

The Fuel and Energy Balance of the Asian Regions of Russia for 2020

R.I. Muzychuk*, B.G. Saneev, A.D. Sokolov

Melentiev Energy Systems Institute of Siberian Branch of the Russian Academy of Sciences, Irkutsk, Russia

Abstract—The Asian regions of Russia play a significant role in the energy sector of the country. Almost 96% of coal and 25% of electricity produced in the country is produced in Asian Russia. More than 50% of this electricity is produced by hydro power plants. The reporting fuel and energy balances (FEBs) are the basis for strategic planning of the energy development of these regions. Specialists of the Melentiev Energy Systems Institute of Siberian Branch of the Russian Academy of Sciences (ESI SB RAS) built the reporting FEBs of the Asian regions for 2020 using the information and reference system for the development of regional FEBs. The FEB made for the Asian regions of Russia give the opportunity to determine the structures of production and consumption of fuel and energy resources in the territory and evaluate the efficiency of their use. The analysis of the FEBs shows the need to improve the energy balance of the Asian regions in terms of changing its structure and increasing energy efficiency and environmental friendliness of fuel use.

Index Terms: energy sector of the Asian regions of Russia, fuel and energy balance, production and consumption of energy resources.

I. INTRODUCTION

The importance of Asian regions in the Russian economy is constantly growing. The main role in the economy of the region is played by the energy sector (oil, gas, coal production) and processing industries, including metallurgical (aluminum and other metals), mining (non-ferrous metal ores), chemical, and timber industries, which depend greatly on the energy sector. Large oil and natural gas fields create the prerequisites for creating powerful

oil and gas complexes in Asian regions, which can satisfy not only the regional demand for natural gas, oil, and their products, but also supply excess hydrocarbons for export to Japan, China, Korea, and other countries of Asia-Pacific (APAC) region. The ports of the Far Eastern Federal District (FEFD) have a great importance for the development of Russia's trade with the countries of the Asia-Pacific region.

The Asian regions of Russia are the territories of the federal subjects of the Siberian Federal District (SFD) and the (FEFD) of Russia. They differ in scale and density of population, as well as in the development of the territory. The territory of the Asian regions is 11.3 mln km² or 66.1% of the country's area, where about 25.1 mln people or 17.2% of the country's population lives. These territories produce 16.1% (more than 15 trn rubles) of the country's gross domestic product [1].

The fuel and energy balances of the regions contain interrelated indices of the quantitative correspondence between the supply of fuel and energy resources and their consumption in the territory. They also indicate the fuel and energy distribution among the energy (electricity, heat, gas, and others) supply systems and energy consumers (groups of consumers), and assess the efficiency of the fuel and energy use [2].

The reporting fuel and energy balances serve as a basis for determining existing trends and conducting an energy-economic analysis of the current state of the energy sector [3]. They are built relying on the relevant reporting forms of Rosstat. Main objective of the balances is to show the availability, structure, and efficiency of the energy use in a certain territory.

II. METHODOLOGY

The Melentiev Energy Systems Institute SB RAS (ESI SB RAS) has accumulated extensive experience in the development of regional energy programs, part of which is the FEBs of the territories [4, 5]. The methodological approach is based on the principles of a systems approach, economic and mathematical modeling of the energy sector, and the balance method [6]. Since some forms of statistical reporting were nullified and some were changed, appropriate adjustments were made to the data input procedure of the information and reference system

* Corresponding author.

E-mail: rmuz@isem.irk.ru

<http://dx.doi.org/10.25729/esr.2023.01.0005>

Received March 16, 2023. Revised April 01, 2023.

Accepted April 03, 2023. Available online April 30, 2023.

This is an open access article under a Creative Commons Attribution-NonCommercial 4.0 International License.

© 2023 ESI SB RAS and authors. All rights reserved.

TABLE 1. Main Indices of Fuel and Energy Production in Russia, Asian Regions, SFD, and FEFD (as of 2020)

Index	Russian Federation	Asian regions	SFD	FEFD	Share of Asian regions in Russia, %
- Electricity, bn kWh	1 089.7	275.1	206.0	69.1	25.2
- Heat, mln Gcal	1 242.5	269.1	187.5	81.6	21.7
- Coal, mln t	398.1	382.1	306.9	75.2	96.0
- Natural and associated gas, bcm	694.5	58.8	16.8	42.0	8.5
- Oil, mln t	513.1	79.9	45.2	34.7	15.6
- Oil refining, mln t	275.1	54.1	42.6	11.5	19.7

Source: Rosstat data

TABLE 2. Main Indices of Fuel and Energy Consumption in Russia, Asian Regions, SFD, and FEFD (as of 2020)

Index	Russian Federation	Asian regions	SFD	FEFD	Share of Asian regions in Russia, %
Electricity, bn kWh	1 085.0	272.6	207.0	65.6	25.1
Heat, mln Gcal	1 126.3	235.0	164.8	70.2	20.9
Coal, mln t	167.6	114.8	81.8	33.0	68.5
Natural and associated gas, bcm	476.3	37.4	19.1	18.3	7.9

Source: Rosstat data

[7]. The adoption of the «Procedure for making fuel and energy balances of the subjects of the Russian Federation, municipalities» (Order of the Ministry of Energy of Russia dated October 29, 2021 No. 1169) required changes to the models for building the reporting and forecast fuel and energy balances.

III. SOURCE DATA

The energy sector of the Asian regions has a great resource potential, which made it possible to create a large fuel and energy base in these territories. In total, the SFD and the FEFD extract 96% of the country's coal, generate 25.2% of electricity and 21.7% of heat, produce 15.6% of oil and 8.5% of natural gas, and process 19.7% of all oil refined (Table 1).

Asian regions consume 142.3 mln t.c.e. of primary energy resources, which is 18.4% of all primary energy consumed in the country. In 2020, 114.8 mln t of coal was consumed in total, which accounted for 68.5% of the total coal consumption in Russia. Asian regions account for about a quarter of electricity consumed in the country (25.1%), just over a fifth of thermal energy consumption (20.9%), and a very low share of natural gas (7.9%)

(Table 2).

In Asian regions of the country, the structure of primary energy consumption is dominated by coal – 54.9% (whereas in Russia on average, the dominant fuel is gas – 71.2%).

IV. FUEL AND ENERGY BALANCE RESEARCH

According to the above methodological approach, the FEB was developed for the Asian regions of Russia for 2020 (Table 3).

In 2020, the energy sector of the Asian Russia produced (extracted) 473.8 mln t.c.e. (tons of coal equivalent) of primary energy. Coal predominates in the primary fuel and energy produced in the Asian regions of Russia (57.2%), oil accounts for 24.1%, natural gas makes up 14.2%, and the share of hydropower and renewable energy resources is 3.7%.

Asian regions imported 55.2 mln t.c.e. of energy resources, of which about 94% is oil.

Energy resources exported from the Asian regions make up 320.7 mln t, including 57% of coal, 27% of oil, 9% of oil products, and 7% of natural gas.

In 2020, the Asian regions of Russia consumed 208.7 mln t.c.e. of primary energy. The structure of primary

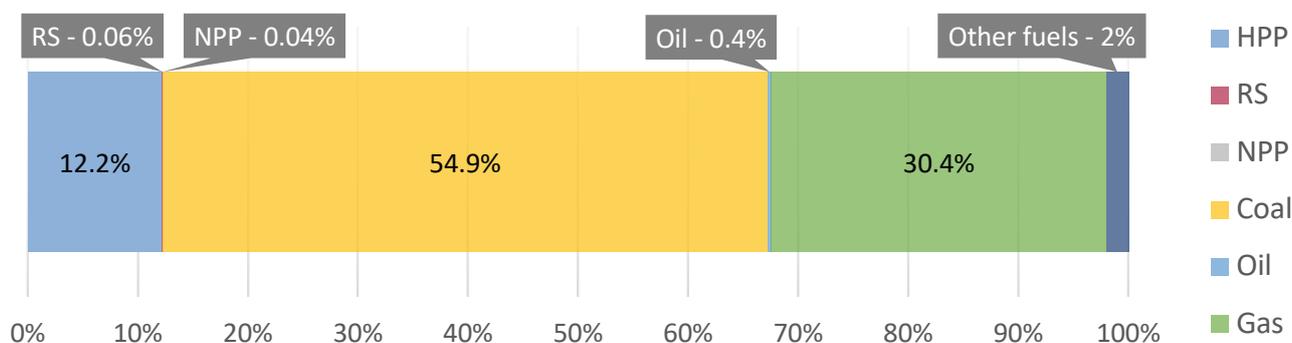


Fig. 1. Structure of primary energy consumption.

TABLE 3. FEB of the Asian Regions of the Russian Federation for 2020, Thousand t.c.e.

	Coal	Oil and oil products	Natural gas	Other solid fuels	Hydro energy and non-conventional RES	Nuclear energy	Electricity	Heat	Total
Energy production	271.2	114.2	67.9	2.9	17.5	0.06			473.8
Imports	3.3	51.8					0.1		55.2
Exports	-182.7	-114.9	-22.7				-0.4		-320.7
Reserves update	0.8	-0.4							0.4
Primary energy consumption	92.6	50.8	45.2	2.9	17.5	0.06	-0.3		208.7
Production of electricity at HPP, renewable and non-conventional energy sources and NPP					-17.5	-0.03	17.5		0
Thermal power plants	-47	-1.34	-13.7	-1			16.2	20.2	-26.6
Boiler plants	-10.6	-1.9	-4.4	-1.4				16.1	-2.2
Electric boiler plants, heat recovery units, and other heat sources							-0.03	-0.3	2.2
Coal processing	-14.5								-14.5
Oil refining		-2.4							-2.4
Auxiliaries							-2.1	-2.2	-4.3
Transmission loss		-2.8	-2				-2.7	-4.3	-11.8
Final consumption of energy resources	20.5	42.4	25.1	0.5			28.3	32	148.8

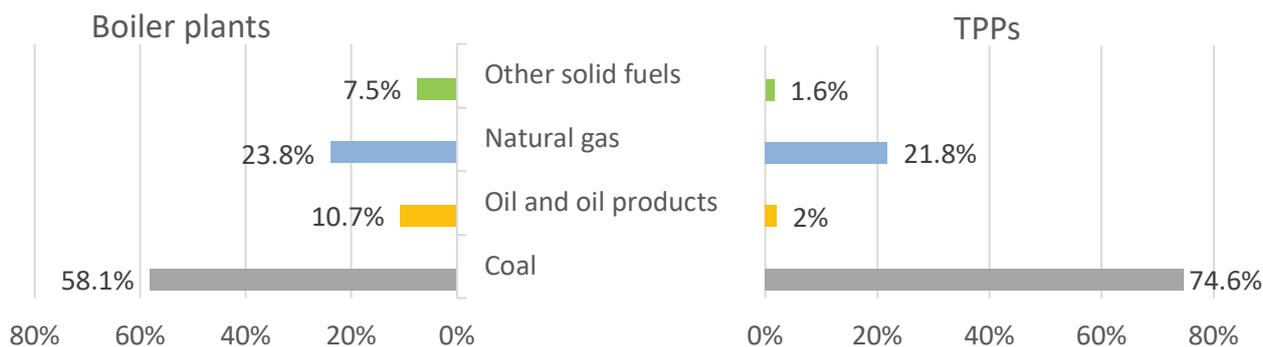


Fig. 2. Structure of fuel consumption at boiler plants and TPPs in the Asian regions of Russia.

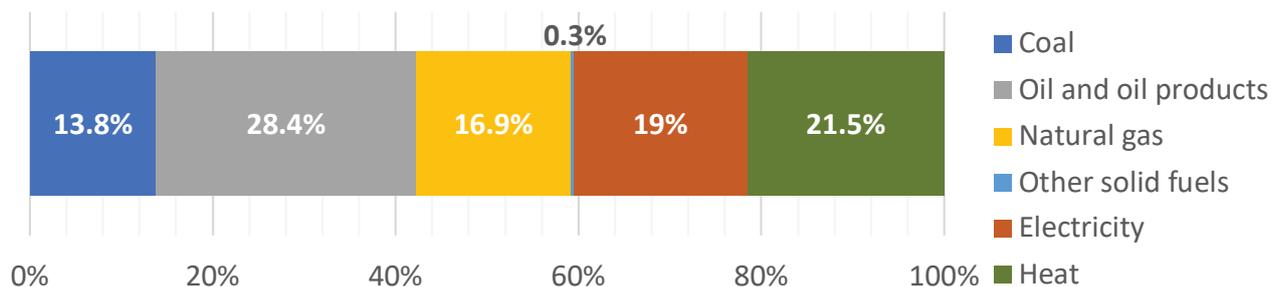


Fig. 3. Structure of final energy consumption in the Asian regions of Russia.

energy consumption is shown in Figure 1. The share of coal in the primary energy consumption is 54.9%, that of natural gas is 30.4%, and the proportion of energy from HPPs is 12.2%. For comparison, in the structure of primary energy consumption in Russia as a whole, coal accounts for 16%, natural gas makes up 54%, and the share of oil is 20%.

In 2020, 52.5 mln t.c.e. of electric and thermal energy was produced from primary energy resources. Conversion of primary energy to produce 16.2 mln t.c.e. of electric energy and 36.3 mln t.c.e. of thermal energy required 81.3 mln t.c.e. of fuel and energy in total. The production of electricity at HPPs, unconventional renewable energy sources, and nuclear power plants in 2020 amounted to 17.5 mln t.c.e.

In 2020, coal was the main fuel for the production of electricity and heat in the Asian regions of Russia (Fig. 2).

The share of coal in fuel consumption by boiler plants was 58.2% and that by TPPs – 74.6%.

Final energy consumption in 2020 amounted to 148.8 mln t.c.e., its the structure is shown in Fig. 3. The share of oil products in the final energy consumption is 28.4%, most of this volume falls on the transport needs. In addition, the share of heat (21.5%) and electricity (19%) is significant, the share of natural gas accounts for 16.9%, and the proportion of coal is 13.8%.

V. CONCLUSION

The FEB analysis for the Asian regions has indicated a high share of mined coal and a significant share of hydropower. It has also revealed the predominance of coal and a low share of gas in the fuel balance of thermal power plants and boiler plants. These factors stress the need to improve the FEB of the Asian regions of Russia in terms of changing its structure, increasing energy efficiency, and environmental friendliness of fuel use. These improvements will contribute to solving the economy decarbonization problem in the Asian regions of Russia.

ACKNOWLEDGMENTS

The research was carried out under State Assignment Project (no. FWEU-2022-0004) of the Basic Research Program of the Russian Federation 2021–2030 and made use of the resources of the «High-Temperature Circuit» shared research facilities center (Ministry of Science and Higher Education of the Russian Federation, project no. 13.CKP.21.0038).

REFERENCES

- [1] Regions of Russia. Main characteristics of the subjects of the Russian Federation – 2020. [Online]. Available: https://gks.ru/bgd/regl/b20_14s/Main.htm. (In Russian)
- [2] Order of the Ministry of Energy of Russia (2021, Oct. 29). *No. 1169, The procedure for making fuel and energy balances of the subjects of the Russian Federation, municipalities*. Moscow, Russia, Nov. 12, 2021, no. 65788. (In Russian)
- [3] B. G. Saneev, A. D. Sokolov, S. Yu. Muzychuk, R. I. Muzychuk, «Energy-economic analysis of the current state of the regional fuel and energy complex of the Russian East,» *Energy policy*, no. 5, pp. 14–22, 2016. (In Russian)
- [4] *Methods and models for the development of regional energy programs*, B.G. Saneev, Ed. Novosibirsk, Russia: Nauka, 2003, 140 p. (In Russian)
- [5] A. Sokolov, S. Muzychuk, R. Muzychuk, «Innovative development of the fuel and energy complex in the eastern regions of Russia,» *E3S Web of Conferences*, vol. 209, Art. no. 05020, 2020. DOI: 10.1051/e3sconf/202020905020.
- [6] A. Sokolov, S. Muzychuk, R. Muzychuk, «Trends and regularities of energy development in Russia's eastern regions: methods and results of research,» *E3S Web of Conferences*, vol. 77, Art. no. 02002, 2019. DOI: 10.1051/e3sconf/20197702002
- [7] R. Muzychuk, «The information system for the regional energy balance formation,» *E3S Web of Conferences*, vol. 77, Art. no. 02005, 2019. DOI: 10.1051/e3sconf/20197702005.



Roman Muzychuk entered MESI SB RAS as an engineer and a Ph.D. student in 2005, after receiving an engineering degree from Irkutsk State Technical University, Russia. In 2019, he received a master's degree in electric power and electrical engineering from Irkutsk National Research Technical University, Russia. Now he is a junior researcher at MESI SB RAS. His research interests include the study of the current state and modeling of energy development based on fuel and energy balances.



Boris Saneev is the Head of the research area "Complex Energy Problems and Regional Energy Policy" at the Melentiev Energy Systems Institute, the Siberian Branch of the Russian Academy of Sciences (MESI SB RAS). He holds the degree of Doctor of Engineering. His research interests include the issues of economic and energy development, energy cooperation between Russia and the Northeast Asian countries.



Alexander Sokolov received D. Sc. degree in engineering from MESI SB RAS in 2006. Currently, he is a chief researcher and the head of the Laboratory of the Energy Sector of Siberia and the Far East at MESI SB RAS. His research interests include the studies and modeling of the development prospects of the energy sector industries.