Prospective Markets for Russian and Mongolian Energy Resources in the Region of North-East Asia

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***Abstract* — The paper shows the importance of East Asian countries for energy export from Russia and Mongolia. Groups of factors that affect the development of the global and regional energy the most and are considered in the long-term forecast of energy consumption are identified. The high-tech energy development scenario built by the Institute of Energy Economics of Japan in 2021 for China and Japan is analyzed. The scenario assumes a decrease in energy consumption in Japan and its stagnation in China. This effect is to be achieved by enhancing energy efficiency and restructuring energy consumption. Both countries will reduce coal and oil consumption, but increase the share of nuclear and renewable energy. Japan will also cut down the consumption of natural gas. The paper concludes that, given the limited resource potential in China and the "island" economies of East Asia, even in the context of a forced energy transition, there will remain favorable prospects for the export of traditional energy sources from Russia and Mongolia to these markets.**

Index Terms: **Northeast Asia, energy forecast, energy transition, energy cooperation.**

I. Introduction

The energy resource exports are and will bSe of great importance for the development of the energy sector in Russia and Mongolia in the coming decades [1, 2]. The availability of significant resources of both traditional and renewable energy and the proximity to the world's largest energy importers (the countries of East Asia (EA)) indicate the need for a systematic update of assessments of opportunities for the development of energy cooperation in Northeast Asia (NEA – The economies of East Asia include China (with Hong Kong), Japan, Republic of Korea (R.Korea), Chinese province Taiwan, Democratic People's Republic of Korea (hereafter DPRK), and Mongolia. The economies (countries) of East Asia together with Russia constitute North-East Asia (NEA). The island economies of NEA include Japan, R.Korea, and Chinese province Taiwan.). The region has a traditionally high potential for cooperation in the trade in primary non-renewable energy resources (coal, oil, natural gas, uranium, hereafter NRER), the expansion of the relevant infrastructure, and for cooperation in the field of renewable energy [3–5] and hydrogen technologies [6, 7].

Table 1 presents several indicators that characterize the importance of the energy consumption in the EA countries for the world energy trade. China, Japan, R. Korea and Taiwan account for almost a third of world energy consumption, and their demand for NRER imports makes up a significant part of demand in the respective world markets.

For Russia and Mongolia, as the most important NRER exporters, these countries represent the most promising export market since their dependence on NRER imports in physical terms is 90–95%, see Fig. 1.

Further, we will consider three groups of NEA countries – China, island economies (Japan, R. Korea and Taiwan (or JKT)), Russia and Mongolia. The prospects for the energy development in the DPRK and its participation in the regional energy markets are not considered due to the significant uncertainty about the development of this country.

China's energy balance is characterized by the predominance of coal in primary energy consumption and an increasing dependence on oil and gas imports, while the country is self-sufficient in domestic fuel for nuclear power plants, has uranium enrichment technologies and capacities, and has achieved world-class competencies in the field of nuclear energy and renewable energy. Despite the lower level of dependence on energy imports in general compared to the JKT group, the most economically developed coastal provinces of China are energy deficient almost to the same extent as the second group of countries in the region (JKT), and generally follow the directions set

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Table 1. Importance of East Asian countries in the global energy sector in 2020, percent.

Indices	Total: China, Japan, R. Korea, Taiwan	Including China
Share in total energy consumption	32	26
Share in oil imports	39	25
Share in gas imports	43	17
Share in coal imports	49	17
Solar and wind power generation	30	27

Source: [8, 9].

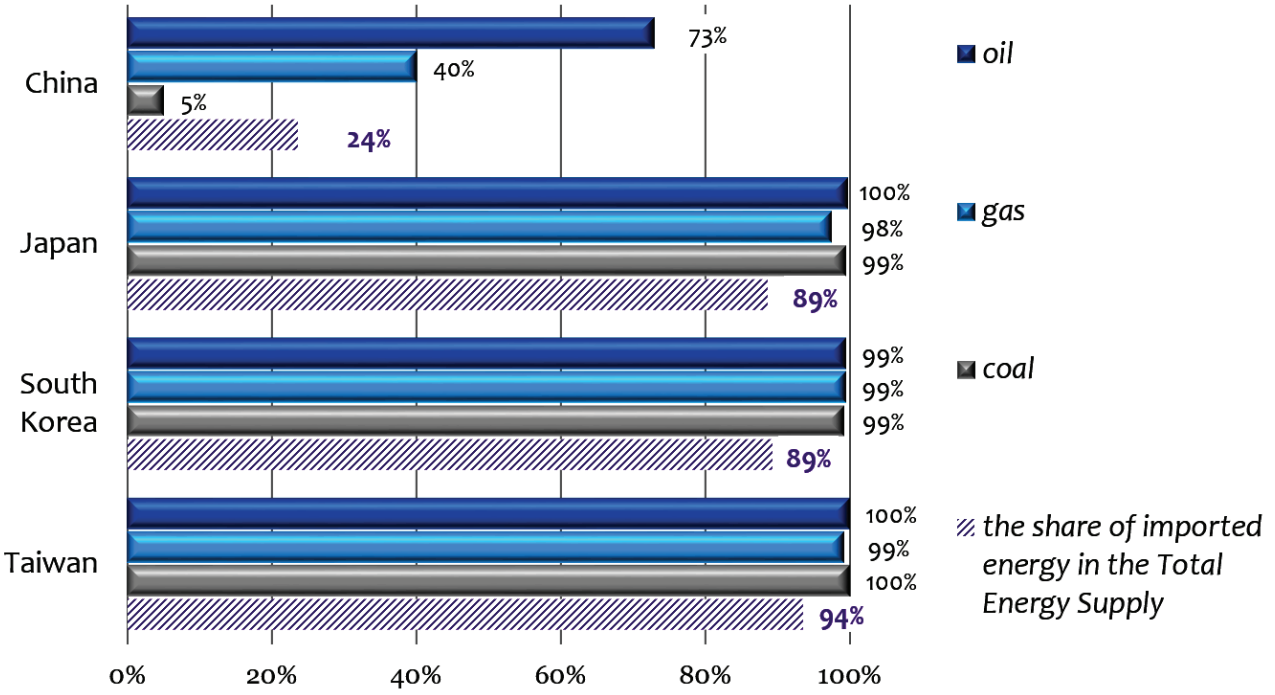

Fig. 1. Dependence of large East Asian countries on energy imports in 2020. Source: Estimated based on [8, 9].

by these countries for the development of energy systems.

The second group is characterized by the greatest degree of dependence on energy imports, and also by a higher energy efficiency of the economy. In addition, Japan and Taiwan have restrictions on the use of renewable energy resources due to elevated seismicity and high land costs.

II. World energy development trends

There are four main groups of factors that currently have the greatest impact on the development of energy sector as the most important infrastructure subsystem of human society: technological, social, economic, and political. All of them fully manifest themselves in the NEA region and the Indo-Pacific region as a whole. The following is a list of the main factors for each group, which are taken into account to predict the global and regional energy development in the long term.

Technological factors:

- Enhancement of the efficiency of energy resources at the stages of energy transportation, conversion, and final consumption;
- Growth of consumer electrification, including the electrification of the transport sector through the introduction of hybrid power plants and electric drives;
- Commercialization of solar and wind energy technologies;
- Complication of energy storage and transportation systems with an increase in the share of renewable energy sources in the structure of primary energy, accompanied by an extension of energy supply chains and, accordingly, an increase in energy losses while meeting the needs of society in energy services;
- Surge in the research on the development of hydrogen technologies for energy purposes.

Social factors:

- Change in lifestyle and increase in the consumption of energy services aimed at meeting the non-production, social, and creative needs of social development;
- Change in the demographic profile of the population in economically developed and developing countries.

Economic factors:

- Increase in the range of issues about resource support for technological development, including the transition to the development of new NRER fields, which are

Table 2. Main indices of the possible energy sector restructuring in the largest economic countries of East Asia in 2020-2050.

Indices	China		Japan		OECD	
	2019	2050	2019	2050	2019	2050
Final energy consumption, EJ, including	72	74	12	8	155	117
Electricity, %	27	46	29	42	22	37
Total energy consumption, EJ, including	142	114	17	13	219	170
Coal, %	61	30	28	13	15	5
Oil, %	19	19	38	27	35	24
Natural gas, %	7	14	22	14	29	25
Nuclear energy, %	3	11	4	19	10	14
RES, %	10	27	8	27	11	32

Source: Estimated based on [10].

Table 3. Relative change in the capacity of the energy markets of China, Japan and the developed countries of the world, % (a ratio of 2050 indices to 2020 indices).

Indices	China	Japan	OECD
Electricity consumption	144	101	127
Energy conversion, storage and transportation losses	90	110	106
Energy consumption, including	80	73	77
Coal	39	33	28
Oil	79	52	53
Natural gas	152	46	67
Nuclear energy	321	341	110
RES	222	259	218

Source: Estimated based on [10].

characterized by high production costs;

- Exacerbation of problems in building the international value chains in the context of uneven resources available in the countries and their technological development.
- *Political and geopolitical factors*:
- The beginning of a period of active transformation of all international institutions as a result of the global financial and economic crisis;
- Transformation of the architecture of world energy markets and the capital market in the face of political pressure on energy companies;
- Lobbying for "green" energy at the national and international level.

In addition to the above, it is worth noting that the importance of environmental and climatic factors increases when planning the development of energy infrastructure and substantiating investment decisions. Furthermore, the developing global financial and economic systemic crisis has raised the importance of the geopolitical factor in assessing the prospects for the transformation of global and regional energy markets.

Ahead of all Mankind are decades of hard work on building a new energy infrastructure, as one of the most crucial components of its civilizational development, which should be energy efficient, environmentally friendly, accessible to all, contributing to social and economic development. East Asian countries are at the forefront of these processes.

III. Energy Prospects for East Asia

The total impact of these factors on the energy sector of the first two groups of NEA countries will be considered using the scenario of high-tech energy development in Asian countries and the world as a whole until 2050, which was built in the framework of the world energy development forecast prepared by the Institute of Energy Economics of Japan (Table 2). The forecast was made in 2021 and does not reflect the radical changes in the institutions of world energy trade, as well as the increased influence of geopolitical factors, which fully manifested themselves in the autumn and winter of 2021–2022.

Against the backdrop of a significant decline in the final energy consumption in Japan and the OECD countries, the stagnation of this indicator for China draws attention. This is explained, apart from the integration of demographic and socio-economic factors, by the delay in the processes of China's energy sector restructuring, a decrease in the coal share in the structure of energy consumed, and the later start of the processes related to the improvement in the energy efficiency of technologies at the stages of conversion and final consumption. These conclusions are supported by the difference in the proportion of electricity in final energy consumption and changes in electricity consumption over the period under review for China, Japan and the OECD as a whole (Tables 2 and 3).

The integrated index of change in the energy efficiency differs depending on the stage of saturation with innovative energy technologies. The "Energy conversion, storage and transportation losses" index in

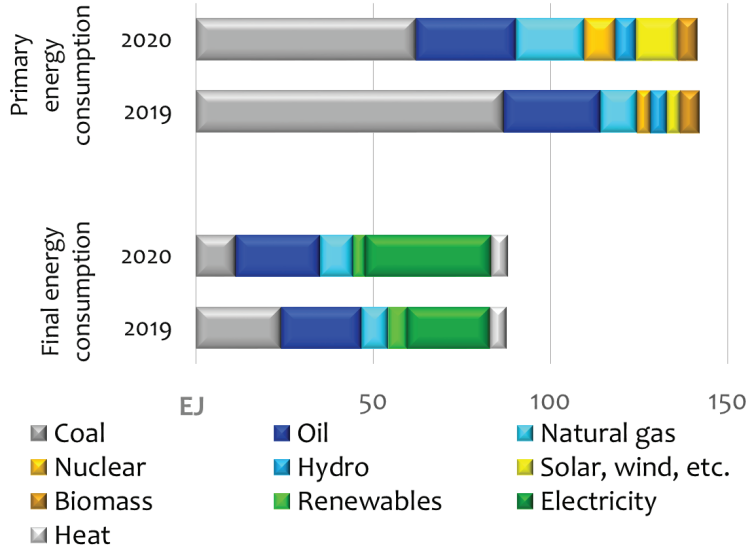

Fig. 2. China's energy consumption forecast 2019-2050. Source: Estimated based on [10].

Table 3 indicates a significant decrease in energy losses for China (by 10%, from 38% of total energy consumption in 2019 to 35% in 2050) and their growth for Japan and the OECD, respectively, by 10% (from 33% of total energy consumption in 2019 to 36% in 2050) and 6% (from 29% of total energy consumption in 2019 to 31% in 2050).

The total energy consumption for all considered subjects of the world economy will decrease. In 2050, compared to 2018, energy needs of China may decrease by 20%, the OECD – by 23%, and Japan – by 27%. At the same time, these countries will see a significant reduction in the coal and oil consumption, with a decrease in natural gas consumption in Japan and the OECD as a whole. In China, the demand for natural gas will increase by 1.5 times. The need for nuclear energy in China and Japan will rise by 2.2–2.6 times, and the consumption of RES – by 3.2–3.4 times. It is however necessary to factor in the limited natural potential of RES, the absence of natural potential of NRER (with the exception of methane hydrates) for the group of JKT countries and low economic potential for increasing natural gas production in China, which is due to the high share of hard-to-recover reserves in their overall structure. An additional limitation for the JKT countries is the absence of uranium enrichment facilities.

The forecast of changes in China's energy consumption for 2019–2050, presented in Fig. 2, reflects trends in the structure and scale of the country's final and total energy consumption. Given the available domestic NRER and RES, as well as the advances in the development of the nuclear energy industry, China will be able to ensure the highest possible level of independence from coal imports and uranium enrichment services. At the same time, the need for oil, natural gas, and unenriched uranium imports may remain at a fairly high level. The IEEJ calculations point to an increase in the energy efficiency of the total energy resources in China from 62% in 2019 to 65% in 2050. This effect will be primarily achieved through the enhanced energy efficiency at the stage of end-use. It will be crucial to replace some energy carriers with others (coal with gas, nuclear energy, and renewable energy sources) and to increase the electrification of consumers of energy services. In addition, it is assumed that after 2030, the creation of hydrogen energy industry will begin to accelerate, and after 2040–2050, there will be an accelerated construction of the infrastructure for large-scale transportation of green hydrogen and hydrogen carriers.

IV. Russia and Mongolia to support the energy export in the long term

In the context of the expected decline in the total volumes of imports of all types of NRER in the energy markets in the NEA region, Russia and Mongolia, acting as energy exporters, aim at:

- Diversifying buyers of energy carriers and energy services both in the NEA region and in adjacent markets in the Asia-Pacific and Indo-Pacific regions;
- Maintaining high competitiveness of their products, including coal and energy of RES (Russia and Mongolia), hydrocarbons and uranium enrichment services (Russia);
- Developing cooperation with purchasing and transit countries to strengthen the institutions of energy markets and expand the technological infrastructure for energy transportation.

As already mentioned, in the coming decades, the pace of transformation of the international energy infrastructure in the NEA region will be determined by political, economic, social, technological, and natural factors. Energy market institutions, both regional and

international, will set the conditions for transforming the energy infrastructure. At the same time, these institutions can act as objects of influence due to the impact of new geopolitical factors created by already completed critical stages in the development of such an infrastructure. Thus, the creation of an international power interconnection in NEA requires prior political consent to such close energy cooperation, which significantly affects national security. In turn, the fact of a significant share of Russia in the supply of oil and natural gas to Japan and the Republic of Korea strongly opposes the US policy pushing the countries of the second group in the NEA region to refuse from energy cooperation with Russia.

The economic and geographical features of the NEA region favor the formation of China's transit monopoly on export routes from Mongolia to markets emerging in the countries of Indo-Pacific region. There are no river routes bypassing China, and the use of road and rail transport to deliver the products to the ports of the Russian Far East, with the obligatory stage of transshipment to sea vessels, significantly reduces the competitiveness of energy resource exports. The coastal provinces of China and the Korean Peninsula will remain areas of competition between energy supplied by land transport from Russia and Mongolia, and energy imported by sea. This situation will be most noticeable in the natural gas market, where the LNG spot market acts as a source of balancing supplies during periods of peak demand.

Land freight transport systems are immobile since they are based on the pipelines, roads and railways, the construction of which is capital-intensive, and the transportation of goods by them is an energy-intensive and costly activity often involving transit through third countries. Unlike land systems, maritime transport allows transporting energy carriers at any distance and along any route, avoiding (for the considered groups of energy importers) transit problems.

The technological factor, i.e., the commercialization of electricity generation based on renewable energy sources, primarily solar and wind energy, supplemented by storage batteries, allowed oil-importing countries, relying on transnational corporations, to put forward a new energy development paradigm, the so-called "carbon-free energy." This approach is also supported by advances in the commercialization of hydrogen technologies (fuel cells, hydrogen and hydrogen carrier storage and transportation systems). The political course towards accelerated «decarbonization» is combined with the expansion of information technologies and their wide-scale adoption. The latter involves the automation of control of almost all technological processes and even a change in social life, which rely on the creation of global communication systems (the most significant example is the Internet), and systems for collecting, storing, and processing large amounts of data.

The energy transition, which aims to provide "clean, green" energy to a technologically renewed society, is a socio-economic and political project. This project is implemented relying on the coordination of the efforts of such influential actors as transnational corporations and governments of the "most developed countries of the world," the so-called generalized West. The process of globalization at the beginning of 2022, however, shows a clear lack of unity among the actors, as well as the presence of other opinions in the world on the pace and mechanisms for the transition of mankind to a new technological base for its development.

Based on the above understanding of the Energy Transition, we will put forward a hypothesis that the pace of energy transformation will be determined by the interaction of political, economic, social, technological and natural factors. They will differ for all three previously identified groups of NEA countries at the national level (and subnational – for China and Russia). An even greater complication of the geopolitical situation in the NEA region will lead to deeper processes of transformation of the international cooperation institutions. The political factor will be aimed at changing the structure of the total energy consumption in East Asian countries and regulating the choice of partners for energy imports.

The analysis of the current situation in the energy markets in the NEA region, the prospects for restructuring energy consumption in China and the group of JKT countries, changes in the institutions of international energy cooperation in the world, in general, and in the NEA region, in particular, allows some qualitative conclusions about the prospects for energy exports from Russia and Mongolia (the third group of countries). Traditional energy sources (oil, coal, natural gas (methane), and electricity (to China)) will remain competitive. At the same time, quantitative estimates of the prospective needs of East Asian countries for energy imports and the development of regional energy markets require significant joint systematized, coordinated and regular studies.

By the end of the 2040s, the conditions for a market for green hydrogen (hydrogen carriers) and the related electro-hydrogen infrastructure can be created in the region. Given the extent to which the infrastructure for the maritime transport of oil, oil products and natural gas in the form of LNG is developed in the NEA region, one should expect the formation of a unified gas transmission system in the region to begin. This system will combine the nodes of LNG import and regasification, with developed national and, in the future, international gas pipeline systems, and the establishment of relevant international institutions for regional trade in natural gas (methane). In the event of successful development of this process, the likelihood that an international electric power (electro-hydrogen) infrastructure will appear in the NEA region will also increase since the energy security factor is critical for creating such an infrastructure.

V. Conclusion

The energy development of the industrialized economies in East Asia is aimed at transforming the infrastructure for energy supply to consumers by replacing fossil energy sources with renewable ones. Given the availability of sufficiently efficient traditional fuel energy resources, the increase in the proportion of renewable energy sources will require the accelerated development of electricity transportation and storage systems. This process contributes to a significant complication of the entire energy system and the restructuring of sectors of the economy in East Asian countries.

As the economic potential of renewable energy resources is exhausted at the national level in the countries of East Asia, the need to create a regional international infrastructure for the import of green energy will increase. Russia and Mongolia have abundant natural resources both non-renewable and renewable, which far exceed the needs of these countries. These surplus resources can be in demand in North-East, South, and South-East Asia.

Quantitative estimates of projected energy consumption can vary over a wide range depending on the assumptions made in scenario. An example of a long-term high-tech energy development scenario constructed by the Institute of Energy Economics of Japan demonstrates that the expected reduction in energy consumption within its framework is based on optimistic estimates of energy efficiency and the commercialization of some innovative technologies. The multivariate development of the energy industry and the uncertainty about the prospects for the enhancement of innovative energy technologies require that our countries have several independent think tanks able to quantitatively assess the prospective needs of East Asian countries for energy imports and conduct regular research into the development of international transport infrastructure and energy market institutions in NEA region.

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References

[1] S. P. Popov, D.V. Maksakova, “East Asia as an object for Russia-Mongolia energy cooperation,” *Energy Systems Research*, no. 4, pp. 45–55, 2018.

[2] E. V. Batunaev, Yu. G. Grigoryeva, “Mongolia and the countries of Northeast Asia: trade, economic and integration cooperation (2009–2018),” Asia-Pacific Region: Economics, Politics, Law, no. 3, pp. 15–28, 2019. (In Russian)

[3] N. I. Voropai, S. V. Podkovalnikov, B. G. Saneev, “Interstate Energy Cooperation in Northeast Asia: Status, Potential Projects, Energy Infrastructure,” *Energy Policy*, no. 2, pp. 55–65, 2014. (In Russian)

[4] A. M. Mastepanov, “Integration processes in the energy sector of Northeast Asia and the role of natural gas in their development,” *Energy Policy*, no. 6, pp. 38–57, 2018. (In Russian)

[5] T. Otsuki, “Costs and benefits of large-scale deployment of wind turbines and solar PV in Mongolia for international power exports,” *Renewable energy*, vol. 108, pp. 321–335, 2017. DOI: 10.1016/j.renene.2017.02.018.

[6] S. P. Popov, D. V. Maksakova, O. A. Baldynov, “Evaluation of the possibilities and directions of creating an electro-hydrogen infrastructure in Northeast Asia,” *Geoeconomics of Energy*, vol. 17, no. 1, pp. 132–155, 2022. DOI: 10.48137/2687-0703_2022_17_1_132. (In Russian)

[7] S. P. Popov, “Methodological approach to the study of the electro-hydrogen system in Northeast Asia,” International Journal of Hydrogen Energy, vol. 47, no. 28, pp. 13524–13531, 2022. DOI: 10.1016/j.ijhydene.2022.02.191.

[8] World Energy & Climate Statistics – Yearbook 2021. Available at: https://www.enerdata.net/publications/world-energy-statistics-supply-and-demand.html (accessed 19.03.2022).

[9] BP Statistical Review of World Energy 2021. Available at: https://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy.html (accessed 19.03.2022).

[10] R. Casaubon, S. Endo, H. Hashimoto etc., *IEEJ Outlook 2022*. IEEJ: 2021. Available at: https://eneken.ieej.or.jp/data/10041.pdf (accessed 19.03.2022).

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