Formation of the territorial cost of electricity in the Russian Federation for the economic evaluation of HVAC systems

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Abstract. Comparison of various energy-saving technologies used in the systems of heat and gas supply, ventilation and thermal protection of the building is associated with the mandatory economic justification of the options under consideration (with and without energy-saving measures). According to the economic calculation, the cost of energy resources has the main influence on the profitability of the option. On the territory of the Russian Federation in various areas, for different categories of consumers, their own tariffs are set for the cost of energy resources. This article has collected, systematized and obtained data on the dynamics of changes in the cost of electricity for various tariffs for consumers equated to the population in various regions of the Russian Federation, which in the future simplifies the economic assessment of energy saving measures in DHW systems.

1 Introduction

All over the world, an important role is given to energy saving in buildings, which is aimed at reducing the consumption of the country's fuel and energy resources [1-5]. The problem of energy saving in buildings is solved, among other things, by the use of energy-saving solutions in the design of heating, ventilation, air conditioning systems [1, 3, 4] and the design of thermal protection of buildings [2]. To assess the profitability of the use of such measures, it is customary to do an energy assessment, on the basis of which the next step is an economic assessment. A key factor in this assessment is the correct determination of the cost of energy resources. On the territory of the Russian Federation, the cost of energy carriers in different regions can differ significantly from each other, primarily due to the remoteness from energy supplying enterprises [6-11].

2 Methods

To simplify the calculations of the economic assessment of energy saving measures in various regions of the country, data were collected on the cost of electricity in 85 territories, regions and republics on the territory of the Russian Federation. Electricity tariffs for

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consumers equated to the population were considered: a one-part tariff differentiated by two time zones and differentiated by three time zones for 2021 and 2022.

3 Results

Based on the results of the data obtained, the systematization and assessment of the cost of 1 kWh of electricity in the territory of the Russian Federation was carried out. The highest cost of electricity for 2021 refers to such regions of the Russian Federation as the Astrakhan Region, the Vologda Region, the Kaluga Region, the Krasnodar Territory, the Moscow Region, the Nenets Autonomous Okrug, the Novgorod Region, the Republic of Adygea, the Republic of Kalmykia, the Republic of Sakha (Yakutia), St. Petersburg, Stavropol Territory, Chukotka Autonomous Okrug and are presented in Table 1.

Table 1. Ranges of maximum electricity costs per 1 kWh in the Russian Federation in 2021

District, region, republic	Ranges of maximum electricity costs per 1 kWh, rub					
	One-part tariff	Differentiated by two time zones		Differentiated by three time zones		
		Day zone	Night zone	Peak	Semi-peak	Night zone
Astrakhan Region, Vologda Region, Kaluga Region, Krasnodar Territory, Moscow Region, Nenets Autonomous Okrug, Novgorod Region, Republic of Adygea, Republic of Kalmykia, Republic of Sakha (Yakutia), St. Petersburg, Stavropol Territory, Chukotka Autonomous Okrug	4,52 - 6,7	4,58 - 7,10	2,42 - 4,24	5,02 – 7,93	4,52 – 6,17	2,42 – 4,24

The highest cost of electricity for 2022 refers to the same regions of the Russian Federation as for 2021, but such regions as the Vladimir Region, the Altai Republic were added and are presented in Table 2.

Table 2. Ranges of maximum electricity costs per 1 kWh in the Russian Federation in 2022

District, region, republic	Ranges of maximum electricity costs per 1 kWh, rub					
	One-part tariff	Differentiated by two time zones		Differentiated by three time zones		
		Day zone	Night zone	Peak	Semi-peak	Night zone
Astrakhan Region, Vologda Region, Vladimir Region, Republic of Altai, Kaluga Region, Krasnodar Territory, Moscow Region, Nenets Autonomous Okrug, Novgorod Region, Republic of Adygea, Republic of Kalmykia, Republic of Sakha (Yakutia), St. Petersburg, Stavropol Territory, Chukotka Autonomous Okrug	4,62 - 8,9	4,81 - 10,24	2,55 - 5,54	5,27 – 11,43	4,75 – 8,9	2,55 – 5,54

It is interesting to note that in percentage terms, the increase in prices in the areas presented in tables 2 relative to 2021 ranged from 4 to 48%. The largest increase in prices refers to the Chukotka Autonomous Okrug.

For clarity, in Figure 1, on the map of the Russian Federation, the subjects with the maximum cost for electricity in 2021 were highlighted in red, and the subjects that were added in 2022 were highlighted in dark red (burgundy).

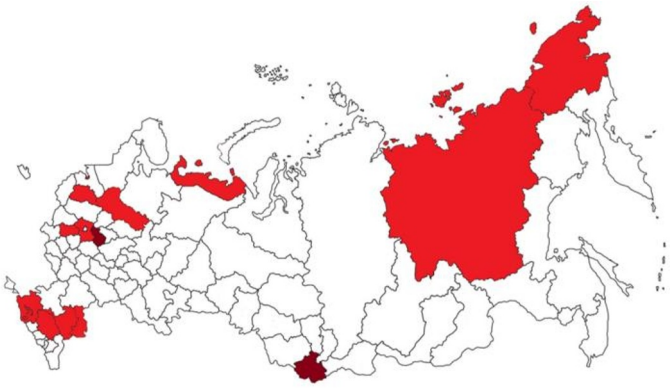

Fig. 1. Map of constituent entities of the Russian Federation with the highest cost of electricity

4 Discussion

The lowest cost of electricity for 2021 refers to such regions of the Russian Federation as the Irkutsk Region, Krasnoyarsk Territory, the Republic of Dagestan, the Chechen Republic and are presented in Table 3.

Table 3. Ranges of the minimum cost of electricity per 1 kWh in the Russian Federation in 2021

District, region, republic	Ranges of maximum electricity costs per 1 kWh, rub					
	One-part tariff	Differentiated by two time zones		Differentiated by three time zones		
		Day zone	Night zone	Peak	Semi-peak	Night zone
Irkutsk Region, Krasnoyarsk Territory, Republic of Dagestan, Chechen Republic	1,17 - 2,06	1,35 - 2,36	0,78 - 1,58	1,52 – 2,47	1,17 – 2,06	0,78 – 1,58

The lowest cost of electricity for 2022 refers to the same regions of the Russian Federation as for 2021 and is presented in Table 4.

Table 4. Ranges of minimum electricity costs per 1 kWh in the Russian Federation in 2022

District, region, republic	Ranges of maximum electricity costs per 1 kWh, rub					
	One-part tariff	Differentiated by two time zones		Differentiated by three time zones		
		Day zone	Night zone	Peak	Semi-peak	Night zone
Irkutsk Region, Krasnoyarsk Territory, Republic of Dagestan, Chechen Republic	1,23 – 3,09	1,41 – 3,55	0,82 – 1,85	1,60 – 3,71	1,23 – 3,09	0,82 – 1,85

In percentage terms, the increase in prices in the areas presented in tables 4 relative to 2021 ranged from 5 to 50%. The largest increase in prices refers to the Krasnodar Territory.

For clarity, in Figure 2, on the map of the Russian Federation, subjects with a minimum cost for electricity in 2021 and 2022 were highlighted in green.

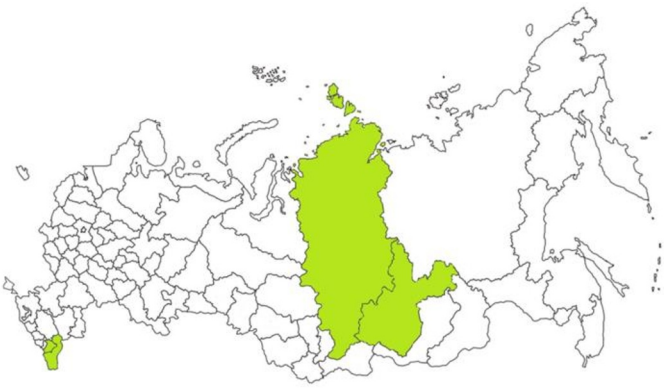

Fig. 2. Map of subjects of the Russian Federation with the minimum cost of electricity

The average price throughout the Russian Federation for electricity is approximately 3.37 rubles per 1 kWh in 2021 and 3.41 rubles per 1 kWh in 2022, which is equal to a 13% price increase in 2022 relative to 2021 year.

The cost of electricity in 2022 relative to 2021 increased by a maximum of 50% in such areas as the Voronezh Region, the Trans-Baikal Territory, the Kabardino-Balkarian Republic, the Karachay-Cherkess Republic, the Kirov Region, the Kostroma Region, the Krasnoyarsk Territory, Moscow, the Orenburg Region , Penza Region, Pskov Region, Republic of Bashkortostan, Ryazan Region, Samara Region, Sverdlovsk Region, Smolensk Region, Tomsk Region, Khabarovsk Territory, Chechen Republic, Chukotka Autonomous Okrug and Yaroslavl Region.

For clarity, in Figure 3 on the map of the Russian Federation, these subjects were highlighted in blue.

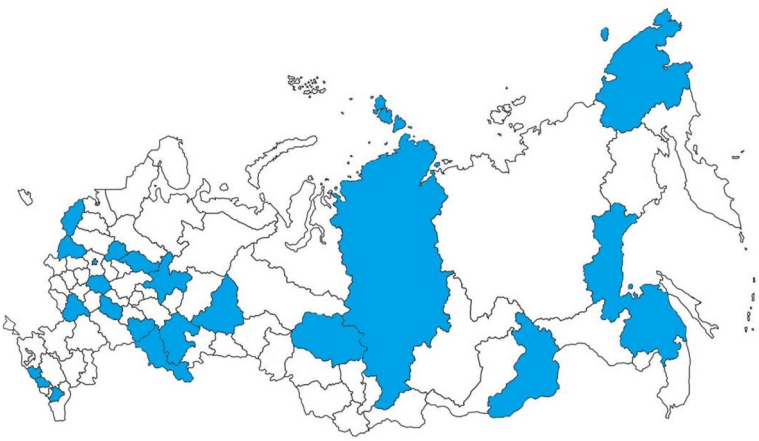

Fig. 3. Map of subjects of the Russian Federation with the maximum increase in the cost of electricity

5 Conclusion

The results of the obtained data on the cost of electricity in various regions of the Russian Federation make it possible to carry out an economic assessment of energy-saving solutions for DHW systems in the ranges of indicated costs with the possibility of predicting the cost for the future by the percentage of price increases.

References

1. E. G. Malyavina and A. A. Frolova, E3S Web of Conferences 2021. 263. No 04017. DOI:10.1051/e3sconf/202126304017
2. E. G. Malyavina and A. A. Frolova, MATEC Web of Conferences 2018. 196. No 04078 DOI: 10.1051/matecconf/201819604078
3. E. G. Malyavina and A. A. Frolova, Advances in Intelligent Systems and Computing 2018. 692. pp. 498–511 DOI: 10.1007/978-3-319-70987-1_53
4. E. G. Malyavina and A. A. Frolova, IOP Conference Series: Materials Science and Engineering 2019. 661(1). No 01207 DOI: 10.1088/1757-899X/661/1/012077
5. Jiang, L., Bie, Z., Long, T., Xie, H., Xiao, Y., CSEE Journal of Power and Energy Systems 2021. 7(3). pp. 541 – 554 DOI: 10.17775/CSEEJPES.2020.02000
6. Kochev, A., Sokolov, M., Lushin, K., E3S Web of Conferences 2021. 263(9). No 04048
7. DOI: 10.1051/e3sconf/202126304048
8. Khromchenkov, V.G., Shuts, W., Yavorovskiy, Y.V., Voitovich, E.V., Zaytsev, S.V. Izvestiya Vysshikh Uchebnykh Zavedenii, Seriya Teknologiya Tekstil'noi Promyshlennosti 2017. 368. pp. 281–286.
9. Tsyganov, V.V., E3S Web of Conferences 2023. 376. DOI: 10.1051/e3sconf/202337601077.
10. Hosseini Imani, Mahmood & Bompard, Ettore & Colella, Pietro & Huang, Tao, Energy Systems 2023. 1-35. DOI: 10.1007/s12667-023-00576-1.
11. Lerede, Daniele & Savoldi, Laura, Energy Strategy Reviews 2023. 47. No 101080. DOI: 10.1016/j.esr.2023.101080.
12. Xiong, Chu & Luo, Dan & Han, Liang, International Journal of Energy Research. 2023. 1-23. DOI: 10.1155/2023/2425608.