

---

---

# SOCIO-ECONOMIC DEVELOPMENT OF REGIONS

---

---

ROTWLY

## ASSESSMENT OF ENERGY EFFICIENCY OF RUSSIAN REGIONS IN THE CONTEXT OF ECONOMIC DECARBONISATION AND SUSTAINABLE TERRITORIAL DEVELOPMENT

---

V. I. Belov<sup>1, 2</sup> 



---

<sup>1</sup> Northwestern Institute of Management – Branch of RANEPa, 57/43 Sredny Prospekt, St. Petersburg, 199178, Russia

<sup>2</sup> A. S. Pushkin Leningrad State University, 10 Peterburgskoe Shosse, St. Petersburg, Pushkin, 196605, Russia

Received 2 February 2024

Accepted 28 November 2025

doi: 10.5922/2079-8555-2026-1-7

© Belov V. I., 2025

*In modern conditions, boosting the energy efficiency of regional economies by reducing energy consumption by businesses and households stands as an imperative for their greening. Russia's legal regulations establish concrete deadlines for reaching sustainable development targets. Against this backdrop, the study aims to evaluate the current energy efficiency status of Russian regions, thereby identifying prospects (by 2030) for achieving decarbonization and sustainable development goals in their economies. The author's methodology, spanning multiple stages, centres on calculating growth rates for relevant energy efficiency indicators over 2016–2022, followed by their extrapolation to 2030. The findings indicate that few Russian regions can meet the established targets by the deadline. The reasons behind this projected shortfall are as diverse as the regions themselves. However, data analysis reveals a common trend: insufficient growth rates in reducing industrial energy intensity, energy consumption by economic entities, and atmospheric pollutant emissions across most Russian regions. This, in turn, underscores the need for regional authorities – accounting for each subject's unique developmental specifics and features – to implement active regional policies whose tools align seamlessly with all sustainable development components. The practical value of this research lies in its preliminary energy efficiency estimates for regions, which not only spotlight emerging 'energy' issues but also enable authorities to adopt congruent, timely decisions based on their identification, fulfilling the immanent sustainability tasks set by national leadership.*

### Keywords:

greening of the economy, energy consumption, energy intensity, energy losses, emissions into the atmosphere, industries

---

**To cite this article:** Belov, V. I. 2025, Assessment of energy efficiency of Russian regions in the context of economic decarbonisation and sustainable territorial development, *Baltic Region*, vol. 18, № 1, p. 117–133, doi: 10.5922/2079-8555-2026-1-7

## Introduction

By Decree of the Government of the Russian Federation<sup>1</sup> of 21 September 2019, Russia adopted the Paris Agreement on climate change at the national level.<sup>2</sup> This decree defines a framework for environmental sustainability, emphasises the importance of promoting non-carbon benefits, and calls for the development of rational models of consumption and production. In the Message of the President of the Russian Federation to the Federal Assembly (dated February 29, 2024),<sup>3</sup> the Head of State, within the framework of implementing the environmental and climate agenda, emphasised the need to reduce harmful emissions and pollutants by half by 2030. Relevant regulatory documents were adopted,<sup>4</sup> aimed at decarbonisation of the Russian economy and its sustainable development.

During Russian Energy Week on 26 April 2024, the President of Russia, speaking at the plenary session, noted the record growth in energy consumption in the country, which exceeded even the figures recorded during the time of the Soviet Union, and linked this growth to the expansion of the Russian economy.

Indeed, during the existence of the Soviet Union, the rapid growth of the Soviet economy was largely driven by increasing energy consumption across all sectors. For example, from 1960 to 1970, electricity consumption increased 2.52 times (from 292.3 to 735.7 billion kWh); from 1970 to 1980, it grew by 1.73 times; and from 1980 to 1990, by 1.33 times (from 1,274.8 to 1,689.9 billion kWh). Over the same periods, gross social product increased by 2 and 1.68 times, respectively, while from 1980 to 1990 it grew by 1.5 times (from 1,078.5 to 1,631.6 billion roubles). In addition, by 1982, the Soviet Union ranked first

---

<sup>1</sup> On the Adoption of the Paris Agreement, Decree of the Government of the Russian Federation № 1228 of 21 September 2019, 2019, *Garant*, URL: <https://www.garant.ru/products/ipo/prime/doc/72661694/?ysclid=m1mamth6qa446143873#review> (accessed 15.10.2024).

<sup>2</sup> Paris Agreement, 2018, *UN*, URL: <https://www.un.org/ru/climatechange/paris-agreement> (accessed 15.10.2024).

<sup>3</sup> The President's Message to the Federal Assembly, 2024, *the President of Russia*, URL: <http://www.kremlin.ru/events/president/transcripts/messages/73585> (accessed 15.10.2024).

<sup>4</sup> On approval of the Strategy for Socio-Economic Development of the Russian Federation with Low Greenhouse Gas Emissions until 2050, Decree of the Government of the Russian Federation dated October 29, 2021 № 3052-r, 2021, *Garant*, URL: <https://www.garant.ru/products/ipo/prime/doc/402894476/?ysclid=m1mcwbelh6949807444> (accessed 15.10.2024) ; On approval of the Climate Doctrine of the Russian Federation, Decree of the President of the Russian Federation dated October 26, 2023 № 812, 2023, *Garant*, URL: <https://www.garant.ru/products/ipo/prime/doc/407782529/?ysclid=m1mcybsnaf714206529> (accessed 15.10.2024) ; On approval of the Comprehensive State program of the Russian Federation "Energy Saving and Energy Efficiency Improvement", Decree of the Government of the Russian Federation dated September 9, 2023 № 1473, 2023, *Garant*, URL: <https://base.garant.ru/407632842/?ysclid=m1md1oum22851285733> (accessed 15.10.2024) and others.

in the world in steel and pig iron production, oil and iron ore extraction, timber, cement, coke, mineral fertilisers, and the production of mainline diesel and electric locomotives.<sup>1</sup>

The achievements of previous decades shaped a typical development model of the Soviet economy, in which economic growth was accompanied by a significant increase in energy consumption. This kind of “inheritance” is still evident in the contemporary Russian economy. For example, a comparison of the growth rates of Russia’s gross domestic product (GDP) (at constant comparable prices) with the growth rates of energy consumption demonstrates a close relationship: in 2018, the figures were 102.8 % and 101.74 %, respectively; in 2019, 102.2 % and 100.18 %; in 2020, 97.3 % and 97.74 %; in 2021, 105.6 % and 104.65 %; and in 2022, 97.9 % and 101.60%.<sup>2</sup> In other words, it can be argued that significant changes towards the formation of rational production models and a substantial reduction in energy consumption have not yet occurred. At the same time, Western scholars have demonstrated the possibility of achieving economic growth not through an extensive increase in the extraction of non-renewable resources, but through the development of a low-carbon economy model [1; 2].

At the same time, it should be noted that the adopted national regulatory legal acts, which strengthen the current trend towards greening the domestic economy, are largely neglected due to the non-necessity of their implementation, and this, in turn, leads to the reproduction of the previous model of the “brown” economy, when the country’s economic growth is ensured by even greater consumption of energy resources, forming an outdated model with unstable development, while, according to current documents, it is necessary, on the contrary, to reduce energy consumption, to increase energy efficiency and the level of decarbonisation of the economy, to strive to achieve the designated goals in the field of sustainable development.

The term *decarbonisation of the economy* has not yet received a strict scientific definition, and it basically refers to the process of transition to a low-carbon economy associated with the reduction (complete elimination) of carbon dioxide emissions into the atmosphere [3–5]. This process fits into the concept of sustainable development, on the basis of which the world community has developed 17 interrelated goals for the sustainable development of territories.<sup>3</sup>

<sup>1</sup> *National Economy of the USSR in 1990, 1991*, Goskomstat of the USSR, Statistical Yearbook, Moscow, Finance and Statistics, 752 p. ; *National Economy of the USSR in 1982, 1983*, CSU of the USSR, Stat. Yearbook, Moscow, Finance and Statistics, 1983, 574 p.

<sup>2</sup> *Russian Statistical Yearbook 2023, 2023*, Rosstat. Statistical collection, Moscow, 701 p. ; *Industrial Production in Russia 2023, 2023*, Rosstat, Statistical collection, Moscow, 259 p.

<sup>3</sup> Resolution adopted by the General Assembly on 25 September 2015, 2025, *United Nations Conference on Trade and Development*, URL: [https://unctad.org/system/files/official-document/ares70d1\\_ru.pdf](https://unctad.org/system/files/official-document/ares70d1_ru.pdf) (accessed 15.10.2024).

Russia, having aligned itself with the international community in this regard, has developed its own targets, among which, in this context, the following can be highlighted: task 7.3 (“To double the global energy efficiency index by 2030”), which implies reducing the energy intensity of the Russian economy; task 9.4 (“To modernize infrastructure and re-equip industrial enterprises by 2030”), which assumes a reduction in carbon dioxide (CO<sub>2</sub>) emissions into the atmosphere per unit of added value.

Official documents adopted by Russia oblige the country to adhere to the “green” agenda [6; 7] and to fulfil its commitments in this area. In this regard, it seems necessary to analyse the preliminary results achieved so far and to assess the prospects for the timely attainment of the Sustainable Development Goals by Russian regions by 2030.

### **Literature review**

When describing the role of the state and its policy in ensuring sustainable and low-carbon economic development at the national level, a number of scholars identify one of the most significant challenges for Russia — the problem of regional differentiation. To promote the formation of a “green economy,” academic economists propose taking into account the specific features of regional decarbonisation processes, as well as the particular ways in which macro-regulatory measures are perceived by “spatially distributed centres of economic activity and the population” [8; 9].

A similar view is shared by the authors of studies [10—12], in which emphasis is placed on the typologisation of regional systems and the formation of regional clusters as a basis for sustainable economic development. Other studies adopt not a territorial but a sectoral approach: in particular, they examine the consequences of decarbonisation for the energy sector, non-ferrous metallurgy, and the oil refining industries of the Russian economy. They also identify the priorities of sustainable economic development in Russia, taking into account the “rational use of natural resources, environmental safety, and adaptation to climate change” [13—17].

In addition, there are scientific publications that evaluate the activities of enterprises and organisations [18—20], various complexes and sectors of the economy [21], and determine the impact of decarbonisation trends on sustainable development [22; 23]. However, there are not enough “assessment” works that reveal the current state of sustainable development of regional economies and determine the prospects for territorial and sectoral activities at the regional level. For example, in the article [24], only after-the-fact monitoring of target indicators with annual dynamics (2020—2021) is carried out. A similar approach is applied in the article [25], where the authors focus on the analysis of natural resources and assessment of the current state of the environment at the meso-level and at the same time do not assess the potential for sustainable development

of the region in the foreseeable future. In another study [26], the prospects for the region's sustainable development are assessed on the basis of a retrospective analysis using 25 indicators. However, this approach does not allow for an accurate determination of the degree of influence exerted by individual factors on the ongoing changes and, to a large extent, "blurs" the results, making the estimates overly general. Similarly, article [27] employs a system of indicators for the environmental ranking of regions consisting of 18 variable indicators, which also tends to average the results obtained.

It should be noted that many authors rely on aggregated data [28–29]; however, as demonstrated above, such smoothing primarily makes it possible to identify only general trends in economic development. Moreover, the use of different units of measurement often complicates the analysis of large datasets and does not provide sufficiently precise estimates. In this regard, it seems necessary to supplement the assessment of decarbonisation and sustainable development of regional economies with a comparative analysis based on a specific and selective set of indicators. This approach makes it possible to compare not absolute values or heterogeneous units of measurement in an interregional context, but rather the growth rates of the main indicators reflecting progress towards the goals and objectives set by the Russian leadership.

## **Materials and methods**

---

Improving the competitiveness and energy efficiency of the economy, among other things, fundamentally involves reducing energy costs. According to Russia's electricity balance for 2022, electricity consumption by industry (sections B + C + D + E) accounts for approximately 52 %, household consumption for about 16 %, and losses in the power grid for around 9 %. Thus, industry, households, and grid losses together account for nearly 77 % of total electricity consumption. This circumstance predetermined the selection of two main indicators for analysis: (1) energy intensity (electricity intensity) of regional industries and (2) electricity consumption by the population, taking into account energy losses in the grid.

Several methodological remarks should be made regarding the selected indicators. First, due to the lack of data on the consumption of all energy resources at the regional level in the national statistical database of Rosstat, the analysis is based on available data on electricity consumption across the constituent entities of the Russian Federation. Second, according to the federal statistical work plan, the energy intensity of the Russian economy is calculated only in relation to gross domestic product; thus, no regional calculation is provided by Rosstat (at least, the necessary data are not available in open sources). In this study, this limitation is addressed by calculating the "energy intensity (electricity intensity) of regional industries" as the ratio of electricity consumed by industry (sections B + C + D + E — mining, manufacturing, etc.) to gross regional product

(million kWh per 10,000 roubles per year at constant 2016 prices). Third, within the national set of Sustainable Development Goal indicators, Rosstat defines the indicator ‘electricity consumption per capita’, which measures the electricity consumption of an individual resident in a region but does not reflect the total electricity consumption of the regional population as a whole. Such an aggregate measure is necessary for assessing the energy consumption of Russian regions within their administrative-territorial boundaries. For this reason, the second indicator is used in the present study (see indicator 2).

The choice of the third indicator, emissions of pollutants into atmospheric air from stationary sources per unit of added value, is also justified, as it fully corresponds to Target 9.4 (see Introduction) and is directly related to Target Indicator 13.2.2, total annual greenhouse gas emissions, included in the national set of Sustainable Development Goal indicators for Russia. The calculation method for the third indicator is similar to that of the first: the numerator is emissions of pollutants into atmospheric air from stationary sources, while the denominator is gross value added (Section B: Mining and Section C: Manufacturing) (thousand tonnes per 100,000 roubles at constant 2016 prices).

The study pursues the following objectives:

- to calculate the values of the selected indicators for the regions of Russia;
- to determine the growth rates of these indicators across the regions of Russia;
- to identify the target values of the selected indicators for each region;
- to estimate the forecast values of the selected indicators for the regions of Russia;
- to compare the target and forecast values of the selected indicators;
- to develop conclusions and practical recommendations based on the results obtained.

The research methodology proceeds in several stages.

At the first stage, statistical data for 2016 and 2022 were collected. The year 2016 was selected as the baseline year because the relevant Resolution was adopted only in 2015,<sup>1</sup> making the analysis of an earlier period impractical. The year 2022 was chosen as the reporting year, as more recent comparable data were not available in official domestic statistics at the time of writing. At the second stage, the values of the first and third indicators for 2016 and 2022 were calculated. At the third stage, growth rates for the reporting year relative to the baseline year were calculated for all 85 constituent entities of the Russian Federation across the three indicators. At the fourth stage, the target values for 2030 were determined for all regions by dividing the 2016 values of the first and third indicators by two. This approach follows the requirement to achieve Targets 7.3 and 9.4, namely,

<sup>1</sup> Resolution adopted by the General Assembly on 25 September 2015, 2025, *United Nations Conference on Trade and Development*, URL: [https://unctad.org/system/files/official-document/ares70d1\\_ru.pdf](https://unctad.org/system/files/official-document/ares70d1_ru.pdf) (accessed 15.10.2024).

“by 2030, double the global rate of improvement in energy efficiency,” which in practical terms implies halving both energy intensity and atmospheric emissions. The second indicator constitutes an exception: here, the target value was defined as a 10% reduction in energy consumption by 2030. This threshold reflects the average level of excessive energy consumption in Russia over a number of years, which, ideally, should be reduced to zero. At the fifth stage, the forecast values of the targets were estimated by multiplying the calculated regional (individual) growth rates by two. The coefficient of “2” was chosen deliberately, since 2022 represents the midpoint of the 2016–2029 interval, effectively dividing this period into two equal parts. This makes it possible to extrapolate the growth rates observed during 2016–2022 to the subsequent period up to 2029, assuming that the existing rates of change remain stable; hence, the use of the coefficient “2.” At the same time, it should be noted that this extrapolation method does not account for the influence of external and internal factors such as economic, political, and technological changes, structural transformations in the economy, or major institutional reforms. These factors are treated as constant in order to assess the achievability of the targets in a “pure” form under the assumption of continued growth at the same rate. At the final stage, the results were summarised, conclusions were drawn, and recommendations were formulated on the basis of the data obtained.

## **Results**

The highest energy intensity (electricity intensity) of industries (sections B + C + D + E) in both 2016 and 2022 was observed in the following constituent entities, which ranked among the ten most energy-intensive regions: the Murmansk, Kemerovo, Chelyabinsk, Irkutsk, and Vologda regions, as well as the Republics of Khakassia and Karelia. The Smolensk and Kursk regions and Zabaykalsky Krai, which were among the ten most energy-intensive regions in 2016, had dropped out of this anti-ranking by 2022 and were replaced by the Lipetsk region, Krasnoyarsk Krai, and the Jewish Autonomous region.

The least energy-intensive regions of Russia, which in both 2016 and 2022 showed the lowest industrial electricity consumption per unit of added value, included the Sakhalin and Kaliningrad regions, the Yamalo-Nenets and Nenets Autonomous Okrugs, the Republics of Sakha (Yakutia) and Dagestan, as well as St. Petersburg and Moscow. In 2022, the Altai Republic and the Astrakhan region entered the top ten least energy-intensive regions, while the Chukotka Autonomous Okrug and Kamchatka dropped out of the ranking.

The calculations show that 37 out of 85 regions of the Russian Federation have positive growth rates in energy intensity, whereas achieving the established target requires not only a downward trend but also a twofold reduction in energy intensity by 2030. This suggests that these regions are unlikely to meet the target

within the specified timeframe. Of the remaining 48 regions characterised by negative dynamics, a subset of seven is likely to attain the target value by 2030, according to forecast estimates (Table 1).

Table 1

**Energy intensity (electrical capacity) of industries in regions of the Russian Federation, million kWh per 10,000 roubles**

Subject of the Russian Federation	2016	2022	2022 compared to 2016	By 2030	
	Reported value	Reported value	Growth rate, %	Target value	Forecast
Trans-Baikal Territory	0,4741	0,2348	- 50,47	0,2370	0,1163
Moscow	0,0711	0,0447	- 37,23	0,0356	0,0280
Republic of Buryatia	0,3914	0,2602	- 33,51	0,1957	0,1730
Republic of Dagestan	0,0965	0,0642	- 33,49	0,0483	0,0427
Ivanovo region	0,2784	0,1900	- 31,78	0,1392	0,1296
Republic of North Ossetia	0,3008	0,2142	- 28,79	0,1504	0,1525
Altai Republic	0,1413	0,1023	- 27,56	0,0706	0,0741

Compiled and calculated on the basis of Rosstat data.<sup>1</sup>

An analysis of the energy intensity of industrial sectors across the constituent entities of the Russian Federation shows that the vast majority of regions (91.76 %) are unlikely to achieve the target values by 2030 due to insufficient progress in reducing energy intensity, even in those regions that demonstrate negative growth rates (41 regions).

According to the second indicator, the highest electricity consumption levels in both 2016 and 2022 were found in Moscow, Saint Petersburg, Moscow region, Samara region, Sverdlovsk region, Irkutsk region, Krasnodar Krai, and Krasnoyarsk Krai. The lowest levels were observed in the Jewish Autonomous Okrug, Chukotka Autonomous Okrug, Nenets Autonomous Okrug, the Republics of Tyva, Altai, Ingushetia, and Kalmykia, the Karachay-Cherkess Republic, and the Magadan region. This distribution is largely explained by population size: regions with larger populations tend to demonstrate higher energy consumption, and vice versa. At the same time, Russia recorded a 6.99 % increase in electricity consumption over the period analysed. Of the country's 85 regions, only 26 showed negative growth rates in energy consumption. Among these, 12 regions are unlikely to meet their 2030 targets, given that their rate of reduction remains extremely low (Table 2).

<sup>1</sup> *Russian Statistical Yearbook. 2023, 2023*, Rosstat, Statistical Collection, Moscow, 701 p. ; *Industrial production in Russia. 2023, 2023*, Rosstat, Statistical Collection, Moscow, 259 p. ; *Regions of Russia. Socio-economic indicators. 2023, 2023*, Statistical collection / Rosstat, Moscow, 2023. 1126 s.

Table 2

**Electricity consumption by the population (including grid energy losses)  
in regions of the Russian Federation, million kWh**

Subject of the Russian Federation	2016	2022	2022 compared to 2016	By 2030	
	Reported value	Reported value	Growth rate, %	Target value	Forecast
Vladimir region	2172,1	2121,4	- 2,33	1954,89	2071,88
Kostroma region	1072,9	1030,4	- 3,96	965,61	989,58
Smolensk region	1583	1545,8	- 2,35	1424,70	1509,47
Kaliningrad region	1990	1955,5	- 1,73	1791,00	1921,60
Saint-Petersburg	8443	8345,7	- 1,15	7598,70	8249,52
Sevastopol	853,5	826,4	- 3,18	768,15	800,16
Saratov region	3894,4	3773,1	- 3,11	3504,96	3655,58
Ulyanovsk region	1777,7	1763	- 0,83	1599,93	1748,42
Sverdlovsk region	9235,8	9092	- 1,56	8312,22	8950,44
Republic of Tyva	480,1	474,4	- 1,19	432,09	468,77
Krasnoyarsk Krai	7134,3	6799,9	- 4,69	6420,87	6481,17
The Trans-Baikal Territory	1792	1737,3	- 3,05	1612,80	1684,27

Compiled and calculated on the basis of Rosstat data.<sup>1</sup>

As can be seen from Table 2, a formal reduction in regional household energy consumption by only 1–4% over several years does not imply the automatic achievement of the established targets. Moreover, such a marginal decline to some extent obscures the real problem of improving energy efficiency at both the national and regional levels. Although statistical reporting may formally indicate negative dynamics, desirable in principle, the actual rate of reduction is clearly insufficient. As a result, only 14 regions are likely to meet the 2030 target based on this indicator: Vologda, Kemerovo, Kaluga, Nizhny Novgorod, Magadan and Astrakhan regions; Perm and Altai krais; Nenets and Khanty-Mansi autonomous okrugs; the republics of North Ossetia–Alania, Komi and Khakassia; and Moscow.

With regard to the third indicator, a similar pattern is observed as for the previous two, with largely the same regions exhibiting relative stability in both 2016 and 2022. The highest levels of atmospheric pollution were recorded in the Jewish Autonomous region, Vologda, Amur and Kemerovo regions, and Krasnoyarsk and Primorsky Krai. By 2022, the Chechen Republic, Zabaykalsky Krai, and the Republics of Altai and Buryatia were no longer among the ten most environmentally burdened regions, while Kamchatka Krai, Irkutsk region, and the Republics of Karelia and Kalmykia had joined them.

<sup>1</sup> *Russian Statistical Yearbook. 2023, 2023*, Statistical Collection, Rosstat, Moscow, 701 p. ; *Industrial production in Russia. 2023, 2023*, Statistical Collection, Rosstat, Moscow, 259 p. ; *Regions of Russia. Socio-economic indicators. 2023, 2023*, Rosstat, Moscow, 1126

Among the leading “clean” regions in 2016 were Kaliningrad, Sakhalin, Ulyanovsk, Moscow, and Kaluga regions; Moscow; Saint Petersburg; and the Kabardino-Balkarian Republic. By 2022, however, some of these regions had lost their positions, while the Vladimir region, the Republic of Ingushetia, the Nizhny Novgorod region, and the Republic of Dagestan entered the top ten.

Fifty of Russia’s 85 regions recorded negative growth rates. However, calculations show that not all of them will be able to reach the 2030 targets. Only 20 regions — if their rates of decline continue — are likely to meet the targets (Table 3).

Table 3

**Emissions of pollutants into the atmosphere from stationary sources,  
per unit of added value, thousand tons per 100,000 roubles**

Subject of the Russian Federation	2016	2022	2022 compared to 2016	By 2030	
	Reported value	Reported Value	Growth rate, %	Target value	Forecast
The Chechen Republic	0,3080	0,0711	- 76,93	0,1540	0,0164
Republic of Dagestan	0,0462	0,0142	- 69,23	0,0231	0,0044
Murmansk region	0,2171	0,0903	- 58,43	0,1086	0,0375
The Jewish Autonomous region	0,5403	0,2251	- 58,34	0,2702	0,0938
Moscow region	0,0339	0,0157	- 53,88	0,0170	0,0072
Republic of Tyva	0,1819	0,0845	- 53,53	0,0909	0,0393
Astrakhan region	0,1144	0,0539	- 52,86	0,0572	0,0254
Tula region	0,0667	0,0375	- 43,77	0,0334	0,0211
The Trans-Baikal Territory	0,2620	0,1524	- 41,82	0,1310	0,0887
Ivanovo region	0,0897	0,0523	- 41,68	0,0448	0,0305
Penza region	0,0622	0,0370	- 40,45	0,0311	0,0221
Arkhangelsk region without the autonomous region	0,1434	0,0855	- 40,36	0,0717	0,0510
Tomsk region	0,1717	0,1076	- 37,34	0,0858	0,0674
Rostov region	0,0635	0,0399	- 37,23	0,0318	0,0250
Chelyabinsk region	0,1259	0,0803	- 36,24	0,0629	0,0512
Komi Republic	0,2223	0,1421	- 36,07	0,1111	0,0908
Republic of Buryatia	0,2664	0,1706	- 35,96	0,1332	0,1092
Kirov region	0,1152	0,0745	- 35,35	0,0576	0,0481
Smolensk region	0,0934	0,0652	- 30,18	0,0467	0,0455
Karachay-Cherkess Republic	0,1500	0,1049	- 30,06	0,0750	0,0734

Compiled and calculated on the basis of Rosstat data.<sup>1</sup>

<sup>1</sup> *Russian Statistical Yearbook. 2023, 2023*, Rosstat, Statistical Collection, Moscow, 701 p. ; *Industrial production in Russia. 2023, 2023*, Statistical collection, Rosstat, Moscow, 259 p. ; *Regions of Russia. Socio-economic indicators. 2023, 2023*, Statistical collection of Rosstat, Moscow, 2023, 1126 p.

The conclusion that can be drawn from Table 3 does not differ substantially from the previous findings: to achieve the targets within the required timeframe (by 2030), the rate of reduction in pollutant emissions into the atmosphere for the 30 constituent entities of the Russian Federation demonstrating negative dynamics must be significantly higher and should amount to at least 7 % annually. As for the remaining 35 regions with positive growth rates — where the dynamics should unequivocally be negative — greater attention from the authorities and the adoption of appropriate policy measures are required.

The aggregated quantitative results for all three indicators considered, taking into account the analysed dynamics and the likelihood of achieving the targets in the field of economic decarbonisation and sustainable regional development by 2030, are presented in Table 4.

Table 4

**Assessment of the energy efficiency of Russian regions  
(by number by regions)**

Target / growth rate	Positive	Negative and insufficient	Negative but sufficient
Energy intensity (electrical intensity) of the region's industries	37	41	7
Population electricity consumption (including grid losses)	59	12	14
Emissions of pollutants into the atmospheric air	35	30	20

Compiled and calculated on the basis of Rosstat data.<sup>1</sup>

As can be seen from Table 4, only 7 regions are capable of meeting the requirement of halving energy consumption (electricity consumption) in industry. At the same time, 6 of these 7 regions also participate in achieving other targets. For example, Zabaykalsky Krai, the Republic of Dagestan, Ivanovo region, and the Republic of Buryatia are capable of halving their emissions of pollutants into the atmosphere, while the Republic of North Ossetia—Alania and Moscow are able to reduce household energy consumption (electricity consumption) to the required level.

<sup>1</sup> *Russian Statistical Yearbook. 2023, 2023*, Statistical Collection, Rosstat, Moscow, 701 p. ; *Industrial production in Russia. 2023, 2023*, Statistical Collection, Rosstat, Moscow, 259 p. ; *Regions of Russia. Socio-economic indicators. 2023, 2023*, Statistical collection, Rosstat, Moscow, 1126 p.

## Discussion

The results of the study show that the majority of Russian regions have not yet demonstrated the capacity to achieve the established targets for a variety of reasons, which are as diverse as the regions themselves. Some of these factors can be illustrated by the example of the constituent entities of the Russian Federation included in the North-Western Federal District.

Reducing energy intensity (electricity intensity) in industrial sectors is theoretically possible in at least two ways: first, through the introduction of less energy-intensive but equally productive equipment into the production process; and second, through an increase in output while maintaining low levels of energy consumption. In practical terms, improving regional energy efficiency is therefore a dual task, and the role of the state in this process is crucial.

It is evident that the creation of favourable conditions for investment in fixed assets by regional authorities can and should contribute to the modernisation or replacement of production facilities, the introduction of energy-saving technologies, and the reduction of negative environmental impacts. At the same time, regional authorities possess a sufficiently broad range of instruments to achieve more substantial results, from administrative and restrictive measures to fiscal and incentive-based mechanisms. These include setting limits on energy consumption by economic entities, granting tax benefits and preferences to enterprises that modernise or upgrade their fixed assets, and providing investment subsidies to organisations that develop and implement the best available technologies aimed at minimising environmental damage.

However, given the specific features and development patterns of individual regions, such measures should not be applied universally. Instead, they should be differentiated and targeted. For example, according to the sectoral structure of gross value added in 2022, the dominant sector in the Komi Republic (47.7%), Arkhangelsk region (37.2%), and Nenets Autonomous Okrug (84.7%) was mining (Section B), whereas in the Leningrad (30.0%), Murmansk (33.1%), Novgorod (40.3%), and Vologda (51.6%) regions, the leading sector was manufacturing (Section C). Consequently, government regulatory measures aimed at improving energy efficiency should be concentrated in the most energy-intensive industries and regions, with policy interventions designed in a more precise and targeted manner.

Improving regional energy efficiency by reducing the values of the second indicator, energy consumption (electricity consumption) by the population, taking into account energy losses in the grid, also requires differentiated measures on the part of regional authorities. Explaining increases or decreases in regional energy consumption solely by population size is not always sufficiently justified.

For example, according to the electricity balance for 2022, in the Kaliningrad region (30.51%) and Pskov region (32.62%), the share of electricity consumption

attributed to the category of “urban and rural population” is approximately the same, while the population of the Kaliningrad region (1,027.7 thousand people) is almost twice as large as that of Pskov region (613.4 thousand people). At the same time, the growth rates differ significantly: in the Kaliningrad region, the rate is negative (-1.73%), whereas in Pskov it is positive (+17%). This clearly indicates that regional energy-saving policy measures should also differ, ranging from supporting the emerging trend towards lower energy consumption in the Kaliningrad region to tariff restrictions and measures aimed at limiting excessive energy consumption in the Pskov region.

A similar comparison can be made with Saint Petersburg, which demonstrates a growth rate close to that of the Kaliningrad region (-1.15%). However, the policy approach to improving energy efficiency in this case should be different. For example, the share of urban and rural population accounts for only 18.5% of total electricity consumption in the region, while energy losses in the grid are 12.30%. This proportion differs substantially from that observed in the two regions discussed above, both in terms of the internal ratio between these indicators and in relation to territorial size. The area of the Kaliningrad region is 10.5 times larger than that of Saint Petersburg, and the area of the Pskov region is 38.5 times larger, while grid losses in these regions are only about 1.8 times lower (10.55% and 10.33%, respectively).

Consequently, reducing energy consumption in Saint Petersburg depends to a large extent on state regulatory measures implemented by regional authorities, which should be aimed primarily at reducing electricity losses in the power grid.

An unusual pattern emerges when analysing the third indicator, emissions of pollutants into the atmosphere from stationary sources per unit of added value. The Komi Republic (-0.36%) and Arkhangelsk region (-0.40%), despite demonstrating only marginal negative growth rates of less than 1%, nevertheless appear capable of achieving the target values by 2030. At the same time, the Leningrad region (-6.89%), Vologda region (-13.83%), and Saint Petersburg (-27.27%), which show significantly higher negative growth rates, are unlikely to ensure the timely achievement of the target for this indicator.

The relatively favourable results of the Komi Republic and Arkhangelsk region may be associated with a decline in manufacturing output, as indicated by official statistics: in 2022, the GRP and GVA volume index decreased to 96.4% and 92.4%, respectively. This circumstance does not imply that achieving environmental targets necessarily requires a reduction in economic performance. However, it clearly indicates that, as in the previous cases, regional socio-environmental and economic policy must be coordinated across all components of sustainable development. State regulatory measures should therefore be designed to achieve higher environmental results without compromising the attainment of broader economic and social objectives.

## Conclusion

The conducted study on assessing the energy efficiency of Russia's regions in the context of economic decarbonisation and territorial sustainable development makes it possible to draw the following important conclusions.

First, most regions of the country continue to adhere to an outdated model of the “brown” economy and retain the legacy of the Soviet economic system, under which economic growth was achieved through higher energy consumption at the expense of significant environmental damage. Contemporary policy documents and regulatory frameworks require a different approach grounded in the principles of energy saving and energy efficiency. Therefore, the further sustainable development of regional economies should be accompanied by the adoption of more modern, productive equipment and energy-saving technologies that minimise negative environmental impacts.

Second, to achieve the established targets by 2030, it is necessary to accelerate the rate of reduction in the energy intensity of industrial sectors and household energy consumption, taking into account losses in the grid and emissions of pollutants into the atmosphere. Regional authorities possess a sufficient set of regulatory instruments and policy tools to address these issues. However, their application should be selective and locally adapted, aimed precisely at specific energy-related problems and ultimately leading to more substantial positive results within the required timeframe.

Third, the specific features and development patterns of individual regions determine the need for differentiated, and in some cases unique, mechanisms for building management systems aimed at improving regional energy efficiency. This requires the coordination and harmonisation of various regional policies, including economic, environmental, and social measures.

Fourth, strengthening the responsibility of regional authorities, together with stricter oversight and higher expectations from federal authorities, may contribute to more effective and progressive results in the transition towards the sustainable development of regional economies.

## References

1. Antal, M. 2014, Green goals and full employment: Are they compatible? *Ecological Economics*, № 107, p. 276—286, <https://doi.org/10.1016/j.ecolecon.2014.08.014>
2. Fücks, R. 2014, Intelligent wachsen. Die grüne Revolution, *WSI-Mitteilungen*, vol. 67, № 7, p. 560—561, <https://doi.org/10.5771/0342-300x-2014-7-560>
3. Shmatko, A.D., Ivchenko, B.P. 2022, Decarbonization of the economy: problem analysis with allowance for regional specifics and the need to develop the educational system, *Economics and Management*, vol. 28, № 3, p. 219—225, <http://doi.org/10.35854/1998-1627-2022-3-219-225>
4. Lebedeva, M.A. 2022. Decarbonization problems of the Russian economy, *Problems of Territory's Development*, vol. 26, № 2, p. 57—72, <http://doi.org/10.15838/ptd.2022.1.118.5>

5. Safonov, G., Kozeltsev, M., Stetsenko, A., Dorina, A., Saphonova, Y., Semakina, A., Safonov, M. 2022, Perspectives of Decarbonization of World Economy in the Context of Implementation of the UN Paris Climate Agreement, *International Organisations Research Journal*, vol. 17, №4, p. 38—61, <http://doi.org/10.17323/1996-7845-2022-04-02>
6. Porfiriyev, B.N. 2021, About the green vector of the strategy of social and economic development of Russia, *Scientific Works of the Free Economic Society of Russia*, vol. 227, № 1, p. 128—136, <http://doi.org/10.38197/2072-2060-2021-227-1-128-136>
7. Ershov, D.N., Sigova, M.V., Nikitina, I.A. 2023, Reflection of the concept of energy transfer in the development strategies of industries and regions of Russia, *Vestnik Sankt Peterburgskogo Universiteta Ekonomika*, vol. 39, №1, p. 73—101, <http://doi.org/10.21638/spbu05.2023.104>
8. Gilmundinov, V.M., Pankova, Yu. V., Tagaeva, T. O. 2023, The concept of regional differentiation of the processes of decarbonization of the Russian economy, *Studies on Russian Economic Development*, vol. 34, №6, p. 786—793, <http://doi.org/10.1134/s1075700723060059>
9. Glazyrina, I.P., Zabelina, I. A. 2018, Spatial Heterogeneity of Russia in the Light of the Concept of a Green Economy: The Social Context, *Geography and Natural Resources*, vol. 39, №2, p. 103—110, <http://doi.org/10.1134/S1875372818020026>
10. Gainanov, D.A., Gataullin, R.F., Safiullin, R.G. 2023, Typology of Russian Regional Systems in Connection with the Decarbonisation of the Economy, *Economy of Regions*, vol. 19, №1, p. 29—44, <http://doi.org/10.17059/ekon.reg.2023-1-3>
11. Rokhorov, V.V., Pogorelov, I.Z. 2022, Measures Of state support for the development of regional clusters in the conditions of decarbonization of the economy, *Management Accounting*, №2-2, p. 347—353, <http://doi.org/10.25806/uu2-22022347-353>
12. Ladykova, T.I. 2023, Cluster analysis of indicators characterizing decarbonization processes in the regions of the russian federation, *Oeconomia et Jus*, №4, p. 22—32, <http://doi.org/10.47026/2499-9636-2023-4-22-32>
13. Peshkova, G. Yu., Bondar, E.G. 2024, State policy of the Russian Federation in the field decarbonization of the energy sector, *The economy of the North—West: problems and prospects of development*, №2 (77), p. 57—68, <http://doi.org/10.52897/2411-4588-2024-2-57-68>
14. Dikovenko, A.G. 2024, Current areas in decarbonization of the oil and gas industry, *Naukosfera*, №3-1, p. 171—174, <http://doi.org/10.5281/zenodo.10829617>
15. Kovalev, I.V., Afteni, I.V., Kovaleva, O.Ya. 2024, Decarbonization project management in the russian fuel and energy sector: current challenges and prospects, *Naucnoe obozrenie: teoria i praktika [Scientific Review: Theory and Practice]*, vol. 14, №3 (103), p. 499—510, <http://doi.org/10.26088/2226-0226-2024-14-3-499-510>
16. Shershneva, V.A., Baranova, V.N., Niskovskaya, M. Yu. 2022, The main aspects of the Russian oil refining industry decarbonization, *Bulatovskie chteniya*, vol. 2, p. 146—148 (in Russ.).
17. Matsko, N.A., Kharitonova, M. Yu. 2023, The effect of the decarbonization process on the profitability of the non-ferrous metallurgy (on the example of the copper industry), *Property Relations in the Russian Federation*, №8, p. 19—27 (in Russ.).
18. Popova, E.A. 2024, Substantiation of methods for choosing investment decisions of oil and gas companies in the context of decarbonization, *Economic systems*, vol. 17, №1, p. 132—140 (in Russ.).

19. Plyaskina, N.I. 2023, Energy transformation of oil and gas companies in the context of decarbonization: assessment of the effectiveness of investment projects, in: *Proceedings of the Third Granberg Conference*, Collection of reports from the All-Russian conference with international participation dedicated to the memory of Academician A. G. Granberg, Novosibirsk, p. 276—279 (in Russ.).
20. Salita, S.V., Golubtsova, O.A. 2022, Analysis of trends in socio-economic development of the region in the format of sustainable development, *Vestnik of Lugansk Vladimir Dahl National University*, №9, p. 133—138 (in Russ.).
21. Sheveleva, N.A. 2023, Development of approaches to the economic evaluation of decarbonization projects in the oil and gas complex, *Problems of economics and management of oil and gas complex*, №8, p. 28—36 (in Russ.), [http://doi.org/10.33285/1999-6942-2023-8\(224\)-28-36](http://doi.org/10.33285/1999-6942-2023-8(224)-28-36)
22. Nekhoroshkov, V.P., Sokolova, D.A. 2022, The impact of decarbonization trends on the development of the coal industry, *Ehkonomika i biznes: teoriya i praktika*, №6-2, p. 100—104, <http://doi.org/10.24412/2411-0450-2022-6-2-100-104>
23. Ilyinsky, A.A., Kalinina, O.V., Khasanov, M.M., Afanasiev, M.V., Saitova, A.A. 2022, Decarbonization of the oil and gas complex: priorities and organizational models of development, *Sever I Rynok Formirovanie Ekonomiceskogo Poradka*, vol. 25, №1, p. 33—46, <http://doi.org/10.37614/2220-802X.1.2022.75.003>
24. Kalitseva, K.A., Charaeva, M.V. 2023, Development and systematization of indicators of sustainable development of south Russian regions based on the concept of sustainable development, *Finances, money, investments*, №3, p. 3—9, [http://doi.org/10.36992/2222-0917\\_2023\\_3\\_3](http://doi.org/10.36992/2222-0917_2023_3_3)
25. Preobrazhensky, B.G., Fedorov, Ya.A. 2023, Environmentally sustainable development as a paradigm of modern policy of ecological development of regions, *Region: systems, economy, management*, №4, p. 12—28, <http://doi.org/10.22394/1997-4469-2023-63-4-12-28>
26. Borodin, S.N. 2023, A Model for Assessing Regional Sustainable Development Based on the Index Method, *Economy of Regions*, vol. 19, №1, p. 45—59, <http://doi.org/10.17059/ekon.reg.2023-1-4>
27. Aleshnikova, V.I., Burtseva, T.A. 2023, Integral measurer of environmental development of regions, *Region: Systems, Economy, Management*, vol. 61, №2, p. 41—49, <https://doi.org/10.22394/1997-4469-2023-61-2-41-49>
28. Alferova, T.V. 2020, Sustainable development of the region: Approaches to selecting evaluation indicators, *Perm University Herald. Economy*, vol. 15, №4, p. 494—511, <https://doi.org/10.17072/1994-9960-2020-4-494-511>
29. Hickel, J. 2020, The sustainable development index: Measuring the ecological efficiency of human development in the Anthropocene, *Ecological Economics*, №167, art. №106331, <https://doi.org/10.1016/j.ecolecon.2019.05.011>
30. Bardakhanova, T.B., Eremko, Z.S., Munkueva, V.D. 2019, Methodical approach to the integrated assessment of the level of ecological and economic development of regions, *Business. Education. Law*, №3, p. 26—31, <https://doi.org/10.25683/VOLBI.2019.48.305>
31. Bobylev, S.N., Kudryavtseva, O.V., Solovyeva, S.V., Sitkina, K.S. 2018, Sustainable development indicators: regional dimension, *Lomonosov Economics Journal*, №2, p. 21—33 (in Russ.), <https://doi.org/10.38050/01300105201822>

## The author

---

Prof **Valeriy I. Belov**, Professor, the Department of Economics and Management, Pushkin Leningrad State University; Professor, the Department of Economics, Northwestern Institute of Management, Branch of RANEPA, Russia.

<https://orcid.org/0000-0003-2910-3014>

E-mail: [v.i.belov@bk.ru](mailto:v.i.belov@bk.ru)



Submitted for possible open access publication under the terms and conditions of the Creative Commons Attribution – Noncommercial – No Derivative Works <https://creativecommons.org/licenses/by-nc-nd/4.0/deed.en> (CC BY-NC-ND 4.0)