionnoe.

[27]RUSNANO and EADB to implement alternative energy projects in the EAEU. https://www.in-power.ru/news/alternativnayaenergetika/38447-rosnano-i-eabr-namereny-realizovat-v-eaes-proekty-v-sfere-alternativn.html.

[28]The EEC and the Secretariat of the Shanghai Cooperation Organization signed a memorandum of understanding within the anniversary SCO summit. https://eec.eaeunion.org/news/eek-i-sekretariat-shanhajskoj-organizatsii-sotrudnichestva-podpisali-memorandum-o-vzaimoponimanii-v-ramkah-yubilejnogo-sammita-shos/.

[29]Documents of the Shanghai Cooperation Organization summit on September 17, 2021. http://www.kremlin.ru/supplement/5698.

region; and to strengthen energy resilience through innovation and cooperation. Cooperation with Russia is intended to contribute to this goal, as follows from the joint Russia–ASEAN statement adopted at the end of the 4th Russia–ASEAN Summit in October 2021,[30] aimed at expanding joint research, development, production, and use of all energy sources, including renewable and alternative, promoting low-carbon and energy-efficient sustainable energy technologies.

As researchers rightly point out [Phoumin, 2021], to adapt successfully to the processes of formation of the new ASEAN international energy system, it is necessary to work out a roadmap for hydrogen development with a general agreement on political incentives to promote its development and to pursue a clear investment policy to advance hydrogen development and implementation.

As for cooperation in this area within such regional economic initiatives as the Trans-Pacific Partnership and One Belt, One Road, then, for example, the green concept of Belt and Road is unofficially added to the latter [Korneev, 2021].

In turn, recently created by the joint efforts of ASEAN, Japan, China, and South Korea, who actively participate in the international hydrogen trade chains for the energy needs, the largest economic integration entity in East Asia—the Regional Comprehensive Economic Partnership (RCEP)[31]—is also included in its agenda innovative energy cooperation, one of the areas of which is hydrogen energy. Cooperation between RCEP members can help not only existing strong players but also new ones to achieve competitiveness in the hydrogen export market.

EUROPEAN UNION (EU)

Actively promoting the idea of global decarbonization, the EU, having adopted the Green Deal, embarked on the path of transformation of the economy and the energy system, in which hydrogen is assigned a key role. A Hydrogen Strategy for a Climate-Neutral Europe,[32] published in 2020, provides for measures to promote the rapid and targeted development of green hydrogen production capacity. These include international cooperation, both with neighboring countries and within international institutions, to develop international standards, common definitions, and common approaches to methodology.

It is complemented by The European Clean Hydrogen Alliance, an entity that will play a leading role in establishing and shaping the future of the hydrogen market in Europe, to help expand the production, distribution, and deployment of renewable and low-carbon hydrogen sources by 2030 [Belov, 2020], which has launched several initiatives to engage hydrogen stakeholders and encourage investment. However, by 2021, a course correction was required to meet the declared indicators, which led to the adoption of the Fit for 55 agreement,[33] which set the goal to produce up to 5.6 million tons of green hydrogen by 2030. In addition, with the adoption of the Hydrogen and Gas Market Decarbonization Package[34] by the EU Commission in December 2021, a review of existing EU gas legislation has begun to create a regulatory framework for the production and trade of hydrogen.

Fit for 55 is the backbone of REPowerEU, the European Commission's May 2022 plan to make Europe independent of Russian fossil fuels by 2030 in light of Russia's "invasion" of Ukraine. The plan calls for rapidly reducing dependence on Russian fossil fuels and accelerating the green transition, while improving the resilience of pan-European energy systems. Along with other measures for this purpose, it is planned to: carry out general purchases of hydrogen through the EU Energy Platform for all Member States; establish new energy partnerships with reliable suppliers; roll out solar and wind power projects in combination with renewable hydrogen and approve the first pan-European hydrogen projects in the short term, as well as build a 17.5 GW electrolyzer hydrogen accelerator and develop a modern regulatory framework for hydrogen in the medium term (until 2027).

As the Plan suggests, renewable hydrogen is seen as the "key" to replace natural gas, coal and oil in hard-to-decarbonize industries and transport. It should also be noted that along with green hydrogen, other forms of hydrogen also play an important role in replacing natural gas. REPowerEU sets a target of 10 million tons of renewable hydrogen domestic production and the same amount of imported renewable hydrogen by 2030. To achieve the set targets, it is planned to: quickly complete the revision of the hydrogen and gas market package; replenish Horizon Europe's Hydrogen Joint Venture investment to double the number of hydrogen valleys; submit for public consideration two delegated acts on the definition and production of renewable hydrogen; complete the evaluation of the first important projects of common European interest

[30] Russia–ASEAN Summit. http://kremlin.ru/events/president/news/67019.

[31] The signing of the Regional Comprehensive Economic Partnership Agreement (RCEP) took place on November 15, 2020, and from January 1, 2022, it entered into force for ten APR countries (Australia, Brunei, Cambodia, China, Japan, Laos, New Zealand, Singapore, Thailand, and Vietnam).

[32] A hydrogen strategy for a climate-neutral Europe. COM (2020) 301 final, Brussels, 8.7.2020. https://ec.europa.eu/energy/sites/ener/files/hydrogen_strategy.pdf. Cited August 10, 2021.

[33] Fit for 55. https://www.consilium.europa.eu/en/policies/green-deal/fit-for-55-the-eu-plan-for-a-green-transition/

[34] Hydrogen and decarbonized gas market package. https://energy.ec.europa.eu/topics/markets-and-consumers/market-legislation/hydrogen-and-decarbonised-gas-market-package_en. Cited August 10, 2021.

in hydrogen by summer 2023; Accelerate work on missing hydrogen standards – in particular for hydrogen production, infrastructure and instrument end-use; from 2025 to report, in close collaboration with Member States, on the uptake of hydrogen and the use of renewable hydrogen in hard-to-reach appliances in industry and transport.

As steps towards achieving the above goal, one can regard the industry's commitment to tenfold increase in the corresponding production capacity by 2025, enshrined in the Joint Declaration adopted at the European Electrolysis Summit (05.05.2022), as well as the discussion of draft legal acts aimed at clarifying the definition of renewable hydrogen [Belov, 2022].

The goal of REPowerEU to diversify supply and support the EU Energy Platform is being pursued by the EU Energy Platform Task Force. It is designed to provide alternative supply and demand aggregation, conduct capacity coordination and power negotiation, provide support to Regional Task Forces of Member States and neighboring countries, and manage the outreach of international partners. According to the plan, the combined international activity is expected to focus on establishing a long-term cooperation framework with trusted partners through binding or non-binding agreements that support the development of gas, hydrogen and clean energy procurement projects, while fully utilizing the alliance's collective strength.

In addition, the IPCEI Hy2Tech approved by the European Commission on July 15, 2022, "the first ever important project of common European interest in the hydrogen sector," contributes to the implementation of the REPowerEU plan. It involves 35 companies and 41 projects from 15 Member States. The project aims to develop innovative technologies for the hydrogen value chain to decarbonize industrial processes and mobility.

The documents discussed above are intended to ensure cooperation in areas where it is more effective to act in a coordinated manner at the EU level, rather than at the national level. The key factor for achieving the goals stated in them should be the renewal of national energy plans and strategies, including in the area under consideration.

It should be noted that at present almost all EU countries have developed hydrogen strategies. However, they differ significantly. For example, Germany puts an emphasis on the chemical, petrochemical, and steel industries, as well as on heavy vehicles; France prioritizes the replacement of carbon-based hydrogen in existing industrial sectors and the production of electrolyzers; the Netherlands develops a hydrogen infrastructure to connect various users; Norway aims at hydrogen production close to customers and transporting CO_2 back to Norway for storage; while Spain and Portugal seek renewable hydrogen production and domestic consumption with long-term export targets.[35]

Despite the existing differences, it is essential that national ambitions develop over time into a common strategy at the European level. As rightly noted by researchers, structural differences between EU countries open up the potential for a new European division of labor within a common hydrogen network, in terms of both production and consumption. This highlights the need for cross-country cooperation when planning the European hydrogen infrastructure [Wolf and Zander, 2021]. The aforementioned alliance, which is open to all stakeholders (industrial companies, government agencies, and the research and innovation community, as well as representatives of civil society), is also called upon to contribute to this, both striving to contribute to the introduction of renewable and low-carbon hydrogen and planning to use it by ensuring the use of advanced hydrogen technologies and equipment in cooperation with the relevant EU partner networks in the field of research, development, and innovation [Belov, 2020].

In general, the set of documents aimed at the transition to a carbon-neutral economy and society in Europe by adopting the principles of a circular economy and the use of hydrogen on a large scale as a fuel, as a means of storing energy as a feedstock for various industries [Bonciu, 2020], including the Green Deal, the New Industrial Strategy for Europe, the EU Energy System Integration Strategy, and the Hydrogen Strategy for a Climate-Neutral Europe, could well be seen as a comprehensive roadmap. At the same time, the adoption of REPowerEU as a first step to create an internal market for hydrogen and calcified gases, as well as regulation of the calcined gas sector, has become a serious bid to be a major player in today's geopolitical energy landscape.

Nevertheless, in the end, as noted by I. Kopytin and A. Popadko, the prospects for the development of hydrogen energy depend on the ability of companies in the real sector to integrate hydrogen into their business models [Kopytin and Popadko, 2021]. Within the framework of this article, it is not possible to consider all international projects of leading European companies. Let's take a look at some of them, for example:

—the NortH2 green hydrogen project implemented by Royal Dutch Shell in cooperation with RWE, Equinor, Gasunie and Groningen Sea Ports;

—H2SHIPS – an EU project aimed at developing infrastructure for shipping using a hydrogen engine, which is implemented by a subsidiary of the EDF Group;

[35]Hydrogen on the horizon: Ready, almost set, go?, Working Paper, National Hydrogen Strategies. https://www.worldenergy.org/assets/downloads/Working_Paper_-_National_Hydrogen_Strategies_-_September_2021.pdf. Cited August 11, 2022.

—HyLaw, an FCH JU funded project to raise awareness of legal barriers that need to be removed, brought together 23 partners from Austria, Belgium, Bulgaria, Denmark, Finland, France, Germany, Hungary, Italy, Latvia, Norway, Poland, Romania, Spain, Sweden, Portugal, the Netherlands and the United Kingdom;

—GET H2 is a project for the construction of an integrated hydrogen infrastructure linking the electric power industry, thermal power industry, industry and transport along the entire value chain, in which RWE-Generation, Nowega, OGE, Gascade, BP, BASF, Stadtwerke Lingen, Hydrogenious Technologies and others are participating.

Also supported by ArcelorMittal, Enagás, Fertiberia and DH2 Energy is HyDeal Spain, the world's largest renewable hydrogen project (according to IRENA) for green steel, green ammonia and green fertilizer. BP Plc will lead another of the world's largest clean energy projects, AREH, which aims to bring green hydrogen from Australia to key markets.

Examples of the latest hydrogen projects of European companies include a large hydrogen storage facility being built by Uniper SE, Robert Bosch GmbH's investment in the development of components for the electrolysis production of hydrogen until 2030, a project by Deutsche Bahn AG and Siemens Mobility GmbH to create a train running on hydrogen fuel and others [Belov, 2022].

LEGAL SUPPORT OF HYDROGEN ENERGY

For the formation of a new sector of the economy, it is of fundamental importance to create a system of legal regulation not only at the international level but also at the national level. At present, hydrogen energy is only at the beginning of its development. As it develops, legal regulation in this area will begin to take shape. To date, we can state the absence of a comprehensive and clearly defined legislative framework necessary for the development of hydrogen energy.

Interest in hydrogen is growing, and an increasingly more countries are involved in the development of clean hydrogen value chains. It is significant that over the past five years the number of states that have developed or are developing strategies for the use of hydrogen has increased from 1 to 30.[36] However, there are significant differences in the scope and details of these strategies.

Countries claiming leadership in clean hydrogen technology include Japan, the United States, Germany, South Korea, China, and Russia. Policies to regulate and incentivize industry players and consumers, as well as the development of a regulatory framework to facilitate hydrogen production, have an important role to play in achieving leadership.

For example, Japan, the first country that adopted a national hydrogen strategy (2017) and announced its intention to create a "hydrogen society" through the widespread use of hydrogen in all sectors of the economy, currently has no laws regarding the use of hydrogen [Niunoya et al., 2021]. Hydrogen safety is governed by the provisions of the High Pressure Gas Safety Act,[37] and its storage and transportation, along with the above, by the Road Traffic Act,[38] the Road Transport Vehicle Act,[39] the Seaports Act, rules for the transport of dangerous goods, and other rules that establish technical standards. Environmental safety issues in hydrogen handling are regulated by the Air Pollution Control Act,[40] Noise Regulation Law,[41] the Vibration Regulation Law,[42] and others.

Regulation in this area in the United States at the federal level, dating back to the 1990s, is based on the provisions of the Spark M. Matsunaga Hydrogen Research, Development, and Demonstration Program Act,[43] Hydrogen Future Act (1996),[44] Energy Policy Act (2005),[45] Energy Independence and Security Act (2007), and the 45Q Tax Credit.[46] As part of the latter, in July 2020 alone, about $64 million were allocated to finance 18 projects for the affordable production, storage, transportation, and use of hydrogen [Azni and Md Khalid, 2021]. In 2002, the National Hydrogen Energy Roadmap was adopted.[47] It is also important to note here that each US state has its own roadmaps for the implementation of hydrogen infrastructure. At the state level, California, Texas, and

[36] IRENA (2022), *Geopolitics of the Energy Transformation: The Hydrogen Factor*, International Renewable Energy Agency, Abu Dhaby. https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2022/Jan/IRENA_Geopolitics_Hydrogen_2022.pdf.

[37] High Pressure Gas Safety Act. Act No. 204 of June 7, 1951. https://www.japaneselawtranslation.go.jp/en/laws/view/1974.

[38] Road Traffic Act. 1960. Act No. 32 of 2022. Official Gazette, April 27, 2022. https://perma.cc/LJA3-7YHL. Cited August 10, 2021.

[39] Road Transport Vehicle Act Amended. Act No. 185 of 1951. https://perma.cc/KRD3-8WXU. Cited August 10, 2021.

[40] Air Pollution Control Act. Act No. 97 of June 10, 1968 (2018 ed.). https://www.japaneselawtranslation.go.jp/en/laws/view/3561/en. Cited August 10, 2021.

[41] Noise Regulation Law. https://www.env.go.jp/en/laws/air/noise/ap.html. Cited August 10, 2021.

[42] Vibration Regulation Law. https://www.env.go.jp/en/laws/air/vibration/ap.html. Cited August 10, 2021.

[43] Spark, M. Matsunaga Research, Development, and Demonstration Program Act. https://www.hydrogen.energy.gov/pdfs/matsunaga_act_1990.pdf. Cited August 10, 2021.

[44] Hydrogen Future Act. https://www.hydrogen.energy.gov/pdfs/hydrogen_future_act_1996.pdf. Cited August 10, 2021.

[45] Energy Policy Act of 2005. https://www.energy.gov/sites/prod/files/2014/03/f14/EPAof2005.pdf. Cited August 10, 2021.

[46] 45Q Tax Credit. https://www.law.cornell.edu/uscode/text/26/45Q. Cited August 10, 2021.

[47] National Hydrogen Energy Roadmap. https://www.hydrogen.energy.gov/pdfs/national_h2_roadmap.pdf. Cited August 10, 2021.

Louisiana are recognized by the US Department of Energy as top hydrogen producing states.

In South Korea, hydrogen energy is subject to the Act on the Development and Use of Alternative Energy Technologies, adopted back in 1987. The next step to create a legal framework for regulating relations in this area after the adoption in 2019 of the Hydrogen Economy Roadmap until 2040 in Korea[48] was the adoption in 2020 of the Act on Fostering the Hydrogen Economy and Hydrogen Safety Management (Hydrogen Economy Law).[49]

Germany is also one of the few countries with specific legislation in this area. Along with the National Hydrogen Strategy, adopted in 2020,[50] the updated Energy Act is in force,[51] containing provisions ensuring the regulation of hydrogen networks, as well as the Electric Mobility Act[52] and Climate Action Plan up to 2050.[53]

Unlike the above countries, China has not yet enacted laws or regulations on the use of hydrogen energy. However, the Energy Law[54] lists hydrogen as an energy source that is subject to inclusion in the energy statistics of the National Bureau of Statistics.

In Russia, according to the Decree of the President of the Russian Federation On the National Goals and Strategic Objectives of the Development of the Russian Federation for the Period up to 2024[55] and the provisions of the Energy Strategy of the Russian Federation for the Period up to 2035,[56] hydrogen energy is one of the priority areas of the state energy policy, and its development is one of the strategic tasks facing the state. The forecast for the scientific and technological development of the Russian Federation for the period up to 2030 classifies hydrogen technologies as one of the most promising areas of scientific technology research.

The program of measures designed to ensure the formation of hydrogen energy in Russia was approved by the roadmap for the development of hydrogen energy in the Russian Federation until 2024.[57] The result of the first stage of its implementation was the development and approval of the Concept for the Development of Hydrogen Energy in Russia.[58]

Furthermore, the priority measures to be implemented at the first stage of the industry development include activities to create the hydrogen energy necessary to ensure its functioning and integration into the country's economy with access to the international markets of the legal framework. As for the currently existing regulatory framework, it includes a system of standards governing the generation, storage, transportation, and some types of use of hydrogen and establishing a common terminology, safety requirements, test methods, etc., as well as legislative norms in energy supply, which are mainly declarative and programmatic in nature and only indirectly regulate relations in the area under consideration.

Also, when characterizing documents of a program-strategic nature aimed at developing the area under consideration in the face of new economic challenges, one should also mention the Comprehensive Program for the Development of the Low-Carbon Hydrogen Energy Industry in the Russian Federation until 2035, which is under development (which is scheduled to be completed by the end of 2022). It "will become an aggregator of all previously adopted profile documents – the road map and the Concept for the development of the industry." Particular attention in the document will be paid to the development of domestic competencies and technologies as the final product for export. In addition, strategic initiatives for the socio-economic development of the country (federal projects).

In search of approaches to the legalization of hydrogen energy, lawyers note the possibility of extending gas supply legislation to relations in the field of hydrogen circulation [Semenovich, 2022], as well as the use of the already established infrastructure of the oil and gas industry for the implementation of hydrogen projects with targeted study of projects to create infrastructure solutions for hydrogen energy [Vasilkova, 2022].

[48]Hydrogen Economy Roadmap of Korea. https://docs.wixstatic.com/ugd/45185a_fc2f37727595437590891a3c7ca0d025.pdf. Cited August 10, 2021.

[49]Act on Fostering the Hydrogen Economy and Hydrogen Safety Management. https://www.law.go.kr/LSW/lsInfoP.do?lsiSeq=213891&chrClsCd=010202&urlMode=lsInfoP&efYd=20210205&ancYnChk=#0000. Cited August 10, 2021.

[50]National Hydrogen Strategy. https://www.bmwk.de/Redaktion/EN/Publikationen/Energie/the-national-hydrogen-strategy.pdf?__blob=publicationFile&v=6. Cited August 10, 2021.

[51]Energy Act amendment 4, July 2021.

[52]Electric Mobility Act of 2015. https://www.now-gmbh.de/wp-content/uploads/2022/04/NOW_Leitfaden-EmoG_03.22.pdf. Cited August 10, 2021.

[53]Climate Action Plan 2050. https://www.bmuv.de/en/download/climate-action-plan-2050. Cited August 10, 2021.

[54]http://www.nea.gov.cn/2020-04/10/c_138963212.htm. Cited July 20, 2021.

[55]Decree of the President of the Russian Federation of May 7, 2018, No. 204, On the National Goals and Strategic Objectives of the Development of the Russian Federation for the Period up to 2024, *Collection of Legislation of the Russian Federation* (2018), No. 20, Article 2817.

[56]Decree of the Government of the Russian Federation of June 9, 2020, No. 1523-r, On Approval of the Energy Strategy of the Russian Federation for the Period up to 2035, *Collection of Legislation of the Russian Federation* (2020), No. 24, Article 3847.

[57]Action plan (roadmap) for the development of hydrogen energy in the Russian Federation until 2024, approved by Order of the Government of the Russian Federation dated October 12, 2020, No. 2634-r. https://minenergo.gov.ru/node/19194.

[58]Decree of the Government of the Russian Federation of August 5, 2021, No. 2162-r, On Approval of the Concept for the Development of Hydrogen Energy in the Russian Federation. http://static.government.ru/media/files/5JFns1CDAKqYKzZ0mnRADAw2NqcVsexl.pdf. Cited August 10, 2021.

As noted in the legal literature [Semenovich, 2022; Ratushnyak, 2021], to create an effective legal framework for the emerging energy industry, a number of tasks have to be solved: to develop and legislate a definition of the concept of hydrogen, to include hydrogen among strategic energy resources, to determine the legal regime of hydrogen as an object of public relations, to form a system of relations between the subjects of hydrogen energy, etc. Of no small importance for improving the legal framework for the development of hydrogen energy, along with measures to create mechanisms to stimulate and support the development of hydrogen energy, is amending tax legislation to support the development of hydrogen energy and making changes and additions to the system of trade and customs regulation.

One of the problematic issues is the inclusion of hydrogen in renewable energy sources. The Federal Law of the Russian Federation On the Electric Power Industry[59] contains a closed list of types of energy related to renewable energy, in which hydrogen is not listed, which, in turn, deprives it of state support measures aimed at stimulating renewable energy sources. However, other countries are paying increased attention to the issues of stimulating the development of hydrogen energy. For example, the US Energy Policy Act defines hydrogen as an alternative fuel, and this allows for the full benefits of this Act. In turn, in South Korea, the Law on the Development and Use of Alternative Energy Technologies of 1987 includes the concept of new and renewable energy, where hydrogen is classified as new energy. French legislation enshrines and defines concepts such as *renewable hydrogen*, *low-carbon hydrogen*, and *carbon-based hydrogen*.

In fairness, it should be noted that the current regulation of hydrogen energy in foreign countries is also not free from gaps that hinder the development of the industry. For example, German legislation does not cover aspects such as the capture and storage of emissions associated with the production of blue hydrogen, while the new rules included in the Energy Law are only transitional, and the technical rules for increasing the mixing of hydrogen with the natural gas network are still under consideration.[60] In France, the sale of hydrogen was among the unregulated areas.[61] In the United States, challenges include the need to upgrade codes and standards applicable to hydrogen storage systems and interface technologies and a lack of standardization of hardware and operating procedures.

In addition to legislative measures, the development of hydrogen energy is regulated by instruments such as standardization and certification. However, at this stage, the priorities for standardization between states vary greatly. This hinders cooperation and delays the development of hydrogen demand and investment and raises questions about harmonization.[62] A good example of standards initiatives is Japan's proposal to develop international regulations for the maritime transport of liquefied hydrogen through the International Maritime Organization (IMO). With regard to the standards adopted by states, the Standard and Assessment of Low-Carbon Hydrogen, Clean Hydrogen, and Renewable Hydrogen is worth mentioning as the first official green hydrogen standard in the world, which provides methods for calculating greenhouse gases for various means of hydrogen production [Liu et al., 2022], released by China in December 2020.

A serious problem, in our opinion, is that, in an environment where legislative and regulatory measures are still in the development stage, hydrogen projects are launched rapidly by simplifying the existing framework, as well as reducing potential barriers and administrative burden.[63] The desire for rapid implementation of such projects comes into conflict with safety, which is often seen as an obstacle to promoting the hydrogen market. The widespread use of hydrogen technologies carries risks for society, is associated with negative environmental effects that have not yet been calculated [Degtyarev and Berezkin, 2021], and requires the presence of highly qualified and trained personnel who can ensure the safety of the operation of such systems, as well as the development and adoption of a number of stringent requirements, standards, and regulations, which ensure safety and which are currently absent [Litvinenko et al., 2020]. In this part, it is significant that between 2000 and 2020, more than 90 accidents occurred in the field of hydrogen energy, such as the explosion of hydrogen storage tanks in South Korea in 2019 and the explosion of hydrogen at a Taiwanese power plant in 2022 [Chen et al., 2022].

CONCLUSIONS

Countries are still in search of optimal legal solutions in the field of hydrogen energy. "Optimality" here is determined by the fact that, when creating a new "hydrogen economy," countries (especially the Russian Federation) should not lose their existing competitive advantages, especially due to attempts by

[59] Federal Law of the Russian Federation of March 26, 2003, No. 35-FZ, On the Electric Power Industry, *Collection of Legislation of the Russian Federation* (2003), No. 13, Article 1177.

[60] CMS expert guide to hydrogen energy law and regulation facing the future of hydrogen. https://cms.law/en/int/expert-guides/cms-expert-guide-to-hydrogen. Citedhttps://cms.law/en/int/expert-guides/cms-expert-guide-to-hydrogen August 10, 2021.

[61] Hydrogen law and regulation in France. https://cms.law/en/int/expert-guides/cms-expert-guide-to-hydrogen/france. Cited August 10, 2021.

[62] Hydrogen on the horizon: Ready, almost set, go?, Working Paper, National Hydrogen Strategies. https://www.worldenergy.org/assets/downloads/Working_Paper_-_National_Hydrogen_Strategies_-_September_2021.pdf. Cited August 11, 2022.

[63] Ibid.

a number of states and their associations to deprive Russia of such competitive advantages using sanctions.

With the development of internal regulation, one should also not lose sight of the international legal component in the development of hydrogen energy, especially since many issues that are important and controversial in the field of traditional energy (for example, transportation using pipelines) will also be relevant for the development of hydrogen energy. International cooperation in the field of hydrogen energy is currently actively developing; however, even within the framework of individual integration associations, clear strategies and plans have not yet been formed, which does not contribute to achieving visible effects from cooperation, while ensuring the stability of international energy markets requires a global dialogue on current energy issues.

Ideally, it is necessary to develop new rules at the international level, which should be enshrined in the relevant international agreements in the area under consideration. In addition, the issues of international coordination of the activities of international "hydrogen" initiatives and international organizations the activities of which are more or less related to hydrogen, and, possibly, the issue of creating an international organization that would become a world center for cooperation in the field of hydrogen, also need to be addressed.

This, however, seems to be a long way off. To what extent (and how) international legal acts will determine the development of hydrogen energy is still not completely clear; at the same time, it is obvious that, considering current geopolitical events, the scenario of creating a common international document, broad in scope of the participating countries and deep in scope of subjects of regulation, is not visible. Most likely, in the coming years we will see the implementation of the scenario for regulating hydrogen energy issues at the level of general agreements (declarative in content), bilateral and multilateral (within individual associations of states).

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