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Implementation of Efficient Energy Policy in Russia: Energy Consumption Monitoring and Problem Analysis

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ABSTRACT

The implementation of an efficient energy policy in Russia as an integral part of the social and economic strategy as a whole gives a high profile to the issues of energy consumption monitoring. The importance of the energy sector to the industrial development of all Russian regions requires close attention to the accounting and rational use of energy resources in order to reduce the energy dependence of all industries and make Russian economy less energy-intensive whilst more energy-efficient. The analysis of strategic documents in the field of energy saving proves the importance of the Russian Federation, which is one of the leaders of the world energy sector. The purpose of the article is to study the energy aspects of energy consumption in the regions of the Russian Federation, to conduct their comparative analysis and evaluation, and to identify problems in the supply of energy resources. The methods of research applied to study this problem include data collection and synthesis methods; a balance method; a time-series method; tabular and graphical methods of the study results visualization. The article presents the dynamics of electricity consumption in the regions of the Russian Federation broken down by federal districts and macro-regions set out in the Russian Federation spatial development strategy; also, the consumption balance by types of energy resources is provided for various fuels. In addition, it provides a brief description of the Russian integrated power system operation reflecting the generation and consumption of electricity among the main power systems of the country. Based on the analysis of Russia's energy development forecast, using scenario approaches, the article concludes that the energy efficiency of the national economy requires improvement and there is a need to implement energy-saving projects. The information contained herein is of practical value for the professionals involved in the analysis and evaluation of energy resources consumption and assessment of their contribution to the national economy. The results of the study reveal fundamental differences in the consumption and use of energy resources throughout Russia's regions.

Keywords: Energy Resources Monitoring, Energy Consumption, Energy Security, Energy Saving, Energy Strategy

JEL Classifications: D24, Q43, M31

1. INTRODUCTION

The problem of energy consumption remains today one of the most important issues in maintaining the activity and security of the global and, in particular, Russian economy. The current stage of the global economy development is characterized by

instability, recurring crisis phenomena, trade wars emerging from time to time, etc. Undoubtedly, the hot spots emerge on the planet driven by the growing demographic problem and the related shortage of food and raw material resources, as well as changes in the world energy demand structure and energy consumption patterns. According to the UN (World Population Prospects, 2015),

the world population will be 8.5 billion people by 2030 (mainly driven by the African continent and developing Asian countries), and by 2050-9.7 billion, while in 2100, the earth's population will be 11.2 billion people.

The importance of Russia's role in the world economy is determined by the following facts: (1) it occupies a vast area of the globe, through which major transport routes pass providing economic connections between the regions of the world; (2) there are significant amounts of oil and gas reserves revealed; energy resources, including hydrocarbons and nuclear materials, are produced in the country. According to RBC (2019), which published the estimates of the Ministry of Natural Resources and Environment of Russia, the total cost estimate of all resources (mineral and energy) according to the 2017 calculations amounted to 60% of the national GDP (GDP of the leading countries of the world in 2018, 2018).

However, with the average GDP growth rate for Russia, its share in the world GDP according to the probable scenario of the 2040 world and Russia's energy development forecast will be 2.7% (The forecast for the development of the world's energy industry and Russia up to 2040, 2014). According to the International Monetary Fund, Russia has quite a considerable share in the world GDP: It ranks 11th in nominal gross domestic product and is among the world's top 20 largest economies (GDP of the leading countries of the world in 2018, 2018).

Threats to the Russian economy in various areas, where energy sector is a priority, are outlined in the 2030 National Economic Security Strategy (The Strategy of Russia's Economic Security for the Period to 2030, 2017). The implementation of the energy policy of the Russian Federation is an integral part of the Economic Security Strategy. The latter, in turn, is aimed at strategic planning of the development of economic potential of the country, as a whole, and its regions.

2. LITERATURE REVIEW

Russia's development prospects until 2030 in the field of national energy are set out in Russia's Energy Strategy (The Energy Strategy of Russia for the Period up to 2030, 2009). The strategy sets out the key focus areas that indicate the vector of Russia's development in the field of energy consumption. These are aspects of the economic structure transformation in order to reduce the portion of energy-intensive industries using the energy saving potential; transformation of the electricity consumption geography in the country, which manifests itself through the shift of power consumption centers towards the Eastern economic zone and the cities of the European part of Russia. The strategy also sets the task to reduce imbalance, both in the energy consumption structure and in the energy security of different regions of the country.

The analysis of the results of the power sector reform (Analysis of the results of the reform of the power industry and proposals for increasing its efficiency: An analytical report, 2013) conducted by the Institute of natural monopolies research showed that the worst aspect of the reform was "the growth of electricity

prices for end consumers." This has led to increasing electricity arrears among the retail consumers. Analysts believe that the main problem of the Russian electric power industry is low state regulation efficiency, which is particularly acute at the regional level. In this context, a significant number of consumers do not have the opportunity to choose an electric power company, as there are no alternative suppliers. In view of the above, electric power companies become local monopolies within certain geographical boundaries.

The article by Myznikova (2016) presents regional aspects of electricity generation and consumption, using the case of the Republic of Tatarstan as an example. The author studies the consumption structure in the region, where statistical data proves the prevailing role of industry (the industrial sector consumes 64% of all electricity in the region). In addition, the author touches upon topical issues of energy management, which, according to the author, does not focus enough on the structural changes in local energy consumption, neither are risks and uncertainty taken into account when making investment decisions aimed at the development of the electric power industry.

The study of the electricity consumption issues taking into account the growing demand from the population requires the development of a system aimed at energy saving and overall improvement of Russia's energy efficiency at all levels: National, regional and municipal. The enacted law on energy saving (On energy saving and on increasing energy efficiency, and on introducing amendments to certain legislative acts of the Russian Federation: Federal Law of the Russian Federation N 261-FL, 2009) provides the legal basis for regulation and promotion of energy saving activities in Russia.

The need to implement energy saving programs determines the introduction of energy saving technologies that make energy consumption more efficient. Economic assessment of energy-saving projects is provided in the works of Kvon et al. (2016), Kvon (2018) and Bessel (2013) that contain the methodological guidelines for substantiation and efficiency along with practical aspects of the results of the efficient technologies introduction, both at the regional level and at the national economy level in general.

Optimization of energy consumption brings into focus electricity consumption issues. In view of the above, there is a need for systems that would provide stakeholders with comprehensive information about the energy consumption characteristics of the facilities operated. The monitoring issues are covered in the works of such authors as Vasilyeva et al. (2012), Platonova and Safronov (2016). These works highlight the importance of continuous energy consumption analysis with a glance to the ambient temperature, using intelligent information and measurement systems.

3. RESEARCH METHODOLOGY

3.1. Research Algorithm

1. Research scope and objectives. The main purpose of this research is to identify problems in the energy resources

supply in Russia in the context of the selected objects. As the research object, we have chosen the constituent entities of the Russian Federation classified into different groups: These are federal districts and macro-regions that enable us to evaluate consumption and production by large groups.

2. The objectives of the study include the selection of a research method and initial data, the study of the research legal framework, conducting the analysis, and drawing conclusions.
3. Analysis of publications in the field under study. In view of the strategic importance of electricity consumption and the formation of its sources, we pursued the task to substantiate the importance of the issue. To this end, we have studied the laws, strategies, and forecasts that may help assess the prospects of Russian energy sector in the long term. In addition, the practical aspects of the consumption study are reflected in the publications of Russian researchers that prove the importance of monitoring and evaluation of both consumption and energy-saving projects implementation efficiency.
4. Selection of a research base. We have obtained information from the statistical reports prepared by regional statistical bodies of the Russian Federation, since they reflect the dynamics of various energy consumption indicators in the regions of the Russian Federation.
5. Analysis and conclusions. The analysis of consumption dynamics with the use of statistical data has been carried out on the basis of the above algorithm. The analysis has revealed the problems existing in the energy consumption of the Russian Federation, based on a comparison of different sources in the study dynamics. Comparison of statistical reporting data, legal framework, and strategic documents has suggested the importance of ongoing energy consumption monitoring and evaluation that are substantiated by the analysis.

3.2. Research Methods

The following methods were applied in the course of the research:

1. The collection and compilation methods assume the processing (sorting, editing, and measurement), compilation and interpretation of the data. The storing assumes the classification of the data into categories and its tabulation. Editing means viewing data to determine whether it can be used. Measurement means comparison of objects based on their certain indicators or characteristics.

Data analysis and synthesis are performed with application of manual or computer processing methods using a tool for energy sector trend analysis.

Interpretation means identification and registering of a set of characteristics as well as processed and obtained data in order to detect and explain the main trends and clarify the meaning of the data obtained.

2. The balance method is used to study and compare power generation and consumption. The consumption reflects the demand for electricity, while the generation sets the level of fuel and energy resources production to meet this demand.

For the purpose of the study, the energy balance is classified based on the following characteristics:

- Energy flow stages
- Power plants (PP) and facilities.

3. The time-series method is used to arrange numerical indicators describing the status level and changes in Russia's energy sector in time order. In our research, we have used a discrete-time time series, which reflects the indicator values taken at certain points in time. A time series is a series of values that characterize a phenomenon at any given time.

To analyze the dynamic time series indicators, the following parameters are used:

- Absolute basic increment:

$$\Delta y = y_t - y_1 \quad (1)$$

Where t is the observation number;

y_t —series level corresponding to the t moment.

y_1 —series level corresponding to the reference period.

- Reference growth rate:

$$Tp = y_t / y_1 * 100\% \quad (2)$$

4. Tabular and graphical methods of the study results visualization

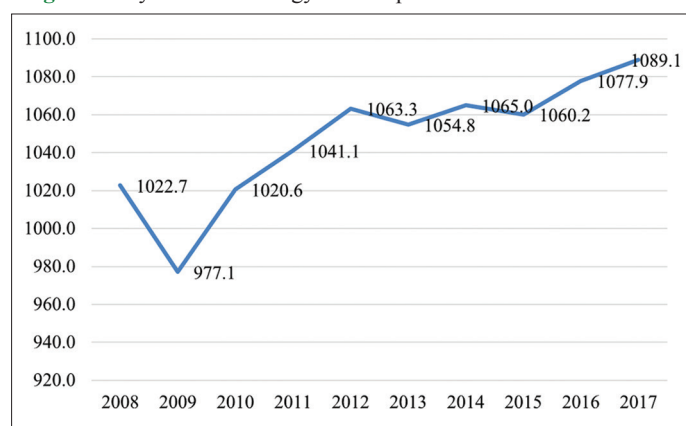
The tabular method of data representation allows to present quantitative characteristics of the process studied in a structured form with explanatory text.

The graphical method shows the visual change of the data reflecting the trends observed in the energy sector indicators as well as their structure and peculiar features of the classification.

4. RESULTS AND DISCUSSION

We consider the analysis of electricity consumption in Russia in dynamics, selecting 2008—2017 as the study period. The consumption dynamics shows an increase in the resource from 1.022.7 billion kWh in 2008–1.089.1 billion kWh in 2017,

Figure 1: Dynamics of energy consumption in Russia for 2008-2017



therefore, the growth is 6.5%. Figure 1 provides graphics reflecting the above.

However, despite the overall positive trend, consumption in 2009 shows a sharp decline (from 1022.7 billion kWh in 2008 to 977.1 billion kWh in 2009), which is 4.5% if compared to 2008. The above is the consequence of the aggravating crisis in the national economy in 2009, which, as we know, eventually resulted in a 7.9% decrease of the country's GDP.

As far as electricity consumption in Russia's regions is concerned, we will consider it based on the following principle.

4.1. Distribution by Federal Districts

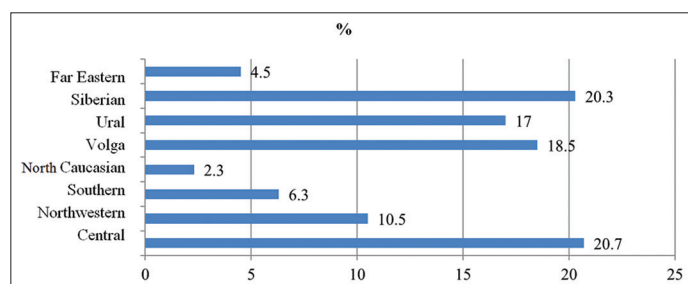
The establishment of federal districts under the Decree of the President of the Russian Federation No. 849 dd. May 13, 2000 (About the plenipotentiary of the President of the Russian Federation in the federal district, 2000) pursued the objectives of strengthening the statehood and simplification of Russia's governance. Administration of management processes allows to perform proper control over the implementation of the federal authorities' decisions in the regions. The consumption breakdown by these 8 districts according to Rosstat data for 2017 (Official Statistics, 2017) is shown in Figure 2.

As the graph shows, the major share of consumption falls on the following federal districts:

- Central (20.7%) – the main consumers are Moscow (the capital's consumption accounts for 25.2% of the total consumption of the federal district) and the Moscow Region (21%);
- Siberian (20.3%) – Krasnoyarsk Region (23.8%), Irkutsk Region (24.3%), Kemerovo Region (16.1%);
- Volga Region (18.3%) – Republic of Bashkortostan (13.9%), Republic of Tatarstan (14.7%), Perm Region (13.2%), Samara Region (12.6%), Nizhny Novgorod Region (11.4%);
- Ural (17%) – Khanty-Mansi Autonomous District — Yugra (40%), Sverdlovsk Region (25.9%), Chelyabinsk Region (19.4%). Uneven power consumption and the predominance of individual regions are the result of economic zoning and the location of large energy-intensive industrial facilities in these regions.

In order to assess the energy security of the regions, we have compared the data on power consumption and production by federal districts. We have made a comparative Table 1 using statistical data (Official Statistics, 2017).

Figure 2: Energy consumption distribution among the federal districts of the Russian Federation



The Table 1 shows that there is a power generation shortage in the Volga Federal District (17.2 billion kWh) and the Siberian Federal District (9.1 billion kWh).

4.2. Distribution by Macro-regions

The Russian Federation spatial development strategy for the period up to 2025 (The Strategy of Spatial Development of the Russian Federation for the Period up to 2025, 2019) adopted by the Government of the Russian Federation in February 2019 divides Russia into 12 macro-regions. This strategy, in accordance with the law on strategic planning (On Strategic Planning in the Russian Federation, 2014), was developed within the framework of area-based goal-setting. Though the strategy was adopted in 2019, we will group Russian regions depending on electricity consumption and production using the data of 2017. In our opinion, this assumption is viable, since the division of the country into macro-regions does not interfere with the functioning of industrial and non-industrial facilities.

The consumption by macro-regions is shown in Figure 3.

It should be noted that in such classification of regions into the macro-regions these groups completely overlap the existing federal districts, such as North Caucasian and Southern districts — constituent regions are absolutely identical there.

Comparison of consumption and production in the Russian Federation, compiled by the authors based on the newly adopted macro-regions, is presented in Table 2.

The comparison of production and consumption among macro-regions reveals the deficit (shortage) of electricity largely in the Volga-Kama and South Siberian macro-regions. A small deficit is observed in the Northern macro-region.

In terms of Russia's constituent entities, electricity deficit is found in the following regions:

- Volga-Kama macro-region: Deficit is observed in the Republic of Tatarstan, the Udmurt Republic, Nizhny Novgorod Region (these regions are part of the Volga Federal District, which (Table 1) is characterized by a shortage of electricity);
- South Siberian — the deficit is observed in all regions of this macro-region (deficit regions are part of the Siberian Federal District, which also suffers from a resource deficit);
- Northern — includes all regions, except the Republic of Komi.

It should be noted that, though other macro-regions are self-sufficient and their total production exceeds total consumption, there is a significant shortage of electricity within some macro-regions.

Thus, the Central macro-region shows a severe shortage in the Moscow Region (a deficit of 26 billion kWh) and Moscow (7.7 billion kWh).

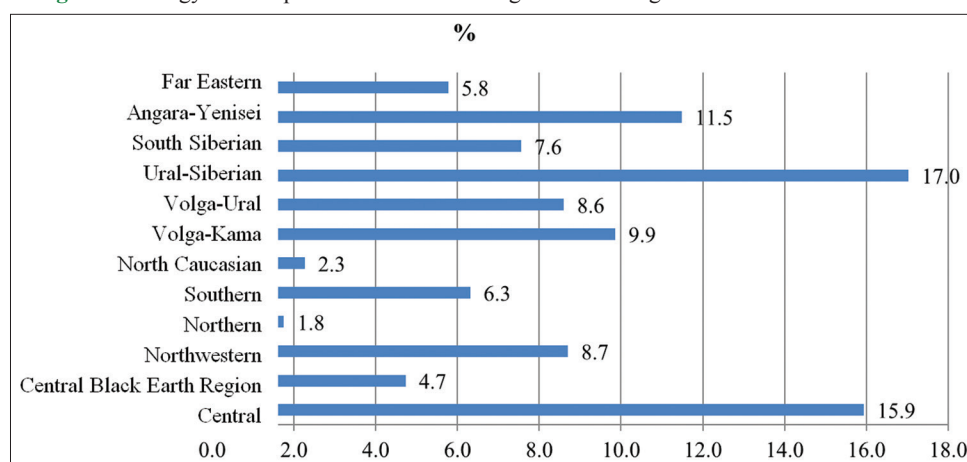
In the Southern macro-region, shortage is observed in the Krasnodar Region (11.3 billion kWh).

Table 1: Comparison of electricity production and consumption in the federal districts of the Russian Federation, billion kWh

Federal districts of Russia	Consumption	Production	Surplus (+)/deficit (-)
Russian federation — total: Including	1089.1	1094.2	5.1
Central federal district	225.1	228.9	3.8
Northwestern federal district	113.9	120.8	6.9
Southern federal district	68.7	74.1	5.4
North Caucasian federal district	24.7	26.8	2.1
Volga federal district	201.0	183.8	-17.2
Ural federal district	185.5	194.7	9.2
Siberian federal district	221.5	212.4	-9.1
Far eastern federal district	48.7	52.6	3.9

Table 2: Comparison of electricity production and consumption in the macro-regions of the Russian Federation, billion kWh

Macro-regions	Consumption	Production	Surplus (+)/deficit (-)
Central	173.6	173.9	0.3
Central black earth region	51.5	55.1	3.6
Northwestern	94.8	102.3	7.5
Northern	19.1	18.6	-0.5
Southern	68.7	74.1	5.4
North Caucasian	24.7	26.8	2.1
Volga-Kama	107.4	79.6	-27.8
Volga-Ural	93.7	104.2	10.5
Ural-Siberian	185.5	194.6	9.1
South Siberian	82.3	56.93	-25.4
Angara-Yenisei	125.1	142	16.9
Far-eastern	62.9	66.1	3.2
Total in Russia	1,089.1	1,094.23	5.1

Figure 3: Energy consumption distribution among the macro-regions of the Russian Federation

Due to the limited scope of the article, the paper provides only the conclusions, since covering the information on all macro-regions for 85 constituent entities of the Russian Federation to support the author's conclusions would overstuff the article.

4.3. Distribution among the Eastern and Western Macro-regions

Distribution among the Eastern and Western macro-regions, representing a high-level breakdown of Russia into two zones.

The Eastern macro-zone, consisting of 24 Russia's constituent entities in total, includes the West Siberian, East Siberian, and Far Eastern economic regions. In terms of federal districts, these are regions of the Siberian, Far Eastern (entirely) and, to some extent, the Ural federal districts.

Table 3: Comparison of electricity production and consumption in two macro-regions, billion kWh

Macro-regions (high-level groups)	Consumption	Production	Surplus (+)/deficit (-)
Eastern	367.3	373.1	5.9
Western	721.8	721.1	-0.8
Total in Russia	1,089.1	1094.2	5.1

In terms of the newly established macro-regions, these are the regions of the Ural-Siberian (partially), South Siberian, Angara-Yenisei and Far Eastern macro-regions.

The consumption structure for these macro-regions (Eastern and Western) is shown in Figure 4.

The low electricity consumption in the Eastern macro-region is determined by the fact that, historically, the regions of the Eastern macro-zone occupying 75% of the territory of the Russian Federation account for only 21% of the country's population.

The comparison of consumption and production in these two macro-regions is presented in Table 3.

As is seen from the Figure 4 and Table 3, there is imbalance in power consumption and production in the regions of the Russian Federation. As mentioned earlier, the objectives of the energy strategy (The Energy Strategy of Russia for the Period up to

2030, 2009) are to reduce imbalances and evaluate the prospects for the power industry development, taking into account the shift in energy consumption towards the Eastern regions of Russia.

We would like to consider one more aspect that reflects the results of the operation of Russia's IPS (integrated power systems). Analysis of IPS's operations was carried out on the basis of the report on IPS's operations in 2017 (Report on the functioning of the UES of Russia in 2018, 2018). IPS's operations are distributed among the seven united power grids (UPG). Table 4 provides the balance of the distribution among UPGs.

Table 4: Energy consumption balance for Russia's main UPGs

Item	Balance		Surplus, billion kWh
	Consumption Billion kWh (%)	Production Billion kWh (%)	
Russia's IPS – total: Including	1,039.9 (100.0)	1,053.8 (100.0)	13.9
Central UPG	238.6 (22.9)	237.6 (22.5)	–1
Middle volga UPG	108 (10.4)	107.8 (10.2)	–0.2
Ural UPG	261.2 (25.1)	260.7 (24.7)	–0.5
Northwestern UPG	93.9 (9.0)	108.35 (10.3)	14.45
Southern UPG	99.1 (9.5)	100 (9.5)	0.9
Siberian UPG	205.9 (19.8)	202.6 (19.2)	–3.3
Eastern UPG	33.2 (3.2)	36.8 (3.5)	3.6

UPGs: United power grids

Table 5: Comparative characteristics of the development scenarios of the Russian energy sector (Makarov et al., 2016)

Scenarios	Probable scenario	Critical scenario	Optimistic scenario
Scenario details	The scenario assumes that the current situation will not change (limited structural reforms to improve the business climate, reduction of interest rates, intensification of investments, higher government spendings on social, energy and transport infrastructure development, reducing corruption)	The scenario assumes no reforms, no efforts to combat corruption in the field of government spendings, limited budget resources are spent on costly prestigious and infrastructure projects in favor of individual companies and regions. High interest rates, although inflation is lower. Technological progress is limited, and efficiency growth cannot be achieved due to a combination of institutional factors	The scenario assumes economic growth based on the use of competitive advantages both in traditional sectors (energy, transport, agriculture) and in new knowledge-intensive sectors and "knowledge economy". A dramatic change in Russia's export structure is expected. The share of budget expenditures on human capital will increase (by 2030 it will grow to 13% of GDP). Strengthening of the financial sector is expected along with lower interest rates and the revival of small business, since favorable conditions for the country's institutional development are foreseen
GDP growth	Moderate GDP growth; after 2020, the national economy will reach moderate average annual growth rate of 2.2–2.4%	GDP growth slows (on average — 1.7% after 2020), and recession lasts longer	National economic growth is expected to accelerate up to 3.4% per year after 2024. The shares of services, communications and innovative manufacturing industries in GDP are growing
World energy prices	Limited energy consumption growth is expected along with growing export (prices, however, stay below the levels of 2010-2014)	Energy export prices are lower; high competition in energy markets; additional restrictions are expected to be imposed on Russian hydrocarbons import by Western countries	Relatively higher world energy prices boost a greater demand for Russian hydrocarbons in the global markets
Sanction restrictions	Sanction restrictions remain in place, Russian companies have a limited access to capital and state-of-the-art technologies	Sanction restrictions remain in place, Russian companies have a limited access to capital and state-of-the-art technologies	Abolition of any sanctions, easy access to capital and state-of-the-art technologies, dramatic efficiency improvement within Russia
Prerequisites for economic growth	Economic growth will depend on the results of adaptation and reforms in 2018-2024	Russia's share in world GDP decreases from 3.5 to 2.9% in 2014-2020 and cannot recover until 2040	Accelerated growth is anticipated in the course of reforms and the use of national savings by business

It should be noted that there are minor differences (in the range of 3.7-4.7%) in the production and consumption data published by Rosstat and contained in the report on the IPS operations.

Figure 4: Energy consumption distribution in the Eastern and Western macro-regions of Russia

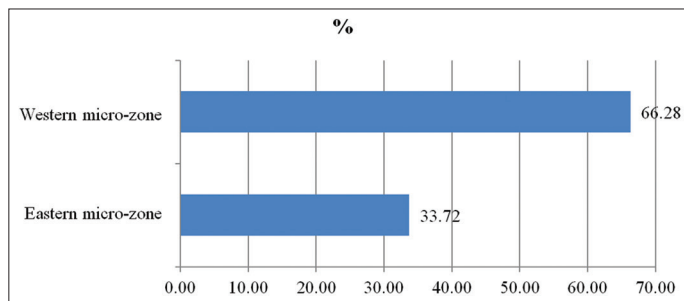


Figure 5: Power generation by power plants (according to 2017 data)

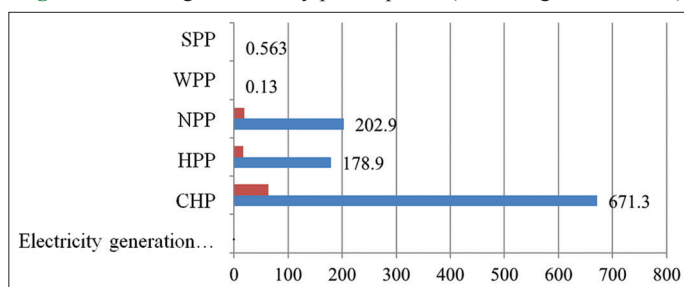
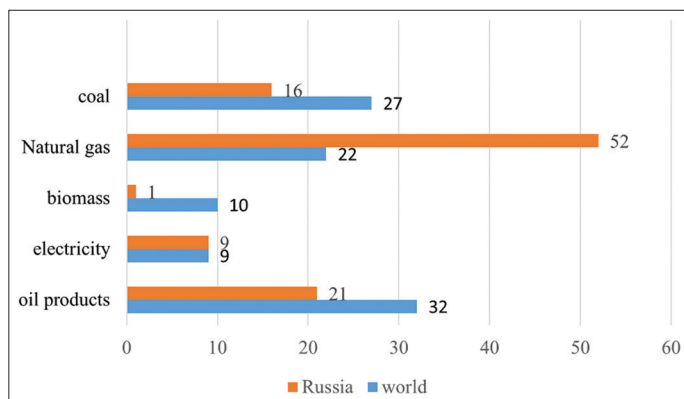


Figure 6: Energy consumption by sources



Each UPG supplies certain regions of the Russian Federation in accordance with the adopted list through the operation of co-generation PP, PP, nuclear PP (NPP), hydroelectric PP (HPP), wind PP (WPP) and solar PP (SPP).

The distribution of power generation by PP is shown in Figure 5.

It makes sense to resort to the Russian energy sector development forecasts based on a number of expected key indicator values that were made in different periods of time. In this study, we consider the forecasts presented in the 2030 Energy Strategy of the Russian Federation (The Energy Strategy of Russia for the Period up to 2030, 2009) as well as the World and Russia's Energy Sector Development Forecast (The forecast for the development of the world's energy industry and Russia up to 2040, 2014) developed by the Energy Research Institute of the Russian Academy of Sciences and the Analytical Center under the Government of the Russian Federation.

The Energy Strategy contains the strategic development indicators for the mineral resource base of the fuel and energy complex as well as development indicators for various industrial sectors (oil, gas, coal, etc.). It should be highlighted that the energy sector development forecast provided in these documents (The Forecast for the Development of the World's Energy Industry and Russia up to 2040, 2014) has different scenarios: The forecast made in 2014 is underlain by the baseline scenario (priority in the development is given to the Western macro-zone of the Russian Federation) and the Other Asia scenario (priority is given to the Eastern macro-zone).

In the Forecast made in 2016 (Makarov et al., 2016), the authors propose three energy sector development scenarios: Probable, critical and optimistic. Since the latest version of the forecast looks more relevant, we will give a brief description of Russia's energy sector development scenarios (Table 5).

These works analyze the primary energy resources that are sources for electricity production. Let us compare the expected results of the above documents, i.e., 2030 Energy Strategy of the Russian Federation (The Energy Strategy of Russia for the Period up to 2030, 2009) and Development Forecasts (The Forecast for

Table 6: Structure of consumed resources according to forecasts up to 2030

Item	Energy Strategy (The Energy Strategy of Russia for the Period up to 2030, 2009)	World and Russia's Energy Sector Development Forecast (The Forecast for the Development of the World's Energy Industry and Russia up to 2040, 2014)		
		(Makarov et al., 2016)		Probable scenario
		Baseline scenario	Other Asia	
Domestic consumption (million tons of conventional fuel) — total: Including resources	100.00	100.00	100.00	100.00
Gas	47.71	52.23	52.07	54.85
Liquid (oil and condensate)	22.40	19.18	19.22	18.46
Solid fuel (coal and other)	18.04	14.73	14.96	14.02
Non-fuel	11.85	13.86	13.75	12.67

Table 7: Structure of energy sources according to 2017 data

Type of energy	Oil products	Electricity	Biomasses	Natural gas	Coal
World	32	9	10	22	27
Russia	21	9	1	52	16

the Development of the World's Energy Industry and Russia up to 2040, 2014; Makarov et al., 2016). We take the low limit consumption indicators from the Energy Strategy. This work provides two options of the world and Russia's energy sector development forecast (The Forecast of 2014 and 2016). The results are summarized in Table 6.

The 2040 forecast presented in the paper (Makarov et al., 2016) reflects no significant changes in the energy sources structure, and therefore, we do not provide it in this study.

Analysis of the sources structure according to the documents mentioned confirms the predominance of gas as the main source of electricity production, accounting for about 50% in the sources structure.

The actual structure of sources (energy resources) according to 2017 data (World Energy Statistical Yearbook, 2018) also suggests the predominance of gas as a source, while the global structure significantly differs from that of Russia (Table 7).

For clarity, the above is presented in Figure 6.

The data presented is in line with the trends reflected in the strategic and forecast documents for the Russian Federation, i.e., the actual consumption of natural gas remains a predominant source for electricity generation. In the world statistics, however, natural gas accounts for only 22% and coal—27%.

5. CONCLUSION

The study has revealed fundamental differences in the consumption and use of energy resources throughout Russia's regions. Three principle approaches have been used to assess energy consumption among Russia's constituent entities: (1) distribution by federal districts; (2) distribution by macro-regions; (3) distribution among Eastern and Western macro-regions.

According to the official statistics for 2017, almost 60% of electricity consumption falls on 3 out of the 8 federal districts (Central, Siberian and Volga); the predominant consumption in some regions is determined by the location of large energy-intensive industries there. The deficit of own electricity production was observed in two federal districts — Volga and Siberian.

Comparison of electricity consumption and production in the newly established macro-regions also revealed an imbalance: Electricity shortage is largely typical for the Volga-Kama and South Siberian macro-regions (the latter is part of the Siberian Federal District). Despite the fact that other macro-regions are self-

sufficient with total production exceeding total consumption, there is a significant shortage of electricity in the constituent regions of a number of macro-regions. An even greater electricity consumption and production imbalance is found upon the assessment of the Eastern and Western macro-regions representing a high-level breakdown of Russia into two zones.

All this not only is not contradictory to, but rather is in line with the priority development of the economic potential, primarily, in Eastern Siberia, the Far East and the Far North, as indicated in the strategic documents. One of the strategic vectors of energy policy for the period up to 2030 is the accelerated development of coal-fired thermal PP in the Siberian and Far Eastern federal districts. These plants will be built both close to the already existing steam coal mines (Kuznetsk and Kansk-Achinsk coal basins) and (in the medium and long term) in close proximity to the new areas of coal production (Transbaikal, Southern Yakutia, Tyva, etc.). This is favored by the huge amount of proven coal reserves in the Eastern zone of the country and its share suitable for opencast mining (99% of such national coal reserves are concentrated here). The accelerated development of coal energy on the basis of new eco-friendly coal technologies will certainly lead to a decrease in the share of gas in the consumption of primary fuel and energy resources from 52 % (2017) to 46-47% by 2030.

According to the forecast documents, the world economy and energy will be greatly influenced by the processes taking place in the developing countries of Asia. Coal is the backbone of the energy mix of the world's two fastest growing energy consumers — China and India. The forecasts suggest that though current domestic demand is satisfied by domestic production, there are high risks of reaching production peaks and observing coal shortages in these countries in the next decade. In this context, due to the possibilities of increasing coal production in the Eastern macro-zone, Russia can become one of the important players in the global coal market.

As our research shows, only after the power complex development in the East of the country, including hydroelectric PP, Siberian PP will have enough capacity to meet the electricity demand of the European part of Russia. In turn, the implementation of the electric power sector strategies will enable the regions to significantly transform and develop labor markets, social and transport infrastructure, and to form new centers of their economic growth.

REFERENCES

- About the Plenipotentiary of the President of the Russian Federation in the Federal District. (2000), Decree of the President of the Russian Federation of May 13, 2000 No. 849. Available from: http://www.consultant.ru/document/cons_doc_LAW_23-329. [Last accessed on 2018 Dec 13].
- Analysis of the Results of the Reform of the Power Industry and Proposals for Increasing its Efficiency: An Analytical Report. (2013), Institute for the Problems of Natural Monopolies. Available from: http://www.ipem.ru/research/power/power_works/79.html.
- Bessel, V.V. (2013), On the issue of assessing the energy efficiency of the Russian economy. *Drilling and Oil*, 12, 18-23.
- GDP of the Leading Countries of the World in 2018. (2018), Information

- Ifinance Site. Available from: <http://www.global-finances.ru/vvp-stran-mira-2018>.
- Kvon, G.M. (2018), Energy saving projects as energy security factors. *International Journal of Energy Economics and Policy*, 8(6), 155-160.
- Kvon, G.M., Samysheva, E.Y., Vaks, V.B., Mararov, N.V., Khamidullin, F.F. (2016), Methods of evaluating the efficiency of energy saving projects with taking risks into account. *International Journal of Environmental and Science Education*, 11(1), 7441-7452.
- Makarov, A.A., Grigorieva, L.M., Mitrova, T.A. (2016), Forecast of the Development of the World Energy Industry and Russia 2016. Moscow: INEI RAS, AC Under the Government of the Russian Federation. Available from: <http://www.ac.gov.ru/files/publication/a/10585.pdf>.
- Myznikova, M.N. (2016), Regional energy system: Analysis of the relationship between the structure of consumption and production of energy resources. *Kazan Economic Journal*, 4(24), 32-37.
- Official Statistics. (2017), Electricity Consumption in the Russian Federation. Available from: http://www.gks.ru/wps/wcm/connect/rosstat_main/rosstat/ru/statistics/enterprise/industrial.
- On Energy Saving and on Increasing Energy Efficiency, and on Introducing Amendments to Certain Legislative acts of the Russian Federation: Federal Law of the Russian Federation No. 261-FL. (2009), Available from: <http://www.legalacts.ru/doc/FZ-ob-jenergobezrezhenii-i-opovyshenii-jenergeticheskoy-jeffektivnosti-i-o-vnesenii-izmenenij-v-otdelnye-zakonodatelnye-akty-Rossijskoj-Federacii>.
- On Strategic Planning in the Russian Federation. (2014), Federal Law of June 28. Available from: http://www.consultant.ru/document/cons_doc_LAW_164841.
- Platonova, E.V., Safronov, A.V. (2016), Monitoring of energy consumption based on the results of the primary energy survey. *Scientific Almanac*, 5(19), 142-145.
- RBC. (2019), Website, 55 Trillion in Stock: How the Authorities Rated all Russia's Natural Resources. Available from: <https://www.rbc.ru/economics/14/03/2019/5c8931029a7947b028b8886c>.
- Report on the Functioning of the UES of Russia in 2018. (2018), Prepared in ACCORDANCE with the Rules for the Development and Approval of Schemes and Programs for the Future Development of the Power Industry. Available from: http://www.so-ups.ru/fileadmin/files/company/reports/disclosure/2019/ups_rep2018.pdf.
- The Energy Strategy of Russia for the Period up to 2030. (2009), Available from: <https://www.minenergo.gov.ru/node/1026>.
- The Forecast for the Development of the World's Energy Industry and Russia up to 2040. (2014), Available from: <http://www.ac.gov.ru/files/publication/a/2194.pdf>.
- The Strategy of Russia's Economic Security for the Period to 2030. (2017), Approved by the Decree of the President of the Russian Federation, No. 208. Available from: <http://www.docs.cntd.ru/document/420398070>.
- The Strategy of Spatial Development of the Russian Federation for the Period up to 2025. (2019), Approved by an Order of the Government of the Russian Federation on February 13, 2019. Available from: <http://www.static.government.ru/media/files/UVA1qUtT08o60RktoOXI22JjAe7irNxc.pdf>.
- Vasilyeva, A.V., Tyzhnenko, D.A., Potekhin, V.V. (2012), Problems of creating an information-measuring system for monitoring and optimizing energy consumption. *Proceedings of St. Petersburg State Technical University*, 514, 62-66.
- World Energy Statistical Yearbook. (2018), Available from: <https://www.yearbook.enerdata.ru/total-energy/world-consumption-statistics.html>. [Last accessed on 2019 Mar].
- World Population Prospects. (2015), The 2015 Revision, Key Findings and Advance Tables United Nations Department of Economic and Social Affairs/Population Division. Available from: https://www.esa.un.org/unpd/wpp/Publications/Files/Key_Findings_WPP_2015.pdf.