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## Analysis of Energy Capacity of the Russian Economy in the Regional Context

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**Abstract:**

**Purpose:** The purpose of this study is to consider options for adjusting primary reporting to clarify energy efficiency indicators.

**Design/Methodology/Approach:** In particular, models based on the study of correlation of gross regional product with regional production factors are considered. This will make it possible to refine the actual output in the regional context.

**Findings:** In comparison with the developed countries Russia essentially lags in the level of power consumption. For this reason, energy intensity is one of the priorities of the country's development. According to the data of Russian and international organizations, assessments of the state program of energy-saving implementation are very controversial, which does not allow making an objective conclusion about the achieved results.

**Practical Implications:** For such assessments, methods of factor analysis of reasons for energy efficiency changes, which are difficult to implement in Russia, are widely used in the world. The reason for this is the low reliability of the initial data due to the peculiarities of obtaining them. As a result, there is an abnormal dispersion of data both throughout the country's economy and in the energy efficiency of regions.

**Originality/Value:** A systematic analysis of the country's energy efficiency problem also requires data from a regional perspective. It is here that the main difficulties are observed, caused by the impossibility of objectively linking production volumes to the actual location of energy resources used.

**Keywords:** Energy efficiency indicators, energy-saving, factor analysis.

**JEL codes:** J01, P18, P48.

**Paper type:** Research article.

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**1. Introduction**

The transition to a market economy has forced Russia to struggle more actively to improve the competitiveness of its products on domestic and global markets. The country's rich raw material and energy resources have traditionally contributed to the development of extractive sectors of the economy and energy-intensive primary processing of raw materials and their subsequent export. With low world oil prices and rising domestic energy tariffs, the existing Russian economy is losing efficiency and needs to be modernized as soon as possible. Russia occupies the 4th place in the world of energy consumption, but in terms of efficiency of its use it occupies the 21st place out of 25 available countries (according to ACEEE rating for 2018.) For this reason, the reduction of energy intensity is one of the main directions of economic reforms in the country.

In 2008, a strategic goal was set to reduce the energy intensity of GDP by 40% by 2020 against the 2007 level (Decree of the President, 2008). To achieve this goal, there should be a system for measuring energy efficiency, which allows an objective analysis of data and comparison of results by regions, sectors, and countries. Ultimately, it should objectively consider the contribution of state regulation and technological development measures to the overall energy efficiency change and under the influence of the whole set of influencing factors. Such an assessment can be made within the framework of various methods of factor analysis of efficiency, which exist in many countries of the world (Ang and Choi, 1997; Ang and Lue, 2001; Ang *et al.*, 2010; Polyakova *et al.*, 2019). Similar methods have been developed and demonstrated by Russian scientists but have not been accepted for use. The difference in assessment methods between Russia and international organizations (IEA) leads to contradictory opinions on energy efficiency in the Russian economy.

In 2019, Russia, drawing on the experience of other countries, attempted to improve its energy efficiency assessment methods. The emergence of new methodological recommendations (Order of the Ministry, 2019) requires the use of factor analysis, calculations in basic prices and the introduction of several other positive innovations. The study aims to develop measures to clarify the energy intensity indicators of the economy in the regional context within the available statistical information. As a result, it was proved impossible to use economic and mathematical algorithms to correct existing statistics without reforming the system of collection

and processing of initial information. Without these actions, domestic energy efficiency statistics will be largely unreliable.

## **2. Materials and Methods**

The study is based on the current Russian methodology for assessing energy efficiency in the country's economy. Based on the analysis of official statistical data and their comparison with foreign research materials, significant discrepancies in estimates were revealed and it is shown that official energy intensity indicators do not correctly reflect the real situation and do not allow an objective assessment of the results of the state energy-saving program. The article shows the urgency of developing an energy efficiency monitoring system based on factor models, as well as problems with their implementation due to the peculiarities of Russian statistical accounting of primary data. Based on a comparison of Goskomstat data, abnormal fluctuations in energy efficiency assessment by Russian regions are shown. They are due to the practice of recording the volume of output at the location of the company's head office, while the energy consumption is recorded at the location of actual energy consumption.

The second approach was to use reporting data on profit tax collection, which is distributed by regions in proportion to the factors of production involved. The theoretical prerequisites for the use of this approach were not confirmed by model calculations. On this basis, the conclusion was made that there is no statistical connection between production factors in Russia and GRP indicators and the energy efficiency of regions. Therefore, without reform of the entire system of primary information collection on energy consumption and production volumes at the level of individual regions, all further methods of information analysis will lead to inadequate results.

## **3. Results and Discussion**

The efficiency of energy use in the economy can be measured by different indicators. The best known of them is energy intensity (EI), which shows the relationship between final energy consumption and real GDP of a country or the inverse indicator - production cost per unit of GDP (productivity). These indicators can be calculated both at the enterprise level and at the level of the entire country, which allows comparing the production and economic activities of entities of different sizes. However, in this form indicators characterize only a statistical trend, but do not disclose the internal causes of change, ignore the differences in the importance of different types of economic activities (Patterson, 1996). For this reason, the idea of decomposing general changes by influencing factors emerged and appropriate indices was developed. They highlight the contribution of technological development, the scale of activity, structural shifts in the economy, degree of equipment utilization and other factors to the change in the final indicator. Such an analysis is of great importance for Russia since the national economy has been in a

state of structural change for a long time (NIU WSHE, 2018). Mention should be made of the impact on the economies during the three crises of 1998, 2008 and 2014 and the highly uneven dynamics of production in key sectors (Dynamics, 2019). Structural changes have affected the most important sectors of GDP, which are also the most energy intensive. Under the conditions of instability in economic development, it is unacceptable to ignore the impact of structural and other factors in energy efficiency analysis. This can lead to significant errors in the assessment of the situation and false conclusions.

Many years of experience in using factor models abroad and numerous studies of this problem by Russian scientists have not been in demand by government agencies, although the government energy-saving program has been in place since 2008 and should be completed in 2020. Its effectiveness is still not clear. Official statistics show a sharp increase in energy efficiency, which has been demonstrated by all Russian regions (Figure 1). This is because Rosstat calculates only in current prices. In conditions of inflation (for the period of 2012-2017, almost 45%), nominal GDP is growing without a real increase in output, so the energy intensity will decrease. This error can be eliminated by recalculating nominal GDP into base prices based on inflation indices.

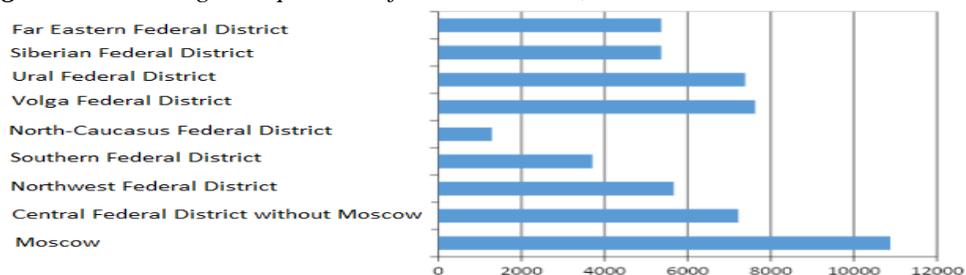
Strong differences in energy intensity estimates by different information sources attract attention. In the official report on energy efficiency for 2017, the real reduction in energy intensity is estimated at 5% (State report, 2017). The situation is even worse with estimates of the contribution of different factors to this reduction. It is believed that more than 60% of this impact is due to structural shifts (Bashmakov and Myshak, 2014; Nagimov *et al.*, 2018; Akhmetshin *et al.*, 2018). In the report on energy efficiency in the Central region for the period of observations ranged from 110 to 80 kg c.e. per 10,000 rubles, while in the data of the State Statistics Committee there are figures 240-160, i.e., the difference is more than 2 times. The reasons for such differences are not mentioned in the report, but in any case, it distorts the result. Comparison of the energy intensity of Russia's GDP according to domestic and international sources (A Statistical Compendium, 2019) shows an almost 50% discrepancy in estimates, with the discrepancies increasing significantly since 2008 after the President adopted the energy policy goals. Officials may be suspected of wanting to show good results, but it is Russian statistics that assess the situation worse than all other studies (IEA).

Lack of adequate data on the dynamics of energy intensity of GDP in previous periods does not allow us to judge the extent to which state policy goals in this area have been achieved. A 40% reduction in energy intensity compared to 2007 will not be achieved. Over more than 10 years of the program implementation, the country has failed to create an adequate and unified system for collecting statistical information and monitoring the achieved results. Only in August 2019, there were a new assessment methodology (Order of the Ministry, 2019) which includes a multi-factor analysis and is as close as possible to the foreign experience. There are no

practical calculations at the moment. Why did this happen? Energy efficiency assessment systems have long existed and are successfully used in many countries, but it has proved difficult to adapt them to Russian conditions. In our opinion, the initial reason is the specifics of GDP and energy consumption accounting. To calculate IE regional indicators, it is necessary to have data on primary energy consumption and GDP from a regional perspective. Data on energy consumption is taken from the energy balance of the region, but the domestic methodology for compiling such balances differs significantly from international standards in this area (OECD/IEA, 2006; Energy Balances, 2008; Key world, 2019).

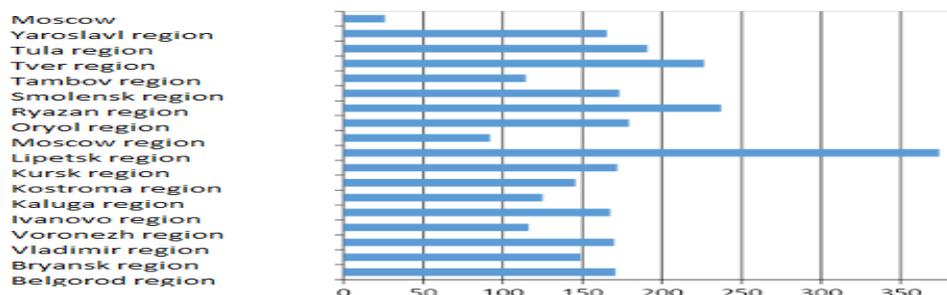
Errors in the conversion of consumed electricity into fuel equivalent will affect energy intensity. This feature distorts the objectivity of the calculation of energy consumption (Bashmakov, 2018) and makes it impossible to compare the results directly with other countries. The possibility to track the dynamics inside Russia remains. According to the Russian practice, the region where the company's head office is located is considered the place where GRP is formed (Order of Goskomstat, 1999). As the offices of major Russian companies are in large cities, they have abnormally high GRP and, consequently, low energy intensity. For example, the GRP of Moscow exceeds all Russian federal districts with their industrial centers (Figure 2). At the same time, there are few energy-intensive industrial enterprises in Moscow and energy consumption for industrial needs is relatively low.

**Figure 1.** Gross regional product of the RF in 2017, billion rubles



*Source:* Based on official Rosstat data.

**Figure 2.** GRP energy intensity in the regions of the Central District in 2017, t.c.e.



*Source:* Based on official Rosstat data.

According to the rating of Russia's 500 largest companies (RBC 500<sup>3</sup>), 82.3% of the country's GDP is generated, with 296 companies having their head offices in Moscow. More than half of the banks registered in Russia are in the capital city. Moscow-based companies account for 78.5% of the total sales volume of all RBC 500 companies. Other centers are St. Petersburg, Krasnodar, Yekaterinburg, Kazan and several other large cities. Many large companies have subsidiaries scattered across many regions. For example, Gazprom is present in 9 regions, Rosneft in 5, etc. For comparison, the largest American corporations from the Fortune 500 ranking have only 48 and 25 headquarters in the main business centers of New York and Houston.

In economic theory, the size of GDP can be calculated by the Cobb-Douglas production function, which relates the size of GDP to the number of manpower (labor) and the value of production assets (capital). Studies of Russian scientists devoted to the application of the Cobb-Douglas function to the analysis of the national economy recommend a more complex type of function reflecting the Russian specifics (Kirilyuk, 2013).

$$Y = AK^{\alpha} L^{\beta} P^{\gamma} e^{ct} \quad (1)$$

where:

Y- GDP;

K - capital, the value of fixed assets in basic prices;

L - labor, number of employed persons in the economy;

P - oil prices.

Exponential multiplier  $e^{ct}$  characterizes the effect of the development of innovation processes in the economy. Variables Y, K, L, and P are taken from national statistics, while other indicators should be calculated based on the regression model (according to Rosstat data).

**Table 1.** Input data for the calculation of the production function

Year	L, number of employees in the economy, in thousands	K, Fixed assets value at base prices 2012, mln. rub.	P, average annual oil price Urals, \$/bar	Y, GDP at base prices in 2012, million rubles
2012	71545.4	121 268 908	109.45	176.97
2013	71391.5	133 521 531	105.87	171.60
2014	71539.0	147 429 656	96.29	177.32
2015	72323.6	160 725 261	49.49	180.54
2016	72392.6	183 403 693	40.68	183.80
2017	72142.0	194 649 464	52.51	177.64

**Source:** Based on official Rosstat data.

<sup>3</sup><https://www.rbc.ru/rbc500/>

The calculations based on the data of 2012-2017 allowed us to determine a model with rather a high degree of approximation ( $R^2=0,88$ ) but the extremely low statistical significance of the coefficients (Table 2).

**Table 2.** Calculation factors for equation (1)

Coefficient	Value	P-value
A	7.79162E-30	0.746205588
$\alpha$	-4.923978884	0.812634581
$\beta$	-0.621207666	0.686299929
$\gamma$	-0.018067661	0.960959764
$\zeta$	0.071829963	0.600855037

*Source:* Calculated by the authors of the study.

Thus, the model was not suitable for scaling data on the entire economy to its regions. Since the region's indicators are less than countrywide data, the model gives an unacceptable error when extrapolating data. The reason may be the insufficient number of statistical data but using an extended time range is also unacceptable. Transformation of the economy and regular crisis phenomena in it has led to the obsolescence of data, which does not allow to work with large time transmissions. The hypothesis that GRP can be adjusted by using a production function has not been confirmed.

Another assumption concerns the possibility of making amendments to GRP based on tax reporting data. Russia's profit tax rate is 20%. Of these, 3% is transferred to the federal budget and 17% to regional budgets (as of 2017). Following Article 288 of the RF Tax Code (n.d.), the regional part of the tax is transferred to the regional budget at the location of the organization, as well as at the location of each of its separate subdivisions, in the amount of the profit share attributable to these subdivisions.

Lack of a uniform objective methodology for data collection by region led to the emergence of some regional models (Kreydenko *et al.*, 2018), however, this cannot be a systematic approach to energy efficiency management. The most promising and radical approaches to solving this problem are detailed descriptions of social reproduction in the context of a region. In fact, at the regional level, it is necessary to create a system of national accounts like the national one.

Another problem of energy efficiency analysis is the accounting of energy embodied in purchased products. Today, energy resources are understood as a certain list of energy carriers (oil, coal, gas, etc.). Any product produced contains energy costs embodied in it. As a result, the energy intensity of high-tech productions is decreasing because the added value is high, and the consumption of energy resources is low. These productions are based on modern equipment, raw materials, and other resources, the cost of which contains a significant share of energy. The

transition from direct to full energy consumption accounting can significantly change performance perceptions.

#### **4. Conclusion**

In this article, approaches to improve the accuracy of energy efficiency indicators are considered as a forced measure for the period of reform of the system of collection and analysis of statistical reporting. Theoretical assumptions did not allow to obtain an adjustment model suitable for practical application. The peculiarity of the Russian economy is the absence of a significant correlation between the volume of production and production factors, which proves the need for a speedy reform of the entire data collection system. It is the shortcomings of Russian statistics that are the weak link in the system of information analysis. The development of information technologies creates a basis for direct monitoring of energetic consumption and production volumes. It is this area of development that should form the basis for all other methods of energy efficiency analysis.

At present, a deep factor analysis of regional energy efficiency is not possible. At the same time, it is still possible to monitor the relative dynamics of indicators. We can compare regions within the country, but it is impossible to speak objectively about the causes of changes.

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