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Functioning efficiency of the electricity market of the western region of Ukraine

Abstract: Scientists are focusing on the introduction of various types of renewable energy sources and the liberalization of energy markets in the regions of the country. The problems of preventing the achievement of goals and various strategies to achieve maximum energy conservation and overcoming

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the current economic and environmental crisis in Ukraine also remain unresolved. We can observe the experience of the leading countries in the electricity sector, which proves that reforming the electricity sector in Ukraine is inevitable. This, in turn, is a critical factor in stimulating economic and social growth and improving the competitiveness of the regions of Ukraine. Given the above, the necessity for the study of the level of efficiency (competitiveness) and the functioning of the regional energy markets of Ukraine is obvious.

This study shows that the efficiency of electricity in the western region is relatively low due to the lack of competition, the presence of an ineffective system of subsidizing the population with cheap resources, the non-transparency of trade operations, excessive regulation of state generation, the lack of a "balanced" system of market functioning, etc.

Introduction

The modernization of the electricity sector and increasing the regulatory processes of the electricity markets in the regions are among the strategic directions of economic development in Ukraine. Electricity generation and distribution companies in the area, as part of the unified energy system of Ukraine, have an impact upon socio-economic development and increase the energy security and independence of Ukraine.

Today, the scientific community focuses on the liberalization of the region's electricity market and the active introduction of renewable energy sources (RES). It would be impossible to achieve strategic goals to overcome the environmental and economic crisis and achieve energy-saving principles without solving these problems.

The best practices in the leading countries convincingly prove that reform of the electricity sector is an essential factor in economic growth and increasing the region's competitiveness. Therefore, the electricity market efficiency in the western Ukraine (which is a set of regions given their heterogeneity and differentiation in terms of socio-economic activity) should be assessed to determine the organizational and economic mechanism for its further reform.

1. Literature review

Solving the problem of efficient use of electricity resources, areas of liberalization of electricity markets are devoted to the work of foreign and domestic scientists and specialists.

Institutional components of national energy security, namely the determination of risks in oil and gas companies and their impact on the general system of energy resources, have been

addressed by Khvostina et al. (2019), while the use of fuel and energy resources for determining the opportunities for the security of the country's energy independence have been forecasted (Andrusiv et al. 2021; Zelinska et al. 2021; Bielinskyi et al. 2021). The need to develop efficient institutional factors of the development of the energy services market in Ukraine and make managerial decisions on the efficiency of the use of energy network for the development and support of a number of areas of economic and industrial activity in the country has been emphasized (Martyniuk et al. 2019; Pryshchepa et al. 2020; Pavlov et al. 2020b; Rukosueva et al. 2021).

Another important direction that deserves attention at present is the compatibility of the standard electricity system with new competitive types of energy. In particular, we have analyzed a number of studies devoted to new trends in energy, namely bioenergy, the use of renewable energy sources, and bioenergy's impact on economic, industrial, and energy security of the country (Hryhoruk et al. 2021; Maksymiv et al. 2021; Panukhnyk et al. 2021; Zelinska et al. 2021a). To determine the competitiveness of electricity enterprises, it is necessary to substantiate the institutional environment as an efficient and strategic direction of their innovative development. These issues have also been examined (Akimova et al. 2020; Reznik et al. 2022; Skrypko et al. 2021; Romanyuk 2021).

Focusing on the institutional-economic and competitive foundations of the development of the national energy market as a mechanism for achieving the highest possible levels of country's energy efficiency, the activity of gas distribution and coal enterprises which provide resources for the efficient functioning of the electricity system in the country have been analyzed (Zelinska et al. 2021b; Danylyshyn et al. 2021; Pavlov et al. 2020a; Andrusiv et al. 2021).

The issues related to the mechanisms of organizational and economic regulation in electricity market, as well as the justification of its strategic results and determination of the environmental effects from the activity of electricity companies have been addressed (Horoshkova et al. 2020; Yakymchuk et al. 2022; Boiar et al. 2018).

Despite the significant number of theoretical and practical developments, further research requires the elaboration of approaches to the prospects of the regional electricity market and the need to form a holistic functioning of its regulation's organizational and economic mechanism. Given the lack of joint scientific work of scientists and specialists, there is a need to study these processes. The importance and effectiveness of the outlined problems became a prerequisite for choosing the study's topic, purpose, and objectives, which is enhanced by the timeliness and particular urgency of the research.

2. Materials and methods

In the course of the study, there was a need to calculate the efficiency of regional electricity markets and determine the efficiency of electricity companies that provide services within the western region for the generation, transportation, and distribution of electricity.

The efficiency of the electric power industry of the western region is calculated using several parameters, which we have grouped as follows and in the appropriate sequence (Akimova et al. 2020).

Relative indicators of determining and assessing the state of property security and the effectiveness of practical use of the property of specialized enterprises

Coefficient of the suitability of fixed assets (C_{sfa}). Fixedness ratio of fixed assets – the ratio is equal to the residual value (initial value of fixed assets less depreciation) to their full initial/ replacement value. The database for its definition is the balance (accounting). The normative value should be more than 0.5.

$$C_{sfa} = \frac{R_{vfa}}{I_{cfa}} = \frac{I_{cfa} - D}{I_{cfa}} = \frac{I_{cfa}}{I_{cfa}} - \frac{D}{I_{cfa}} = D_{rfa} \tag{1}$$

where:

C_{sfa} – coefficient of the suitability of fixed assets,
D_{rfa} – depreciation rate of fixed assets,
I_{cfa} – initial cost of fixed assets,
D – depreciation (amount of depreciation) for the entire period of operation of a particular object of fixed assets (depreciation deductions and their amount from the date of process of fixed assets);
R_{vfa} – the residual value of fixed assets, including the initial cost less the amount of total depreciation transferred to the total cost of the newly created product).

The depreciation rate of fixed assets (D_{rfa}). The level of the coefficient of the depreciation of fixed assets. It is equal to the amount of accrued depreciation relative to the value of the initial cost of fixed assets. The information base for its calculation is the balance (accounting). The normative value should be less than 0.5.

$$D_{rfa} = \frac{D}{I_{cfa}} \tag{2}$$

Coefficient of mobility (Cm). The asset mobility ratio is calculated as the ratio of current to balance. Mobility means the ability of assets to move from one form to another. There is no normative value.

The ratio of current and non-current assets (R_{cnca}). The asset mobility ratio is calculated as the ratio of existing and non-current assets. There is no normative value.

Return on investment (R_i). Return on assets – the indicator's value that shows the level of economic activity of enterprises, which reflects the efficiency of practical use of fixed assets of the profile enterprise. As a result, the indicator rate indicates in advance what share of the finished product has already been produced and how many services have already been provided at the rate of each hryvnia of financial resources that have been invested in fixed assets. The

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value of this indicator is calculated as the ratio of relative sales (revenue) and the average annual value of fixed assets. It is important to note that only the residual value (amount) of fixed assets is considered.

The higher the value of return on capital, the more efficiently used in the enterprise its fixed assets. In accordance with this, the increase in the dynamics is viewed positively. There is no normative value.

Capital intensity (C_i). Capital intensity is the value of the inverse indicator, which reflects the return on capital and which specifies the importance of production costs (funds) per unit of the finished product. There is no normative value.

Capital armament (C_a). Capital adequacy is calculated as the value of fixed assets relative to the average number of employees involved in the enterprise's main activities (workers) and demonstrates what part of the value of fixed assets (production) per unit of the worker. There is also no normative value.

Relative indicators of enterprise liquidity analysis

Current ratio (C_r). The current liquidity ratio characterizes the degree of coverage of short-term liabilities by current assets and is used to assess whether the company can meet its short-t-term obligations. Normative values are in the range of 1–3, but 2–3 are more desirable. The optimal value is 1.25 (Pryshchepa et al. 2020).

Quick liquidity ratio (Q_{lr}). The quick liquidity ratio is a kind of indicator that reflects the company's level of liquidity in the short term, which measures the level of ability of the company to pay on time for existing short-term liabilities using highly liquid assets. They comprise the amount of cash and its possible equivalent (including current financial investments, receivables, etc.). The normative value of this indicator is considered to be – 0.5–1 and above. The optimal value is 1.

Absolute liquidity ratio (A_{lr}). This ratio reflects the liquid part of assets and current liabilities, including the short-term. It is customary to include funds in the liquid part of assets. The value of this indicator illustrates the percentage of current liabilities of the enterprise, which can also be repaid. The optimal value is 0.275.

Relative indicators of enterprise profitability

This group includes the following indicators:

Return on assets. This indicator is calculated as a particular share due to dividing net profit (operating profit before tax) by the average annual value of assets (inventories). It shows how much profit per 1 UAH. Assets. Regulatory value – 0.1 and more (Pryshchepa et al. 2020).

Return on equity. The value of the return on equity is the ratio of direct net income and ave-rage annual value of equity – regulatory – 0.15 and more.

Profitability of sales. Profitability of sales is calculated by dividing the amount of profit from sales of finished products (including services), services, or net profit by the amount of revenue received. This indicator characterizes the amount of profit from the hryvnia sales. It is calculated as a whole for the organization and individual types of its products-regulatory value – more than 0.06.

Profitability of products (works, services). This is the value of net profit of the enterprise relative to the net income obtained as a result of sales and thoroughly characterizes the sales efficiency of the enterprise-regulatory value – more than 0.2.

Payback period of capital. This indicator shows the number of years during which investments in the company (own and borrowed) will be fully repaid. It has no normative significance.

Payback period of equity. This figure shows the number of years during which shareholders' investments in the company will pay off. There is no normative value for this either.

Relative indicators of business activity

This group of indicators includes:

Asset turnover ratio. It measures how efficiently the enterprise uses its current assets. It is the ratio of revenue and the average current assets for the period. The indicator's value indicates the number of turnovers made by current assets. The increase in this indicator primarily indicates the need for fewer resources to maintain the current activity level. The normative value is 0.3 (Romanyuk 2021).

Equity turnover ratio. This ratio is defined as the value of the revenue (net income) ratio to the average value of equity. The high level of this indicator reflects the level of efficiency of the owners' capital use. The value of this ratio illustrates how many goods and services were sold for each hryvnia of borrowed own resources: normative value – 1.

A turnover ratio of current assets. This is an indicator of business activity, which measures the efficiency of use of the current assets of the enterprise. It specifies the revenue in relation to the average amount of current assets for the period. Normative value – 1.

Receivables turnover ratio. Business activity indicator, which characterizes the customer debt management. The ratio illustrates the number of debt turnovers (receivables). The value of this indicator is calculated as a comparison of net income relative to the number of average receivables. Regulatory value – 1.3.

Accounts payable turnover ratio. This indicator of business activity characterizes the number of turnovers made by accounts payable during the year. This ratio is the cost to the average annual amount of accounts payable. Normative value is 1.5.

Relative indicators of financial stability

When analyzing the electricity market, a group of financial stability indicators should be taken into account (Akimova et al. 2020).

Coefficient of financial independence (autonomy). This is equal to the ratio of the company's equity to all financial resources. The indicator's value indicates what part of its assets the company can finance from its financial resources. The normative value ranges between 0.4–0.6. A lower rate indicates a possible high financial risk. Financial autonomy above 0.6 shows that the company fails to use its capacity.

Coefficient of financial dependence. This is determined as the ratio of liabilities to equity. The indicator's value specifies the financial resources used by the company for each hryvnia of equity. The normative value is between 1.67–2.5.

Financial risk ratio (financial leverage). This indicator characterizes the ratio of long-term loans and equity of the enterprise. The coefficient is positively assessed with increasing value in the dynamics. It should be 0.67–1.5. A fall below 0.67 confirms the high possibility of financial risks. A value above the level of 1.5 indicates the presence of additional reserves to increase efficiency by borrowing.

Coverage ratio (solvency). This is determined by the ratio of all current assets (net of prepaid expenses) to liabilities (short-term) and reflects the adequacy of the organization's working capital to repay its debts incurred during the year. The regulatory value is 1–3.

The self-financing ratio is the ratio of own investments (retained earnings, depreciation, etc.) to the total required investments. The normative value is 0.1.

Coefficient of financial stability. This verifies if the company can remain at the appropriate level of solvency (in the long run). The value is calculated as the ratio of equity and long-term liabilities to the number of liabilities. The normative value is 0.7 to 0.9. In turn, a higher level is not typical for active enterprises, as short-term liabilities are formed permanently. The value below indicates a lack of financial stability in the long run.

Meanwhile, to calculate the coefficient of efficiency of the enterprises of the electric power sector of the western region, we use indicators related to the electricity market in general. Their list is given in the annual reports of the National Commission for State Regulation of Energy and Public Utilities (NCSREPU), which is grouped into the following groups (Akimova et al. 2020):

1. Price indicators of oblenergo activity.
2. Technical performance indicators of oblenergos.
3. Actual values of quality of service provision indicators by call centers of SRF oblenergo.
4. Electricity market indicators.
5. Price indicators of oblenergozbut activity.
6. Actual values of quality of service provision indicators by SRC call centers oblenergozbut.
7. Settlements for electricity from RTAs and energy supply companies.

Method of rationing. As is already known,, for a comprehensive comparison of a set of factors that characterize certain economic entities or markets (regional), it is necessary to follow the so-called approach of rationing (unification). At the same time, one aggregate indicator becomes essential, namely, the integrated index, the purpose of which is to integrate the set of primary indicators into one whole. Thus, in order to assess the state of a particular system (in our case, it is the regional electricity markets of the Western region), it is necessary to bring the indicators of its functioning to the interval:

$$0 \leq \bar{} \leq 1 \tag{3}$$

Moreover, if $x_j = 1$, this is the best (optimal) rate, and if $x_j = 0$, this is the worst rate (unacceptable).

After analyzing the economic literature, in our opinion, it is appropriate to identify five main approaches to the procedure of "rationing." Next, we propose to briefly consider their essence and content.

The first approach is called the standard approach. It is traditionally used in mathematical statistics. When using it, find the maximum value (X_{max}) and the minimum (X_{min}). Thus, the rationing is carried out as follows, according to the formula:

$$\overline{x}_i = \frac{x_i - x_{min}}{x_{max} - x_{min}}, i = \overline{1, n}$$ (4)

where:

    n – the amount of data (sample length), or the number of time series points. In this case, $x_i = 0$, if $x_i = x_{min}$ and $x_i = 1$, if $x_i = x_{max}$.

However, at this stage, it is necessary to make a slight clarification: this rule works if the increase in the indicator increases the integrated value index. However, in practice, factors may affect the final result differently. For example, if the growth of the indicator provides the growth of the integrated assessment index, then such indicators are stimulants. If, however, an increase in the indicator leads to a decrease in the integrated assessment index, then such indicators are disincentives. Therefore, the following formula should be used for rationing:

$$\overline{x}_i = \frac{x_{max} - x_i}{x_{max} - x_{min}}, i = \overline{1, n}$$ (5)

In this case, $x_i = 1$, if $x_i = x_{min}$ and $x_i = 0$, if $x_i = x_{max}$.

However, this standard approach to rationing has a significant drawback because when the data sample is updated over time, the values of x_{min} and x_{max} will change. Moreover, there will consequently be a need for a complete recalculation of the results. This factor indicates the lack of appropriate (reasonable) requirements for this indicator's desired or undesirable values.

The second approach. When rationing using this method, use the threshold values of xcomp indicators, which characterize the level of allowable changes in the indicator without a significant impact on the process that characterizes it. Moreover, the rationing here can be multidirectional. The following formula is used for the stimulant indicator:

$$\overline{x}_i = \frac{x_i}{x_{comp}}$$ (6)

And for the indicator – the destimulator:

$$\overline{x}_i = \frac{x_{comp}}{x_i}$$ (7)

If we compare this approach to "normalization" with the previous two, there are no values for x_{min} and x_{max}; in other words, there is no need to recalculate the results over time. Specific threshold values of the indicator set by experts are taken into account. In our opinion, the fact

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that the normalized values can be greater than 1 and/or harmful constitutes a considerable flaw of this approach. As a result, the calculation of integral indices becomes more difficult.

The third approach. The so-called unified approach. Here it is necessary to allocate 2 conditions of its use:

◆ the indicator varies in the range from x_{min} to x_{max},
◆ the lower and upper limits of the norm are p_i^n and p_i^v.

The integrated indicator under the following conditions is calculated as follows:

a) if the value of x_1 falls in the interval:

$$p_i^n \leq x_i \leq p_i^v \tag{8}$$

then the normalized value $\overline{x}_i = 1$;

b) if x_1 falls within the interval:

$$p_i^v < x_i \leq x_{max}, \quad \text{then} \quad \overline{x}_i = \frac{x_{max} - x_i}{x_{max} - p_i^v}, \quad i = \overline{1, n} \tag{9}$$

c) if x_1 falls within the interval:

$$x_{min} \leq x_i \leq p_i^n, \quad \text{then} \quad \overline{x}_i = \frac{x_i - x_{min}}{p_i^n - x_{min}}, \quad i = \overline{1, n} \tag{10}$$

Therefore, when using the 3 methods of rationing, we see that the indicator always falls in the range – [0; 1]. The advantage of this approach is introducing the concept of so-called "limits of the norm." In other words, in this way, we consider the given (reasonable) appropriate requirements for the desired or undesirable values of the indicator. However, the enumeration of indicators over time remains a problem, as x_{min} and x_{max} will change.

The offered methodological approach is unique, as the indices grouped for analysis help to determine the real state of the energy system in a region and to identify the factors that are the most competitive and efficient for the further development of electricity enterprises.

3. Results and discussion

The first method

We apply a standard approach to define the competitiveness of the western region. Based on calculations, the rationing of indicators, and the results obtained (Table 1), we see that the overall competitiveness of the regions is relatively low (Akimova et al. 2020).

Table 1. Rating of competitiveness of the electricity market of the west of Ukraine
in terms of regions, 2016–2020

Tabela 1. Ocena konkurencyjności rynku energii elektrycznej zachodniej Ukrainy
w ujęciu regionalnym, 2016–2020

No.	Region	2016	2017	2018	2019	2020
1	Volyn region	0.021	0.021	0.021	0.026	0.024
2	Lviv region	0.022	0.023	0.02	0.033	0.017
3	Rivne region	0.022	0.023	0.024	0.039	0.016
4	Transcarpathian region	0.018	0.018	0.019	0.031	0.026
5	Chernivtsi region	0.019	0.019	0.019	0.021	0.021
6	Ternopil region	0.017	0.017	0.018	0.035	0.02
7	Khmelnytsky region	0.02	0.02	0.02	0.025	0.021
8	Ivano-Frankivsk region	0.023	0.023	0.021	0.026	0.039

Source: Author's development on the basis of personal calculations (JSC "Chernihivoblenergo" 2022; JSC "Khmelnitskoblenergo" 2022; JSC "Prykarpattyaoblenergo" 2022; National Commission for State Regulation of Energy and Utilities 2022; OJSC "Ternopiloblenergo" 2022; PJSC "Lvivoblenergo" 2022; PJSC "Rivneoblenergo" 2022; PJSC "Volynoblenergo" 2022; PJSC "Zakarpattyaoblenergo"; State Statistics Service of Ukraine 2022; Ukraine energy profile 2022).

As can be seen from Table 2, the Ivano-Frankivsk region became the most competitive region in 2020. The lowest position is occupied by the Rivne region – 0.016.

Table 2. Index of competitiveness of the electricity market of the regions of the west of Ukraine, 2020

Tabela 2. Wskaźnik konkurencyjności rynku energii elektrycznej regionów zachodniej Ukrainy, 2020 r.

No.	Region	2020
1	Ivano-Frankivsk region	0.039
2	Transcarpathian region	0.026
3	Volyn region	0.024
4	Chernivtsi region	0.021
5	Khmelnytsky region	0.021
6	Ternopil region	0.020
7	Lviv region	0.017
8	Rivne region	0.016

Source: Author's development on the basis of personal calculations (JSC "Chernihivoblenergo" 2022; JSC "Khmelnitskoblenergo" 2022; JSC "Prykarpattyaoblenergo" 2022; National Commission for State Regulation of Energy and Utilities 2022; OJSC "Ternopiloblenergo" 2022; PJSC "Lvivoblenergo" 2022; PJSC "Rivneoblenergo" 2022; PJSC "Volynoblenergo" 2022; PJSC "Zakarpattyaoblenergo"; State Statistics Service of Ukraine 2022; Ukraine energy profile 2022).

According to calculations, the studied regions compete closely with each other; the value of this coefficient is in the range of 0.02, which is relatively low and indicates a low efficiency of energy markets. The value of this index should be in the range 0–1.

In general, we are convinced that the efficiency of the electricity markets in the western region is relatively low (Simkiv et al. 2021).

Moreover, we can, for example, agree with the conclusions of the climate organization "Low Carbon Ukraine" on the causes of the inefficient operation of the electricity market in Ukraine:

◆ lack of competition;
◆ the inadequate system of subsidizing the population with cheap electricity;
◆ non-transparency of trade;
◆ excessive regulation of the state generation;
◆ lack of a balanced market system.

The second method

We apply another method of rationing using the threshold values of X_{comp} indicators, which characterize the level of allowable changes in the indicator without a significant impact on the process it characterizes, in order to assess the competitiveness of the western region.

Based on the calculations, the rationing of indicators, and the results obtained (Table 3), we see that the overall competitiveness of the regions is relatively high.

TABLE 3. Rating of competitiveness of the electricity market of the west of Ukraine
in terms of regions, 2016–2020

TABELA 3. Ocena konkurencyjności rynku energii elektrycznej zachodniej Ukrainy
w ujęciu regionalnym, 2016–2020

No.	Region	2016	2017	2018	2019	2020
1	Volyn region	0.762	0.783	0.801	0.855	0.957
2	Lviv region	0.903	0.94	0.912	0.895	0.866
3	Rivne region	0.43	0.571	0.618	0.73	0.988
4	Transcarpathian region	0.756	0.757	0.768	0.818	0.758
5	Chernivtsi region	0.813	0.804	0.758	0.89	0.862
6	Ternopil region	0.692	0.659	0.823	0.887	0.911
7	Khmelnytsky region	0.804	0.915	0.842	0.803	0.81
8	Ivano-Frankivsk region	0.711	0.729	0.9	0.808	0.938

Source: Author's development on the basis of personal calculations (JSC "Chernihivoblenergo" 2022; JSC "Khmelnitskoblenergo" 2022; JSC "Prykarpattyaoblenergo" 2022; National Commission for State Regulation of Energy and Utilities 2022; OJSC "Ternopiloblenergo" 2022; PJSC "Lvivoblenergo" 2022; PJSC "Rivneoblenergo" 2022; PJSC "Volynoblenergo" 2022; PJSC "Zakarpattyaoblenergo"; State Statistics Service of Ukraine 2022; Ukraine energy profile 2022).

According to the calculations, the studied regions compete closely with each other; the value of this coefficient is within 0.9, which is relatively high and indicates a high efficiency of energy markets. The value of this index should be in the range of 0–1.

As can be seen from Table 4, the most competitive region in 2020 was the Rivne region – 0.988. The lowest position is occupied by the Transcarpathian region – 0.758.

TABLE 4. Index of competitiveness of the electricity market of the regions of the west of Ukraine, 2020

TABELA 4. Wskaźnik konkurencyjności rynku energii elektrycznej regionów zachodniej Ukrainy, 2020 r.

No.	Region	2020
1	Rivne region	0.988
2	Volyn region	0.957
3	Ivano-Frankivsk region	0.938
4	Ternopil region	0.911
5	Lviv region	0.866
6	Chernivtsi region	0.862
7	Khmelnytsky region	0.81
8	Transcarpathian region	0.758

Source: Author's development on the basis of personal calculations (JSC "Chernihivoblenergo" 2022; JSC "Khmelnitskoblenergo" 2022; JSC "Prykarpattyaoblenergo" 2022; National Commission for State Regulation of Energy and Utilities 2022; OJSC "Ternopiloblenergo" 2022; PJSC "Lvivoblenergo" 2022; PJSC "Rivneoblenergo" 2022; PJSC "Volynoblenergo" 2022; PJSC "Zakarpattyaoblenergo"; State Statistics Service of Ukraine 2022; Ukraine energy profile 2022).

In general, we are convinced that the efficiency of the electricity markets in the western region is relatively high (using another research method). In our opinion, the radically different results of assessing the competitiveness of the electricity market compared to the standard approach are due to several factors: the assessment of market competitiveness was carried out in various aspects. In the standard approach, the macro-aspect is assessed, in the approach with threshold values, the micro-aspect (activity of electricity supply and distribution companies) is analyzed first of all as threshold values are established based on the activity of research companies that are monopolists; threshold values for the electricity market in the regions were defined as the maximum allowable maximum or minimum values during the study period.

The third method

We apply another method of rationing – unified – to assess the competitiveness of the western region. Based on the calculations, the rationing of indicators, and the results (Table 5), we can see that the overall competitiveness of the regions is above average (if evaluated in the range from 0 to 1).

Table 5. Rating of competitiveness of the electricity market of the west of Ukraine
in terms of regions, 2016–2020

Tabela 5. Ocena konkurencyjności rynku energii elektrycznej zachodniej Ukrainy
w ujęciu regionalnym, 2016–2020

No.	Region	2016	2017	2018	2019	2020
1	Volyn region	0.416	0.432	0.416	0.487	0.504
2	Lviv region	0.663	0.657	0.644	0.578	0.576
3	Rivne region	0.402	0.564	0.601	0.63	0.687
4	Transcarpathian region	0.503	0.523	0.532	0.497	0.502
5	Chernivtsi region	0.511	0.567	0.6	0.612	0.612
6	Ternopil region	0.431	0.498	0.523	0.527	0.557
7	Khmelnytsky region	0.501	0.576	0.598	0.587	0.566
8	Ivano-Frankivsk region	0.5	0.529	0.543	0.603	0.622

Source: Author's development on the basis of personal calculations (JSC "Chernihivoblenergo" 2022; JSC "Khmel-nitskoblenergo" 2022; JSC "Prykarpattyaoblenergo" 2022; National Commission for State Regulation of Energy and Utilities 2022; OJSC "Ternopiloblenergo" 2022; PJSC "Lvivoblenergo" 2022; PJSC "Rivneoblenergo" 2022; PJSC "Volynoblenergo" 2022; PJSC "Zakarpattyaoblenergo"; State Statistics Service of Ukraine 2022; Ukraine energy profile 2022).

Calculations show that the studied regions compete closely with each other; the rate ranges between 0.5–0.6, which is an acceptable level of efficiency of energy markets. After all, the value of this index should be in the range 0–1. As can be seen from Table 6, the most competitive region in 2020 was the Rivne region – 0.687. The lowest position is occupied by the Transcarpathian region – 0.502.

In general, we are convinced that the efficiency of the electricity markets of the western region is exceptionally high quality and plausible (using a unified research method) because in this case, the coefficient value is approximately in the middle of the range from 0 to 1, which indicates the presence of problems and specific achievements.

In addition, considering the set (reasonable) appropriate requirements for the desired or undesirable values of indicators enables a comprehensive approach for determining the competitiveness index. The only problematic point is the lack of normative values for some indicators, which complicates the standardization of input statistics. Based on the considered methods of calculating western Ukrainian electricity organizations (regional electricity markets), we can see that each of them differently characterizes the electricity market.

In our opinion, this is because various aspects of competitiveness (micro- or macro-scale) are assessed and certain limitations in the calculation are used, including thresholds, optimal values etc.. In order to achieve the generalization of the obtained results, it was decided to rank the obtained indicators by assigning the highest rating position - 8 points and the lowest - 1 point (Table 7).

TABLE 6. Index of competitiveness of the electricity market of the regions of the west of Ukraine, 2020

TABELA 6. Wskaźnik konkurencyjności rynku energii elektrycznej regionów zachodniej Ukrainy, 2020 r.

No.	Region	2020
1	Rivne region	0.687
2	Ivano-Frankivsk region	0.622
3	Chernivtsi region	0.612
4	Lviv region	0.576
5	Khmelnytsky region	0.566
6	Ternopil region	0.557
7	Volyn region	0.504
8	Transcarpathian region	0.502

Source: Author's development on the basis of personal calculations (Boiar et al. 2018; JSC "Chernihivoblenergo" 2022; JSC "Khmelnitskoblenergo" 2022; JSC "Prykarpattyaoblenergo" 2022; National Commission for State Regulation of Energy and Utilities 2022; OJSC "Ternopiloblenergo" 2022; PJSC "Lvivoblenergo" 2022; PJSC "Rivneoblenergo" 2022; PJSC "Volynoblenergo" 2022; PJSC "Zakarpattyaoblenergo"; State Statistics Service of Ukraine 2022).

Conclusions

As a result, as we can see in Table 7, the highest rating positions are held by Ivano-Frankivsk region (JSC "Ivano-Frankivskoblenergo") – 21 points; Rivne region (JSC "Rivneoblenergo") – 17 points; Volyn region (JSC "Volynoblenergo") – 15. The lowest ranking positions were held by Khmelnytsky region (JSC "Khmelnytskoblenergo") – 10 points and Transcarpathian region (JSC "Zakarpattyaoblenergo") – 9 points.

In the course of the study, there was a need to calculate the efficiency of regional electricity markets and determine the efficiency of electricity companies that provide services for the generation, transportation, and distribution of electricity within the western region of Ukraine.

Our research is based on several indicators grouped within certain correspondences: relative indicators of the level of assessment of property status and the level of efficiency of property used by the enterprise (fixed assets; the ratio of current and non-current assets; return on assets; also in our calculation of activity, the taken relative indicators of liquidity analysis of the enterprise, the ratio of current liquidity; the ratio of quick liquidity; the ratio of absolute liquidity).

Relative indicators of profitability of the enterprise (return on equity assets, sales of products (works, services), the payback period of capital, the payback period of equity).

Relative indicators of financial stability (coefficient of the value of financial independence (autonomy), coefficient of the value of financial dependence, coefficient of the value of financial risk, coefficient of the value of coverage (solvency): coefficient of the value of the self-financing, coefficient of the value of financial stability.

TABLE 7. Rating positions of the regions of the west of Ukraine according to the results of a study using four different methods on 01.01.2021

TABELA 7. Pozycje rankingowe regionów zachodniej Ukrainy według wyników badania czterema różnymi metodami na 01.01.2021 r.

Position	1 (8 points)	2 (7 points)	3 (6 points)	4 (5 points)	5 (4 points)	6 (3 points)	7 (2 points)	8 (1 point)
1 method	Ivano-Frankivsk region	Transcarpathian region	Volyn region	Chernivtsi region	Khmelnytsky region	Ternopil region	Lviv region	Rivne region
2 method	Rivne region	Volyn region	Ivano-Frankivsk region	Ternopil region	Lviv region	Chernivtsi region	Khmelnytsky region	Transcarpathian region
3 method	Rivne region	Ivano-Frankivsk region	Chernivtsi region	Lviv region	Khmelnytsky region	Ternopil region	Volyn region	Transcarpathian region

Summarizing the results obtained (number of points) for each region, a generalized indicator of competitiveness was summarized as follows:		
No.	Region	Rating
1	Ivano-Frankivsk region	21
2	Rivne region	17
3	Volyn region	15
4	Chernivtsi region	14
5	Ternopil region	11
6	Lviv region	11
7	Khmelnytsky region	10
8	Transcarpathian region	9

Source: Constructed and systematized by the authors based on the results of calculations (JSC "Chernihivoblenergo" 2022; JSC "Khmelnitskoblenergo" 2022; JSC "Prykarpattyaoblenergo" 2022; National Commission for State Regulation of Energy and Utilities 2022; OJSC "Ternopiloblenergo" 2022; PJSC "Lvivoblenergo" 2022; PJSC "Rivneoblenergo" 2022; PJSC "Volynoblenergo" 2022; PJSC "Zakarpattyaoblenergo"; State Statistics Service of Ukraine 2022; Ukraine energy profile 2022).

In addition, we use indicators relating to the electricity market in general, these are price indicators of oblenergos, technical indicators, the actual quality of services by call centers, etc.

We propose to adhere to the principle of rationing for a comprehensive comparison of the set of factors that reflect the activities of regional market participants. After reviewing the existing methodology, it is necessary to identify five essential components of this principle: standard, optimal, allowable changes, unification, nonlinear normalization.

A standard approach to assessing the competitiveness of the regions of the western region has been applied. Based on the calculations of rationing indicators and the results obtained, we see that the overall competitiveness of the regions is relatively low.

In applying the index of competitiveness of the market of electric power regions of the western region, it should be stated that the most competitive region in 2021 was the Ivano-Frankivsk region.

In general, we are convinced that the efficiency of electricity in the Western region is relatively low. Possible causes of low competitiveness include a lack of competition, an ineffective system of subsidizing the population with cheap resources, non-transparency of trade operations, too high a level of regulation of state generation, a lack of a "balanced" system of market functioning.

References

Akimova at al. 2020 – Akimova, L.M., Levytska, S.O., Pavlov, K. and Kupchak, V. 2020. The role of accounting in providing sustainable development and national safety of Ukraine. *Financial and credit activity: problems of theory and practice* 3(30), pp. 54–61, DOI: 10.18371/fcaptp.v3i30.179501.

Andrusiv et al. 2021a – Andrusiv, U., Zelinska, H., Galtsova, O., Kupalova, H. and Goncharenko, N. 2021. The modeling and forecasting of fuel and energy resources usage in the context of the energy independence of Ukraine. *Polityka Energetyczna – Energy Policy Journal* 24(1), pp. 29–48, DOI: 10.33223/epj/132892.

Andrusiv et al. 2021b – Andrusiv, U., Zelinska, H., Kupalova, H., Galtsova, O., Marynchak, L. and Dovgal, O. 2021. Optimization of balance components of fuel and energy resources for organizational and economic support of energy efficiency in ukraine. *Ecological Engineering and Environmental Technology* 22(6), pp. 27–35, DOI: 10.12912/27197050/141611.

Bielinskyi et al. 2021 – Bielinskyi, A., Khvostina, I., Matviychuk, A., Semerikov, S., Serdyuk, O., Solovieva, V. and Soloviev, V. 2021 Predictors of oil shocks. Econophysical approach in environmental science. *IOP Conf. Series: Earth and Environmental Science* 628 012019 IOP Publishing DOI: 10.1088/1755-1315/628/1/012019.

Boiar et al. 2018 – Boiar, A., Shmatkovska, O. and Stashchuk, O. 2018. Towards the theory of supranational finance. *Cogent Business & Management* 5(1), pp. 1–12, DOI: 10.1080/23311975.2018.1482594.

Danylyshyn et al. 2021 – Danylyshyn, B., Olshanska, O., Zabaldina, Y., Mazurets, R., Khlopiak, S. and Pivnova, L. 2021. Designing a Marketing Strategy for the Development of Industrial Tourism in the Region *Journal of Optimization in Industrial Engineering* 14 (Special Issue – Serial Number 29) pp. 1–8, DOI: 10.22094/joie.2020.677809.

Horoshkova et al. 2020 – Horoshkova, L., Khlobystov, I. and Danylyshyn, B. 2020. Multifactor mathematical modelling of ecological and economic systems (the example of coal mining development). *Geoinformatics 2020 – XIXth International Conference "Geoinformatics: Theoretical and Applied Aspects"*, DOI: 10.3997/2214-4609.2020geo068.

Hryhoruk et al. 2021 – Hryhoruk, I., Yakubiv, V., Sydoryk, Y., Maksymiv, Y. and Popadynets, N. 2021. Modelling of prognosis for bioenergy production in Ukraine. *International Journal of Energy Economics and Policy* 11(6), pp. 27–34, DOI: 10.32479/ijeep.11741.

JSC "Chernihivoblenergo" 2022. [Online] https://chernihivoblenergo.com.ua/ [Accessed: 2023-01-24].

JSC "Khmelnitskoblenergo" 2022. [Online] https://hoe.com.ua/ [Accessed: 2023-01-24].

JSC "Prykarpattyaoblenergo" 2022. [Online] https://www.oe.if.ua/uk [Accessed: 2023-01-24].

Maksymiv et al. 2021 – Maksymiv, Y., Yakubiv, V., Pylypiv, N., Hryhoruk, I., Piatnychuk, I. and Popadynets, N. 2021. Strategic challenges for sustainable governance of the bioeconomy: Preventing conflict between sdgs. *Sustainability* 13(15), DOI: 10.3390/su13158308.

MARTYNIUK et al. 2019 – MARTYNIUK, O., VITVITSKAYA, O., LAGODIIENKO, V. and KRUPITSA, I. 2019. Formation of an innovative concept of management on the basis of reconstruction of genetic algorithm of management technology. *Periodicals of Engineering and Natural Sciences* 7(2), pp. 487–499, DOI: 10.21533/pen.v7i2.560.

National Commission for State Regulation of Energy and Utilities 2022. [Online] https://www.nerc.gov.ua [Accessed: 2023-01-24].

OJSC "Ternopiloblenergo" 2022. [Online] https://www.toe.com.ua/ [Accessed: 2023-01-24].

PANUKHNYK et al. 2021 – PANUKHNYK, O., HRYHORUK, I., POPADYNETS, N., KHYMYCH, H. and FEDOTOVA, Ya. 2021 Modeling of bioenergy impact on food security of EU countries. *IOP Conf. Series: Earth and Environmental Science* 628, DOI: 10.1088/1755-1315/628/1/012002.

PAVLOV et al. 2020a – PAVLOV, K., PAVLOVA, O., KOROTIA, M., HORAL, L., RATUSHNIAK, I., SEMENOV, M., RATUSHNIAK, L., SHAPOVALOV, Y., ANASTASENKO, S., HRYHORUK, I. and POPADYNETS, N. 2020a. Determination and Management of Gas Distribution Companies' Competitive Positions. [In:] Mrugalska B., Trzcielinski S., Karwowski W., Di Nicolantonio M., Rossi E. (eds) *Advances in Manufacturing, Production Management and Process Control.* AHFE 2020. Advances in Intelligent Systems and Computing 1216, pp. 302–309. Springer, Cham, DOI: 10.1007/978-3-030-51981-0_38.

PAVLOV et al. 2020b – PAVLOV, K., PAVLOVA, O. and KUPCHAK, V. 2020b. Integral Indicators Based on Competitiveness Capacity Characteristics of Regional Real Estate Markets of Ukraine. *Journal of Competitiveness* 11(3), pp. 87–108, DOI: 10.7441/joc.2019.03.06.

PJSC "Lvivoblenergo" 2022. [Online] https://www.loe.lviv.ua/ [Accessed: 2023-01-24].

PJSC "Rivneoblenergo" 2022. [Online] https://www.roe.vsei.ua/ [Accessed: 2023-01-24].

PJSC "Volynoblenergo" 2022. [Online] https://energy.volyn.ua/ [Accessed: 2023-01-24].

PJSC "Zakarpattyaoblenergo" 2022. [Online] https://zakarpat.energy/ [Accessed: 2023-01-24].

PRYSHCHEPA et al. 2020 – PRYSHCHEPA, O., KARDASH, O., YAKYMCHUK, A., SHVEC, M., PAVLOV, K., PAVLOVA, O., IRTYSHCHEVA, I., POPADYNETS, N., BOIKO, Y. and KRAMARENKO, I. 2020. Optimization of Multi-Channel Queueing Systems with a Single Retrial Attempt: Economic Approach. *Decision Science Letters* 9(4), pp. 559–564, DOI: 10.5267/j.dsl.2020.8.002.

REZNIK et al. 2022 – REZNIK, N.P., HRIDIN, O.V., CHUKINA, I.V., KRASNORUTSKYY, O.O. and MYKHAYLICHENKO, M.V. 2022. Mechanisms and tools of personnel management in institutional economics. *AIP Conference Proceedings* 2413, 040012, DOI: 10.1063/5.0089330.

ROMANYUK, R. 2021. Organizational and economic mechanism of reforming the electricity market in the western region of Ukraine. Abstract of the candidate's dissertation. Specialty 08.00.05 – development of productive forces and regional economy. Odessa. 2021. ONAFT. [Online] https://www.onaft.edu.ua/download/dissertation/abstract/2021/Abstract-Romanyuk.pdf [Accessed: 2023-01-24].

RUKOSUEVA al. 2021 – RUKOSUEVA, A.A., BARYSHNIKOVA, O.V., TYNCHENKO, V.S., LYTKINA, S.I., RUDYAGA, E.V. and LEONTEVA, A.A. 2021. Evaluating the financial condition of an enterprise using universal process modeling. ISCKMC 2020. International Scientific Congress «knowledge, man and civilization». *European Proceedings of ocial and Behavioural Sciences EpSBS,* DOI: 10.15405/epsbs.2021.05.326.

SIMKIV et al. 2021 – SIMKIV, L., SHULTS, S., LUTSKIV, O. and ANDRUSIV, U. 2021. Analysis of the dynamics of structural processes in the context of ensuring sustainable development. *European Journal of Sustainable Development* 10(1), pp. 153–167, DOI: 10.14207/ejsd.2021.v10n1p153.

SKRYPKO et al. 2021 – SKRYPKO, T., POPADYNETS, N., YAKHNO, T., SHULLA, R., VLASENKO, T., IRTYSHCHEVA, I. and BOIKO, Y. 2021 Optimizing the polymer waste supply chains based on circular economy. *Uncertain Supply Chain Management* 9(2), pp. 343–350, DOI: 10.5267/j.scm.2021.2.008.

State Statistics Service of Ukraine 2022. [Online] http://www.ukrstat.gov.ua/ [Accessed: 2023-01-24].

Ukraine energy profile 2022. [Online] https://www.iea.org/reports/ukraine-energy-profile [Accessed: 2023-01-24].

YAKYMCHUK et al. 2022 – YAKYMCHUK, A., KARDASH, O., POPADYNETS, N., YAKUBIV, V., MAKSYMIV, YU., HRYHORUK, I. and KOTSKO, T. 2022. Modeling and Governance of the Country's Energy Security: The Example of Ukraine. *International Journal of Energy Economics and Policy* 12(5), pp. 280–286, DOI: 10.32479/ijeep.13397.

ZELINSKA et al. 2020 – ZELINSKA, H., FEDOROVYCH, I., ANDRUSIV, U., CHERNOVA, O. and KUPALOVA, H. 2020. Modeling and prediction of the gas pipelines reliability indicators in the context of energy security of Ukraine. Paper presented at the *CEUR Workshop Proceedings* 2713, pp. 415–433.

ZELINSKA et al. 2021a – ZELINSKA, H., ANDRUSIV, U., DALIAK, N., DOVGAL, O. and LAGODIIENKO, V. 2021a. Sustainable Development: Trends in Ukraine and the World. *Journal Of Environmental Management And Tourism* 12(5), pp. 1179–1187, DOI: 10.14505//jemt.v12.5(53).03.

ZELINSKA et al. 2021b – ZELINSKA, H., ANDRUSIV, U., FEDOROVYCH, I., KHVOSTINA, I. and ASTAFIEV, O. 2021b. Rational resource in the context of forming a model of using fuel and energy resources expenditure. Paper presented at the *IOP Conference Series: Earth and Environmental Science* 628(1), DOI: 10.1088/1755-1315/628/1/012003.

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Efektywność funkcjonowania rynku energii elektrycznej zachodniego regionu Ukrainy

Streszczenie

Naukowcy koncentrują się na wprowadzaniu różnego rodzaju odnawialnych źródeł energii oraz liberalizacji rynków energii poszczególnych regionach. Nierozwiązane pozostają również problemy zapobiegania realizacji celów i różnych strategii osiągnięcia maksymalnej oszczędności energii oraz przezwyciężenia obecnego kryzysu gospodarczego i ekologicznego na Ukrainie. Obserwujemy doświadczenia wiodących krajów w sektorze elektroenergetycznym, które dowodzą, że reforma sektora elektroenergetycznego na Ukrainie jest nieunikniona. To z kolei jest kluczowym czynnikiem stymulującym wzrost gospodarczy i społeczny oraz poprawę konkurencyjności wśród regionów Ukrainy. Wobec powyższego oczywista jest konieczność badania poziomu efektywności (konkurencyjności) oraz funkcjonowania regionalnych rynków energii Ukrainy. Niniejsze opracowanie pokazuje, że wydajność energii elektrycznej w regionie zachodnim jest stosunkowo niska ze względu na brak konkurencji, istnienie nieefektywnego systemu subsydiowania ludności tanimi surowcami, nieprzejrzystość operacji handlowych, nadmierną regulację wytwarzania przez państwo, brak „zrównoważonego" systemu funkcjonowania rynku itp.

SŁOWA KLUCZOWE: efektywność, rynek energii elektrycznej, źródła energii, Ukraina