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MANAGING THE ENERGY EFFICIENCY IN THE CONTEXT OF NEW CLIMATE POLICY: AN AGENDA FOR RUSSIAN REGIONS

The paper examines the improvement of energy efficiency in the Russian regions as a leading area for implementing in Russia the Paris Climate Agreement (2015) on reduction of greenhouse gas emissions. The goal is to substantiate the differentiated strategies and tools for managing the energy efficiency in the Russian regions by identifying the main factors affecting this parameter. The focus on the regional context is determined by substantial reserves and differences between the regions in terms of their energy efficiency level, the need to identify problem areas, summarize and systematize the good practices. Based on relevant information, the authors test the hypothesis of statistically significant impact made by structural, spatial, climatic and technological factors on the energy intensity of gross regional product, as well as on the need to consider not only the usually analyzed factors, but also the institutional factors that can have both positive and negative impact on the dynamics of regional energy efficiency. The research methods included comparative method, correlation and regression method and elements of cluster analysis, new concepts of public governance (new public governance and results-based management) adapted to the tasks of improving the energy efficiency and easing climate-related tensions. The results of the study and the scope of their application include identifying three groups of regions. In one of them no significant dependence of the energy intensity from normally applied factors was statistically identified.In the other two groups, it was confirmed, but with substantial differences in the level of energy efficiency. Furthermore, the study reveals the factors that cause these differences, in particular, the sectoral profile and substantiates the differentiated strategies to reduce the energy intensity of the regional economy for their consideration by the federal and regional regulators and reflection in the 2035 Energy Strategy. The conclusions of the study are following: the measures aimed at improving the energy efficiency in the regional context are to be integrated to the Strategy of Long-Term Development of the Russian Federation with Low Greenhouse Gas Emissions until 2050, as well as to further analyze the innovative activities and quality of governance in the regions among the factors that determine the regional differences in terms of energy efficiency.

Keywords: energy efficiency, energy intensity, greenhouse gases, new climate policy, correlation analysis, structural factor, energy efficiency management, differentiated regional strategies, institutional factors, new public governance concepts

Introduction

With the resolution of the most pressing current socio-economic problems in Russia, the specialists switch their attention to the strategic goals, including the substantiation of the key areas for diversifying the national economy in the light of its transition to a sustainable development model and effective response to the new global challenges faced by the economy and society [1, 2]. These include improving the energy, resource and environmental efficiency of the national, sectoral and regional economies. Addressing this task simultaneously allows to build one of the leading areas for implementing in Russia the Paris Agreement adopted on December 11, 2015 at the 21st session of the Conference of the Parties to the UNFCCC (hereinafter, the "Paris Agreement") and designed to replace the Kyoto Protocol, which expires in 2020. According to the Paris Agreement, Russia, like the other countries, should voluntarily set its contribution to the reduction of emissions of greenhouse gases (GHG) defined at the national level, which shall include a timetable until 2030 with the parameters updated every five years. In addition, each of the parties to the Paris Agreement is called to proceed from the need to hold the increase in global average temperature "well below 2 °C above pre-industrial levels, making an effort to limit the temperature rise to 1.5 °C[1]."

As early as on March 30, 2015, the Russian Federation submitted the information on its contribution to addressing this task to UNFCCC Secretariat. The Directive of the Government of the Russian Federation No. 807-r of May 6, 2015, introduced the clarifications to the action plan aimed

[1] Pravitelstvo Rossii uzhe planiruet ispolnyat Parizhskoye sogazhenie o climate In Russian. [Adoption of the Paris Agreement. Framework Convention on Climate Change]. Retrieved from: http://unfccc.int/resource/docs/2015/cop21/eng/l09.pdf (date access: 06/14/2016).

at ensuring, by 2020, the reduction of GHG emissions to no more than 75 % of the volume of these emissions in 1990. To implement the Paris Agreement by July 2017, it is planned to prepare a Decree of the Russian President on the reduction of GHG emissions by 2030.[2] In addition, to fulfill its obligations, each party to Paris Agreement should independently develop the measures aimed at preventing the climate change, including Long-Term Low Greenhouse Gas Emission Development Strategy until 2050. The compliance with the Paris Agreement provides, therefore, the implementation of a complex set of measures, one of which is the energy efficiency viewed by both experts and policy makers as a key task for decarbonization of the national economy and reduction of greenhouse gas emissions. In this case, the emphasis is on how the achievement of this task should be implemented and supported in the regions, including with the tools of the strategic management system, which is being built in accordance with Federal Law No. 172 "On Strategic Planning in the Russian Federation" adopted in 2014.

The priority of the task to improve the energy efficiency in order to comply with the Paris Agreement is determined by the fact that in Russia (as in a number of other countries), the structure of GHG emissions is dominated by the energy sector, which, in 2011, accounted for 82.7 % of total emissions in CO_2 equivalent. Although, in 2012, the level of CO_2 equivalent emissions in Russia as a whole (excluding land use sector, changes in land-use and forestry) was 68.2 % of 1990 level, which allowed to officially state that the targets of the first budget period of the Kyoto Protocol were exceeded, a steady increase in these emissions has been observed since the beginning of this century reaching 112 % of the year 2000 level in 2012.[3] The urgency of improving energy efficiency and reducing the energy intensity of GDP[4] is also emphasized by the significant untapped potential of Russia in this area, which exists despite all the efforts made over the recent years. According to the draft Energy Strategy of Russia until 2035, the energy intensity in the manufacturing of key domestic products is 1.5–4 times higher than the best global examples[5]. Given the severity of this problem, the said document provides for reducing the energy intensity of Russian GDP by 1.6 times and increasing energy production based on non-conventional renewable sources by more than 10 times. A substantial burden in achieving these milestones rests on the Russian regions, in which the relevant activities should become an integral part of socio-economic development strategies being developed in these regions. Moreover, it should be borne in mind that, in some Russian regions, the contribution of the energy sector to aggregate GHG emissions substantially exceeds the national average[6], and these indicators reveal substantial regional differences [3].

Theory, Specification of Research Objectives, and Applied Methods

The energy conservation and improving the energy efficiency are among the issues that are actively studied in the Russian and foreign literature. Along with the general assessment mentioned above, the experts analyze the indicators of energy conservation and energy efficiency to elaborate proposals on their improvement [5], including in relation to the dynamics of GHG emissions and other negative external effects [6–8]. This involves assessing the effectiveness of implementing the low-carbon development strategy in Russia [9], studying the energy mix including the sectoral cross-section of consumers in order to identify their potential for reducing the energy intensity of GDP [1]. There is also a discussion on the need to overcome the so-called "resource curse" [10], a phenomenon that showed the signs of weakening since early 2016, including in conjunction with measures to transform the structure of the national economy by taking into account the factor of its energy intensity [11].

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[2] The Russian government already has plans to implement the Paris Climate Agreement. Retrieved from: http://regnum.ru/news/2104864.html (date access: 04/09/2016).

[3] The first biennial report of the Russian Federation submitted in accordance with Decision 1/CP.16 of the Conference of the Parties to the UNFCCC, 2014.

[4] The energy intensity is an indicator that is in inverse relation to energy efficiency. According to methodology of the Russian Federal State Statistics Service, the energy intensity of GDP (GRP) is defined as the ratio of energy consumed for the production of gross domestic (regional) product and calculated in kilograms of fuel equivalent to the value of GDP (GRP) measured in current prices (which, as we should note, reduces the possibility of comparing this indicator over time).

[5] Energticheskaya strategiy Rossii do 2035 goda. Proekt. Ofitsialnyy sayt Ministerstva energetiki RF. In Russian [The Energy Strategy of Russia until 2035. Draft. The official website of the Russian Ministry of Energy]. Retrieved from: http://minenergo.gov.ru/node/1920 (date of access: 04/19/2016).

[6] For example, in the Khanty-Mansi Autonomous District — Yugra, the energy sector accounts for 99.2 % of GHG emissions (emissions from fuel combustion for energy purposes and leaks in the oil and gas industry, including the burning of associated gas in flares) [4, p. 73].

As for the regional dimension of the problem, the measures aimed at improving the energy efficiency and implementing the energy efficiency policy are analyzed along with the development of criteria and indicators that serve to assess the quality of the economic growth [12], in particular, in the context of the transition to a low carbon economy, improving its energy efficiency and reducing GHG emissions [13]. In a number of publications, the similar studies are carried out by using the example of individual regions, in particular, the identification of decoupling effect (that is, the separation of economic growth trends and environmental pollution). [14] The publications of recent years draw attention to a wider range of issues, including the assessment of territorial governance efficiency in the context of new strategic development guidelines [15]. At the same time, the issue of improving the energy efficiency and energy conservation by taking into account the comprehensive analysis of influencing factors and in the context of easing climate-related tensions should be continued with a focus on regional and interregional levels and substantiating the governance tools that serve to achieve the desired goals.

Given the above, this article implements a number of research tasks. First, based on the results of studies conducted by the experts using regression analysis, we identified the basic factors affecting the energy intensity of the economy in the Russian regions. To this end, we tested the hypothesis of the statistically significant impact made by structural, spatial, climatic and technological factors on this resulting indicator. Second, with the obtained results, we made a classification of Russian regions to identify the groups (distinctive clusters), in which the impact of selected factors is statistically significant, and those, in which such impact is not detected, and substantiated the differentiated strategies to improve the energy efficiency in these groups. Third, with the obtained results and after reviewing the best regional practices, we elaborated a number of recommendations for building the energy efficiency management system in the Russian regions.

The basis for addressing these tasks was provided by economic and mathematical methods, including the econometrics, as well as the elements of cluster analysis. When summarizing the best regional practices and elaborating the recommendations, we relied on the methods of comparative analysis and new concepts of public governance, including new public governance results-based management, which were adapted to the tasks of improving energy efficiency and easing climate-related tensions. The regression model was built by using Gretl, an econometric analysis software package. To visualize the tabular data with identifying three groups of regions, we used Tableau, an analytics software package.

Econometric Analysis of Factors Affecting the Level of Energy Efficiency in the Russian Regions

The following studies were used as the basis to generate hypotheses on the aggregate of factors that determine the level of energy intensity of the regional economy.

1. A joint study by the experts of the Center for Energy Efficiency (CENEF), the World Bank and the International Finance Corporation[7], which identified the following key factors that determine the level of energy intensity of the Russian economy and its regions (according to these experts, by 80 %), including the structural factor determined by contribution (share) of energy industries with high energy intensity to the national (regional) economy, natural and climatic factors; spatial distribution of energy consumption facilities. Among these factors, the key role is played by the structural factor.

2. Large-scale cross-country study of energy efficiency dynamics in the major economies of the world, the results of which allowed to identify two factors in relation to Russia which, to a large extent, predetermined the reduction of energy intensity of its economy [7], namely, the structural factor (change in the structure of the economy) and technological factors (reduction of energy intensity of the economy within the existing industries related to the improvement of technologies in use). However, we did not directly link the technological effect to the energy performance or indicators of innovation and technological development, while limiting its role only to the reduction of energy intensity within the existing sectoral structure of the economy.

Based on the first of the above studies, and using similar indicators (share of highly energy intensive industries in GRP, the average air temperature in January and July, surface area of the region) and proceeding from the conclusion that the energy intensity of the economies in different countries of the world can be by 80 % attributed to the impact of these three factors, we analyzed the situation

[7] Energoeffektivnost v Rossii. Skrytyy rezerv. In Russian [Energy Efficiency in Russia. Hidden Reserves]. Retrieved from: http://www.cenef.ru/file/FINAL_EE_report_rus.pdf (date of access: 05/29/2016).

in the Russian regions. Compared to the "reference" methodology in the existing literature, the novelty of the methodology used in our analysis consists in applying the composition of two statistical data analysis methods, namely, cluster and regression analysis. Complementing the methodology of supporting studies with the methods of cluster analysis is primarily caused by the need to break down the Russian regions by homogeneous group due to the specifics of regional energy consumption. This complementation also allowed to obtain a number of new results, which served as the basis for elaborating the differentiated recommendations on regional energy saving strategies. The correlation and regression analysis was based on the up-to-date data array for all Russian regions and allowed to establish the quantitative impact of the indicator, that reflects the share of energy-intensive industries in the gross regional product, on the level of energy intensity of regional economy, while confirming the statistically significant impact of this parameter on the energy intensity of GRP. In addition, we determined the feasibility of expanding the list of factors that may affect the level of energy intensity of the economy in the Russian regions.

Now, let us present in more detail the course of empirical study and the interpretation of results. For the regression analysis, first of all, we collected the data needed to generate the basic indicators mentioned above (Table. 1).

Table 1

The information database for regression analysis of the factors affecting the energy efficiency in Russian regions (according to Rosstat)

Indicator	Units
Energy intensity of regional GRP	kg of fuel equivalent / 10,000 rubles of gross regional product
Contribution of energy-intensive industries (manufacturing, mining, energy production) to regional GRP	% of regional GRP
Surface area of the region	thousand km^2
Average temperature, July 2014	°C
Average temperature, January 2014	°C

Initially, the information on parameters in Table 1 was on 83 Russian regions using the data for 2014 (available on the website of Rosstat as of May 2016). However, some regions (Yamalo-Nenets Autonomous District, Khanty-Mansi Autonomous District, and Nenets Autonomous District) were excluded from the review because the data provided by Rosstat was contradictory. Based on this information, for all remaining Russian regions we used Gretl, an econometric analysis software package, to build a regression model to describe the dependence of energy intensity of the regional economy on identified factors (namely, share of energy-intensive industries in the GRP, surface area of the region, average air temperature in January and July). For this set of regions, such dependence turned out to be statistically insignificant.

In view of these results, we identified a group of regions with the so-called "outliers" in the analyzed data for at least one indicator. Namely, we identified the regions with excessively high/excessively low energy intensity compared to the other regions, significant variations in the share of energy-intensive industries, variations in the surface area of the region; variations of temperature. The regions where we identified such outliers were included in Group 0. The remaining regions, a total of 48, were in turn divided into two groups (Group 1 and Group 2), each of which can be described as homogeneous in terms of surface area and air temperature (Table. 2).

The regions were divided in Group 1 and Group 2 based on territorial and climatic factors, which allowed to obtain the following results. The level of energy intensity of regional economies in each of these groups was the same in terms of average statistics. However, the share of energy-intensive industries differs statistically between Group 1 and Group 2. This indicates that the group of regions with a higher share of energy-intensive industries (regions of Group 2 in Table 2) operates more efficiently. The result was proven statistically by using the regression model, under which the energy intensity in these regions can be by 40 % explained by the share of energy-intensive industries; in regions with a lower share of energy-intensive industries, the weight of sectoral factor is higher. Figures 1–3 built with Tableau, data visualization software, present the regions of each of the three groups.

Table 2

The classification of Russian regions by groups depending on indicators of the energy efficiency and influencing factors

Group 0	Group 1	Group 2
Arkhangelsk Region	Altai Krai	Astrakhan Region
Vologda Region	Amur Region	Belgorod Region
Moscow	Bryansk Region	Vladimir Region
Saint Petersburg	Zabaykalsky Krai	Volgograd Region
Jewish Autonomous Region	Ivanovo Region	Voronezh Region
Irkutsk Region	Kabardino-Balkar Republic	Kamchatka Krai
Kaliningrad Region	Karachay-Cherkess Republic	Kirov Region
Kaluga Region	Krasnodar Krai	Kostroma Region
Kemerovo Region	Kurgan Region	Kursk Region
Krasnoyarsk Krai	Leningrad Region	Moscow Region
Lipetsk Region	Orel Region	Murmansk Region
Magadan Region	Penza Region	Nizhny Novgorod Region
Novgorod Region	Primorsky Krai	Novosibirsk Region
Orenburg Region	Republic of Adygea	Omsk Region
Republic of Altai	Republic of Mordovia	Perm Krai
Republic of Buryatia	Ryazan Region	Pskov Region
Republic of Dagestan	Stavropol Krai	Republic of Bashkortostan
Republic of Ingushetia	Tambov Region	Republic of Karelia
Republic of Kalmykia	Khabarovsk Krai	Republic of Mari El
The Komi Republic		Rostov Region
Republic of Sakha (Yakutia)		Samara Region
Republic of North Ossetia — Alania		Saratov Region
Republic of Tatarstan		Sverdlovsk Region
Republic of Tyva		Smolensk Region
Republic of Khakassia		Tver Region
Sakhalin Region		Tula Region
Tomsk Region		Ulyanovsk Region
Tyumen Region		Chuvash Republic
Udmurt Republic		Yaroslavl Region
Chelyabinsk Region		
Chechen Republic		
Chukotka Autonomous District		

Groups of regions 1 and 2 were formed following the analysis of available statistical information; the regions in these groups are characterized by homogeneity in terms of surface area and air temperature. A particular characteristic of these groups is the fact that Group 1 has higher level of energy intensity of GRP (namely, 192.5 kg of fuel equivalent/10,000 rubles) compared to Group 2 (the average energy intensity of its regions is 175.1 kg of fuel equivalent/10,000 rubles)

The share of energy-intensive industries in these groups of regions is 22 % in Group 1 and 28 % in Group 2 (Table 3). The difference in the average levels of energy intensity of GRP and the share of energy-intensive industries in these groups is supported by statistical test for equality of means in independent samples.

Table 3

The average indicators of energy intensity of GRP and the share of energy-intensive industries by groups of regions (2014)

Group	Energy intensity of GRP (kg of fuel equivalent/10,000 rubles)	Share of energy-intensive industries in the regional economy (%)
1	192.5	22
2	175.1	28

Therefore, with a higher share of energy-intensive industries, Group 2 is characterized by a lower level of energy intensity as compared to the Group 1. In this case, it can be assumed that

Fig. 1. *Group of regions with variations (outliers) (Group 0) (Here (Figure 1) and thereafter (Figures 2–3) fill color corresponds to the level of the region's energy intensity. Regions with darker fill have higher energy intensity compared to the regions with lighter fill)*

Fig. 2. *Group of regions 1*

Fig. 3. *Group of regions 2*

the energy-intensive production in the regions of Group 2 is more efficient than in Group 1. This assumption is supported by correlation and regression analysis. Let us present its final results.

Let's index the regions from 1 to 48 and designate the regional index as i. The energy intensity of the region for 2014 is described through the variable $EnCon_i$, and contribution of energy-intensive industries in the region for 2014 is described through $Impact_i$. Also, we introduce an additional dummy variable $d\_imp_i = dumm_i \cdot Impact_i$, which shows the change in the impact of the share of energy-intensive industries on the energy intensity depending on the group of regions ($dummy_i = 0$, if i-th region is included in Group 1 и $dummy_i = 1$, if i-th region is included in Group 2). We estimate the equation by using the Least Squares Method (LSM). Testing procedures have shown that the equation is not subject to heteroscedasticity. Therefore, the results of assessment under LSM can be considered correct.

Following the assessment, we obtained the following equation:

$$EnCon_i = 85{,}3 + 5{,}01\ Impact_i - 1{,}68\ d\_imp_i + e_i. \quad (1)$$

The values of t-statistics that correspond to this equation are equal, respectively, to (4.32; 5.44; −3.66); F-statistics is the estimated value of Fisher's statistics, (F = 15.21); R^2 is the coefficient of determination (indicator of model quality) (R^2 = 0.4); n = 48 is the number of observations used to estimate the regression equation (n = 48).

These results allow to quantify the contribution made by the share of energy-intensive industries in the region to the indicator of the region's energy intensity. In other words, they allow to understand the impact made by each unit of the change in the share of energy-intensive industries on the energy intensity of the region as a whole. Therefore, the average contribution to the region's energy intensity made by each percentage point of the share of energy-intensive industries in the regions of Group 1 is 5.01 kg of fuel equivalent/10,000 rubles of ВРП; and, for the regions of Group 2, this contribution is lower by 1.68 kg of fuel equivalent/10,000 rubles of GRP and stands at 3.33 kg of fuel equivalent/10,000 rubles of GRP. These results allow to assess the impact of potential changes in the structural factor on the energy intensity of the region. The applications of results obtained following the correlation and regression analysis of regional energy intensity are presented in the next section.

Key Findings of the Study and the Potential Areas of Their Application

The study of the statistically significant impact of structural, spatial and climatic factors on the level of energy intensity of gross regional product by combining the correlation and regression method and cluster analysis allows us to formulate the following key findings and identify potential areas of application for obtained results.

1. The analysis of energy intensity across the entire set of Russian regions on the basis of normally applied indicators, such as the structural factor determined by the share of energy-intensive industries in the GRP, surface area of the region and climatic parameters, revealed no statistically significant results. However, after excluding from consideration the regions with atypical data (regions of Group 0) and establishing, on the basis of the remaining regions, two groups that are homogeneous in terms of surface area and climatic characteristics (which allowed to eliminate the impact of these factors on the studied indicator), we obtained the following substantial results. In the regions of Group 1 and Group 2, the changes in the energy intensity of GRP can be by 40 % explained by a structural factor. As for the parameters related to the surface area and air temperature, like in several other similar studies, we did not include them in the regression model, but used only as criteria for clustering. Therefore, the hypothesis that we wanted to verify with regard to statistically significant impact of indicators traditionally applied by the experts to explain the energy intensity of GRP has been confirmed on the new data set, but only for 48 out of 83 Russian regions (i.e., about 60 % of the total number of regions).

2. Group of regions 2 is characterized by the fact that, despite its higher average (by 6 %) contribution of energy-intensive industries to GRP, their average energy intensity of GRP is lower than in the regions of Group 1 (175.1 compared to 192.5 kg of fuel equivalent/10,000 rubles). Consequently, the regions in the Group 2, which also includes Sverdlovsk Region, have achieved higher energy efficiency results compared to Group 1. This is in spite of the structure of their economy, which is characterized by a significant share of energy-intensive industries in the production of GRP. These results raise the question of additional studies to identify the factors that determine the high effectiveness of their efforts to reduce the energy intensity, while the positive experience in the area of improving the energy efficiency demonstrated by the regions of Group 2 can be recommended for study by the regions of Group 1. In this context, we should draw attention to the fact that, among fifteen best Russian regions in terms of the quality of strategies for socio-economic development in 2013 (according to the last study conducted by Expert RA, a rating agency[8]), six regions are from Group 2, and only two are from Group 1, while the rest are from Group 0. Therefore, the high level of strategic planning can be considered as a potential factor for the best results achieved by the regions from Group 2, including in the area of energy efficiency, and the study of the relevant positive experience can be recommended as a model of best practices to other subjects of the Russian Federation.

3. The regions of Group 0 also require additional studies for identifying specific subgroups and applying the differentiated analysis towards them. First, it is advisable to analyze and summarize the successful experience gained by a number of regions in achieving a relatively low level of energy intensity, despite the sectoral structure of their economies characterized by a significant share of energy-intensive industries (Kaluga Region, Kaliningrad Region, Republic of Tatarstan, and others). Second, it is necessary to identify the causes that lead to excessively high values of energy intensity in the economy of such regions as Irkutsk Region, Republic of Buryatia, and Tyva Republic. Third, high energy intensity of the economy identified in regions with a significant share of metallurgy in their GRP (Lipetsk Region, Vologda Region, Chelyabinsk Region, Kemerovo Region, and Republic of Khakassia) sets for the regional and federal authorities the task of conducting an in-depth analysis of technological and innovative parameters describing these regions followed by the elaboration of specific practical recommendations.

4. To identify the factors that determine the high effectiveness of efforts to reduce the energy intensity of regions in Group 2 and some of the regions in Group 0 designated in paragraph 3 with the subsequent elaboration of recommendations based on the experience of these regions and aimed at promoting the best practices, we considered the results of the latest study conducted by Expert RA, a respectable rating agency, which assessed the quality of strategies of socio-economic development and

[8] Reyting kachestva strtegiy sotsialno-ekonomicheskogo razvitiya regionov Rossii na aprel 2013 goda. Lidery planirovaniya. Metodika reytingobogo agentstva Ekspert RA. In Russian [Quality Ranking of Strategies for Socio-Economic Development of Russian regions as of April 2013. Leaders of planning. Methodology of Expert RA rating agency]. Retrieved from: http://raexpert.ru/researches/regions/soc_eco_regions_04_2013/ (date of access: 10/28/2016).

identified the leading regions[9]. In 2013 (the year of that study), six out of fifteen best Russian regions belonged to Group 2 of three groups identified in this article, seven represented Group 0, and only two were from Group 1. These results lead us to conclusion, that the high level of strategic planning can be viewed as a prerequisite for the regions to achieve the best results in the area of energy efficiency, and the relevant positive experience of the regions in the indicated two groups can be recommended for studying by other Russian regions as an example of best practices.

In general, the results of correlation and regression analysis of factors affecting the level of energy intensity of Russian regions and grouping of regions based on such analysis can be used to substantiate the differentiated regional strategies of long-term development with low GHG emissions, and to assess the effectiveness of executive branch in the subjects of the Russian Federation by taking into account the reduction of GHG emissions, as provided in the Directive of the Government of the Russian Federation No. 807-r of May 6, 2015. Moreover, in addition to the factors analyzed in this article, the obtained data allow to identify other factors, which may impact the level of energy intensity of the economy in the Russian regions. Other researchers came to similar conclusions and, in such situations, drew attention to the need of assessing the quality of institutions that can make both positive and negative impact on the dynamics of relevant indicators [7, 10, 16].

Following these recommendations, we compared the rankings of regions in terms of governance risk assessed in accordance with the methodology of Expert RA rating agency[10] and in terms of energy intensity of the regional economy. We should note that, under this methodology, the governance risk includes such parameters as the quality of budget management, the stability of human resources involved in the public governance, quality of interaction with the public and businesses, and other parameters that allow to comprehensively assess the quality of governance at the regional level. By using the methodology of Expert RA, we found that out of 20 regions which, in 2014, were the leaders in terms of governance risk level, 12 were among the 22 best regions in terms of energy intensity of the economy. At the same time, most of these regions are included in Group O identified in this study.

The additional analysis conducted by some of the authors with regard to relationship between the quality of strategic governance and indicators of the energy intensity of regional economies [3] revealed the importance of not only investing significant funds in energy savings, which is often the focus of literature, but also stability in the operation of high-quality governance systems, which was assessed by the fact of whether the region belonged to the group of leaders in terms of the governance risk in 2010–2014. The subjects of the Russian Federation that hold leading positions on both indicators (sustainable high quality of strategic governance and reduction of energy intensity) included the regions from both Group 0 and Group 2. They include Kaluga Region, which is part of Group 0 and, for several years, remains the leader in terms of the quality of strategic planning among the Russian regions and pays special attention to the mechanisms of implementing the strategies and assessing them, openness and transparency of authorities, as well as to interaction with public and businesses. Similar conclusions on priorities attached to achieving high performance in the area of energy efficiency amid resource intensive sectoral structure can be made with regard to the Republic of Tatarstan, where the system of regional governance consistently and seamlessly integrates the key elements and principles of modern governance concepts.

These results support the conclusion on the substantial importance of governance factor for all groups of regions identified in this article, in order to improve the energy efficiency of the economy in the Russian regions with the mandatory formation of a systemic approach to strategic management [3]. Its basis should be provided by the synthesis of basic public governance concepts, including new public management, new public governance, etc., as well as the active introduction of management innovation and a number of methods that have been successfully implemented by commercial organizations in their management practices (results-based management, risk management and other).

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[9] Reyting kachestva strtegiy sotsialno-ekonomicheskogo razvitiya regionov Rossii na aprel 2013 goda: lidery planirovaniya. Metodika reytingovogo agentstva Ekspert RA. In Russian [Quality Ranking of Strategies for Socio-Economic Development of Russian Regions as of April 2013: Leaders of Planning. Methodology of Expert RA rating agency]. Retrieved from: http://raexpert.ru/researches/regions/soc_eco_regions_04_2013/ (date of access: 10/28/2016).

[10] Reyting investitsionnogo riska regionov Rossii v 2–14 godu, metodika reytingovogo agentstva Ekspert RA [Rating of investment risk in Russian regions in 2014, methodology of Expert RA rating agency]. Retrieved from: http://raexpert.ru/rankingtable/region_climat/2014/tab02/ (date of access: 10/12/2016).

Conclusion and Possible Areas for Further Study

This article reviewed the problem of energy savings and improving the energy efficiency in the regional context, which is one of the priority areas for implementing Paris Climate Agreement (2015) providing for decarbonization of national economies and substantial reduction of GHG emissions. With this goal in mind, we verified the hypothesis on the dependence of the level of energy intensity of the gross regional product (GRP) from the share of energy-intensive industries, the surface area of the region and a number of climatic parameters. The impact made by these factors on the level of energy intensity of the regional economy was assessed by using the correlation and regression analysis based on the results of studies conducted by a number of Russian and foreign authors, including in the cross-country context. The result was the classification of regions by identifying the groups, in which the impact of selected factors was found statistically significant (Group 1 and Group 2) and a group of regions, where this impact was not detected (Group 0).

Given the results and the review of best regional practices in the regions included in Group 2 and Group 0, and in addition to the proposals set forth in the preceding paragraph, the following recommendations may be elaborated for federal and regional regulators, and the following potential areas can be identified for further studies:

1. It is advisable that the currently drafted Strategy of Long-Term Development of the Russian Federation with Low Greenhouse Gas Emissions until 2050 includes the regional dimension reflecting the differentiated strategies to reduce the energy intensity of the regional economies.

2. While supporting the conclusion on the substantial importance of governance factor for all groups of regions identified in this article, in order to improve their energy efficiency with the mandatory formation of a systemic approach to strategic management, the obtained results imply its further detailed analysis [3].

3. In the context of the implementation of the Paris Climate Agreement (2015) by Russia, it is advisable to reorient the system of strategic public governance in the area of energy efficiency, which is currently being formed in Russia and its regions, towards the modern concepts of public management while systematically bringing up to date the recommendations based on summarizing the best regional practices (domestic and foreign).

4. To assess how stable is the composition of "clusters" of regions identified in this study and capture the relevant trends, it is advisable to continue the studies following the publication by Rosstat of the new data for 2015 and subsequent years, including through correlation of indicators in the area of energy efficiency with the ranking of regions in terms of the quality of their governance.

In the context of addressed tasks, we also studied the technological and innovation factors, which we analyzed by using such parameters as internal expenditure on R&D as a percentage of GRP, labor productivity index, wear of fixed assets, electricity consumption per employee in manufacturing, share of expenditure on technological innovation in the total volume of goods shipped, and other. However, the results did not support the assumption of the statistically significant impact made by these factors on the level of energy intensity in the economy of Russian regions, which apparently is related to the fact that it takes more time for innovation component to produce an effect on the regional economy. To obtain statistically significant results on the impact produced by innovative components on the energy intensity of the economy in the regions, we intend to assess this impact over time, which is also one of the areas for further study.

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