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Efficiency of use of fuel and energy resources of Ukraine: assessment, simulation and forecasting

Abstract: This work focuses on the fact that the realities of today's Ukrainian economy require not only recovery but also an increase in the volume of production of products produced by energy-intensive

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enterprises in the industry to the pre-crisis level, which stimulated the following: an increase in the demand for fuel and energy resources (FER); the increase in the cost of imported natural gas and oil, which became an excessive burden for domestic economic entities and the state budget and led to increased dependence on the geopolitical influence of the Russian Federation; the weakening of Ukraine's position on the global energy market as a transporter of energy resources; increased competition in the global, national and regional markets of FER under the influence of the growth of general demand, etc.

It was confirmed through analysis that the priority of the state policy in the field of the energy security of Ukraine will continue to be the stimulation of the implementation of energy-saving measures and the improvement of the efficiency of the use of FER by attracting all possible incentives at all levels of management. A visualized model is proposed which will make it possible to systematically manage the processes of the effective use of FES; an action algorithm has been developed that will allow solving problems that arise in changing external and internal environments, simplifying the decision-making procedure regarding the effectiveness of the use of FER, and reducing their specific costs.

The assessment and forecasting of the energy efficiency of Ukraine's economy was conducted using additive and multiplicative convolutions, which made it possible to forecast the energy efficiency index until 2035 in accordance with the adopted energy strategy of the state. It was determined that the strategic directions of increasing energy efficiency and realizing the energy potential of Ukraine remain the technological and structural restructuring of the economy, social infrastructure, and the creation of the economic, managerial and legal mechanisms necessary for the implementation of the state energy efficiency policy.

Keywords: resources, energy efficiency, model, assessment, national economy

Introduction

The peculiarity of the economy of Ukraine in the pre-war period was the restoration of growth in the volume of products produced by energy-intensive industries to the level of the pre-crisis state, which stimulated the following: an increase in demand for fuel and energy resources (FER); the increase in the cost of imported natural gas and oil, which became an excessive burden for domestic economic entities and the state budget and led to increased dependence on the geopolitical influence of the Russian Federation; the weakening of Ukraine's position on the global energy market as a transporter of energy resources; increased competition in the global, national and regional markets of FER under the influence of the growth of general demand, etc.

The mentioned trends stimulated the reorientation of state policy in order to ensure the conditions for increasing the national production of FER and reducing dependence on FER imports by reducing consumption volumes. Experience proves that the implementation of projects aimed at using alternative energy sources and increasing the production of the nation's energy resources requires significant costs (over $1 million), while the implementation of energy-saving measures is economically more profitable.

The existing management system of the energy complex is inefficient and requires careful study, economically justified management decisions, and improvement of the regulatory and legal framework. The priority of state policy and regulation will continue to be the stimulation of the implementation of energy-saving measures and the improvement of the efficiency of the use of energy resources by attracting all possible incentives at the international, national and regional levels.

1. Review of literary sources

Energy efficiency issues have always received special attention from scientists and practitioners at various levels of management. In particular, authors have highlighted the problems of obtaining energy through renewable sources, the better use of renewable energy, carbon, water, etc. Both abroad and in domestic practice, scientists come to the conclusion that the efficient use of energy resources is the key to reducing the specific costs of energy production and is a prerequisite for the energy security of any country. Thus, studying the efficiency of the use of resources in the communal sphere, Reis et al. (2023) prove that increasing the efficiency of the use of natural resources is necessary in order to achieve sustainable development. Scientists from China, Liu et al. (2023), have examined the efficiency of water and land use, energy. According to Onile et al. (2023), electricity consumers often face problems related to the choice of the optimal energy-saving plan. They argued that demand management using battery energy storage systems (BESS) is critical to extending the physical limits of the existing power grid.

Bosu et al. (2023) have paid much attention to the issues of energy management and energy audit in Egypt. They investigated the potential sources of energy loss at the facility according to a unique energy audit and analysis roadmap. This will serve as a guide for the relevant decision-makers to improve energy efficiency, thereby achieving savings and limiting the carbon footprint. Energy management, as a tool for achieving enterprise efficiency and competitiveness, became the subject of research by Monjurul Hasan et al. (2022).

Patterson et al. (1996), considered the range of energy efficiency. It transpired that traditional thermodynamic indicators of energy efficiency have limited application, because insufficient attention is paid to the necessary services of the end user. Abdelaziz et al. (2011) investigated the impact of energy management on energy efficiency. Based on the results of energy-saving technologies, it was found that in industrial sectors, with the help of these technologies, a significant amount of electricity, emissions and utilities can be saved. Hossain et al. (2020) investigated energy processes and their management using the cement industry of Bangladesh as a case study. They concluded that there are certain risks and obstacles in the use of energy management in practical activities.

The most prominent among them are the lack of awareness of the staff, insufficient attention from the authorities and bureaucratic confusion. As the main obstacle to the implementation of

energy management, they identified the risk of high energy prices in the near future and increased demand for energy resources from consumers and organizations.

Paramonova et al. (2015) say that energy efficiency is one of the main means of reducing CO_2 emissions from industrial energy use. From both a societal and a business perspective, it is critical to reduce industrial end-use energy consumption (EEU).

Trianni et al. (2019) concluded that energy efficiency is crucial for industry. They see this in saving energy costs. Furthermore, the authors prove that the potential of enterprises is not used to the full extent due to the low return on the use of energy management. This, in their opinion, became the main reason for the decrease in the competitiveness of enterprises. Scientists conducted their research on the examples of large Italian and Swedish manufacturing companies, confirming that the model confirmed by them is able to describe in detail the state of energy management and compared the level of implementation of energy management practices in relation to specific basic indicators.

Sun et al. (2023) proposed the implementation of an innovative energy management assessment model based on a new characteristic of energy management practices in the Shanghai metropolis. They prove that resource efficiency is a key factor in energy management and leads to a 32% reduction in carbon emissions and a 30% reduction in waste compared to 2010 values.

Domestic scientists have also proposed directions for state energy conservation policy (Yakymchuk et al. 2022, 2023; Horoshkova et al. 2020); however, the effectiveness of the implementation of individual measures in the conditions of globalization and integration processes of the national economic system into the world economy has not been sufficiently investigated. The aforementioned authors investigated various aspects of energy management efficiency. Andrusiv et al. (2021a, 2021b), and Zelinska et al. (2021a, 2021b) dealt with the optimization of the structure of FER through the use of secondary resources, which is extremely relevant for today's domestic economy of Ukraine.

For many years, Ukrainian scientists, practitioners, and government officials have paid considerable attention to solving the issue of the energy intensity of GDP, which has been reflected in legislative and regulatory acts regarding standards relating to the consumption of energy resources (Hridin et al. 2022; Fatkhutdinov et al. 2021), reducing tax pressure when implementing energy-saving technologies, and providing state support for energy-saving innovative projects and environmental investments (Kupalova et al. 2021), making changes to the state target economic program of energy efficiency for 2020–2030, etc. Research on the methodology of the assessment of energy efficiency in the works of domestic scientists and research centers continues (Vlasenko et al. 2019; Kneysler et al. 2020).

Thus, as indicated by studies conducted by various scientists in the world, the issue of energy efficiency does not lose its relevance and requires deep research in the future. The purpose of the article is to analyze, evaluate and forecast the effectiveness of the use of the fuel and energy resources of Ukraine.

2. Methodology

The methodological apparatus of the research consists of general scientific and special economic methods. The work uses the following: induction and deduction – to justify the need to implement energy-saving measures in Ukraine; graph-analytical – for a visual representation of the decomposition of the process of using FER and their institutional support, index method – for converting individual indices, characterizing FER (crude oil, coal, etc.) to determinants and criteria of energy efficiency of the national economy; program-targeted – to reveal the essence of the target program of energy saving and effective use of fuel and energy resources; stepwise regression (adaptive and multiplicative convolution) – to establish the influence of factors on functionality when forecasting energy efficiency; logical – for drawing conclusions from this study.

Main part

The state energy-saving policy involves administrative, legal, financial, and economic regulation of processes related to the extraction, processing, transportation, storage, production, distribution and application of energy resources with the aim of their rational use and efficient consumption. The state policy aimed at improving the energy efficiency of production and reducing energy consumption in Ukraine is being implemented through the development and implementation of energy efficiency programs of various levels (industry-specific, regional, etc.) (2030 Framework for Climate and Energy Policies). The goal of the State Target Economic Energy Efficiency Program is to create conditions for reducing the energy intensity of GDP by 20% compared to 2008 (4% per year) during the program's duration, and optimizing the structure of Ukraine's energy balance. It includes the following measures:

- introduction of the latest technologies for the production and consumption of energy resources, cogeneration technologies;
- introduction of technologies for electric thermal storage heating and those involving the use of heat pumps;
- modernization of the gas transmission system;
- optimization of the structure of the energy balance;
- formation of the state system of monitoring and control over the efficient use of fuel and energy resources and the implementation of sectoral and regional energy efficiency programs;
- execution of structural restructuring of enterprises in which a high share of energy-intensive materials is used;
- execution of structural restructuring of enterprises, in which there is a high share of energy -intensive materials;
- improvement of the financing mechanism of measures aimed at reducing the level of energy intensity of production, increasing the use of secondary energy resources, the volume of emissions of pollutants;

- intensification of cooperation between countries regarding the energy security strategy;
- implementation of measures to promote effective and economical consumption of fuel and energy resources among the general population through the mass media, the inclusion of relevant issues in the programs of educational institutions and the formation of regional public information centers.

The implementation of the state policy is ensured by the introduction of an energy management system, the main purpose of which is to optimize the use of fuel and energy resources and manage the process of energy use. Reducing energy costs for the development, production and use of products (services) and reducing greenhouse gas emissions and reducing the negative impact on the environment is possible by: stimulating energy efficiency throughout the supply chain; the transformation, production and consumption of energy resources; improvements to the level of management. Energy management is considered as a multi-level system for managing energy production and energy consumption which involves not only the introduction of energy-saving technologies and equipment but also the assessment of the efficiency of using secondary and renewable energy resources, pricing policy and the regulation of energy markets.

The rational use of fuel and energy resources means achieving the maximum efficiency of their consumption, using modern equipment and technology and reducing the man-made impact on the environment (Zelinska et al. 2020c). The model of the process of the rational use of fuel and energy resources is shown in Fig. 1, which includes the following elements:

1) development and approval by the governing bodies in the field of the use of energy resources of legislative and regulatory acts regulating issues of energy security, the fuel and energy complex, nuclear policy and nuclear safety and environmental policy, strategic planning and budgeting in the energy sector, the adaptation of Ukrainian energy legislation to EU directives, privatization of energy assets, the restructuring and closing of unprofitable enterprises, the provision of district heating services, the introduction of energy efficiency and energy saving technologies, and the organization and conduct of business activities, etc.;

2) development of methodological recommendations for determining the inefficient use of fuel and energy resources, approval of standards for the unit costs of energy resources, development of environmental and implementation of energy efficiency standards and the use of renewable types of resources in the course of economic activity, monitoring and control of their implementation;

3) institutional support for conducting an energy audit and functioning of an effective energy management system at the sectoral and regional levels in order to reduce the energy costs of individual industries and public sector institutions;

4) conducting an environmental review of objects and activities, the implementation and operation of which may adversely affect the state of the environment;

5) the introduction of a system of measures to diversify the sources of the supply of fuel and energy resources and restructuring the economy by replacing traditional types of energy resources with alternatives;

6) the distribution of rights between economic entities for the use and ownership of fuel and energy resources, monitoring their use;

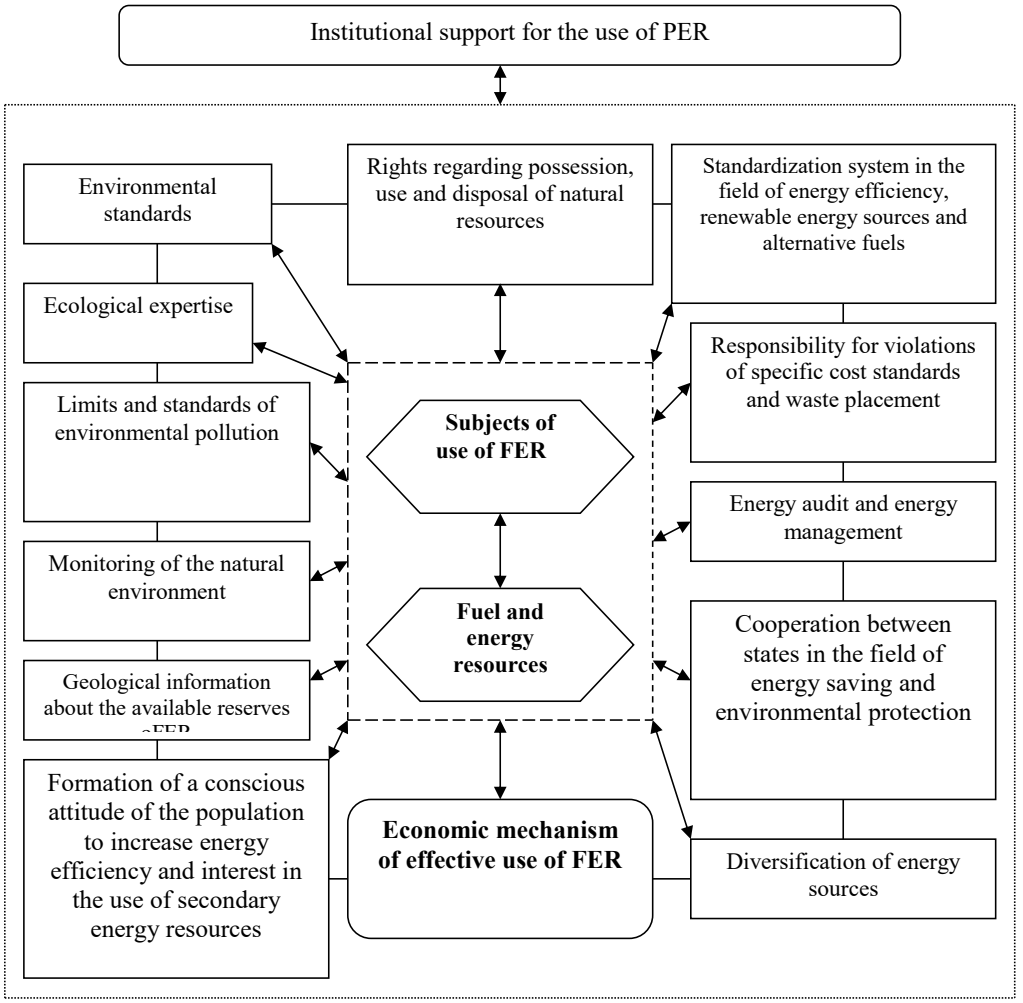

Fig. 1. Decompositional approach to the process of the rational use of FER and their institutional support
Source: generated by the authors

Rys. 1. Dekompozycyjne podejście do procesu racjonalnego wykorzystania FER i ich wsparcia instytucjonalnego

7) keeping records of fuel and energy resources and determining the potential for the use of renewable energy of wind, solar, biomass and secondary resources;

8) monitoring and forecasting the state of the environment;

9) ensuring the functioning of the system of payments for the special use of energy resources, environmental tax, payments for inefficient use of fuel and energy resources and compensation for damage caused;

10) the introduction of incentives and sanctions for violations of regulatory legal acts in the energy sector and the field of energy saving;

11) participation in international projects to ensure energy efficiency, energy saving and environmental protection;

Inefficient use of FER entails their direct losses use exceeding normative indicators of specific fuel and energy consumption.

Coordination of measures and methods for the rational use of energy resources should be ensured through targeted programs for energy saving and the efficient use of fuel and energy resources (Fig. 2).

The main objects of influence of energy conservation measures are GDP growth and a decrease in the physical volume of consumption of energy resources (Table 1).

Due to the instability of energy sources, renewable energy requires the construction of compensatory capacities, which makes it inefficient, and therefore the costs of producing a unit of energy are quite high, which is a restraining factor for the development of this direction of energy. Furthermore, high prices for energy resources are the best incentive for the spread of energy saving, both at the population level and in industry and the budget sphere.

The rational use of fuel and energy resources (FER) should ensure the full existence and development of modern society, provided that the high quality of the human habitat is preserved.

Taking into account this integrated approach when developing an energy saving program will enable the concentration of available resources and the optimization of the efficiency of their use through the complex impact of economic factors on the rational use of fuel-energy resources. The developed approach to the formation of the energy strategy will contribute to the implementation of an effective energy-saving policy, ensuring the competitive advantages of domestic enterprises, increasing their competitiveness, and improving the economic and energy security of the state. The implementation of the process of rational use of fuel and energy resources would concentrate financial and other resources on priority areas of energy saving for the Ukrainian economy, which would contribute to the cumulative economic effect of investments through the development of energy efficient production and the creation of energy-saving facilities and technologies. This approach takes into account the importance of the impact of economic development on reducing the energy intensity of GDP, which is not currently being paid attention to.

Given the importance of energy conservation on a global scale, Ukraine is implementing various measures to reduce the amount of energy consumed in both the industrial and social sectors. The high consumption of fuel and energy resources in Ukraine and, as a result, the high level of energy intensity of GDP necessitate an assessment of the relationship between the volume of fuel and energy resources consumption and economic factors that have a significant impact on the level of its formation.

It is proposed to study the energy efficiency of the national economy in the context of certain types of fuel and energy resources: natural gas, electricity, thermal energy, petroleum products, crude oil with condensate, coal, peat, and biomass. Calculations of the energy efficiency of the use of fuel and energy resources will be carried out by adaptive and multiplicative convolutions.

We consider it expedient to forecast the energy efficiency of the national economy up to 2035, since the adopted Energy Strategy of Ukraine for the period up to 2035 “Security,

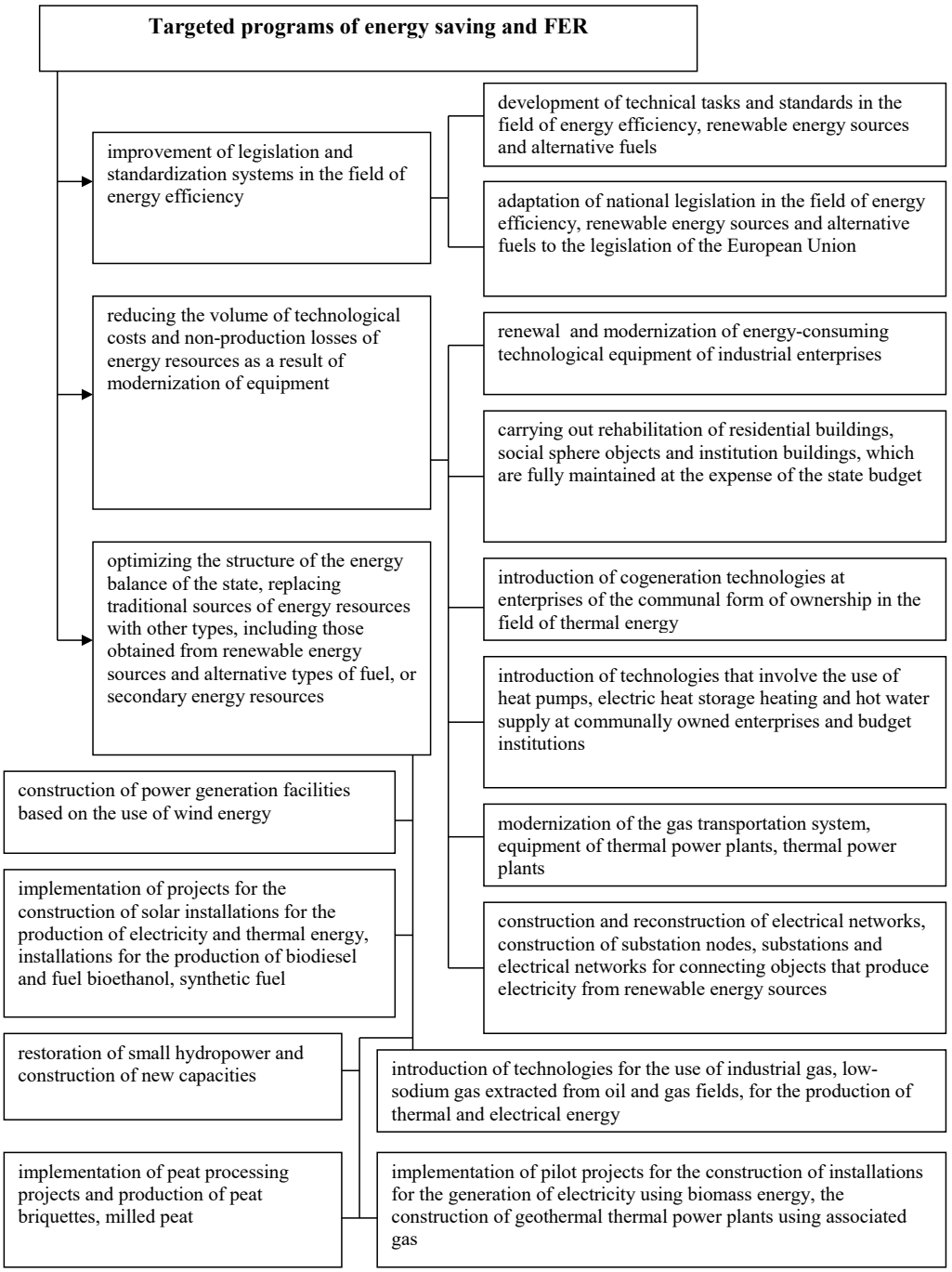

Fig. 2. Targeted programs of energy saving and the efficient use of fuel and energy resources (authors' development)

Rys. 2. Ukierunkowane programy oszczędzania energii i efektywnego wykorzystania zasobów paliw i energii

Table 1. Objects and spheres of influence of the state policy of the rational use of fuel and energy resources

Tabela 1. Przedmioty i sfery oddziaływania polityki państwa w zakresie racjonalnego wykorzystania zasobów paliw i energii i zasobów energetycznych

Sphere of influence	Directions of state policy
1	2
Ensuring GDP growth	
Stimulating demand	A Keynesian approach, a policy of cheap money, perhaps combined with a cap on government spending;
Stimulation of production	Reducing the tax burden in order to encourage capital investments;
Stimulation of external demand	Support of export industries by creating special conditions of activity;
	Protectionism of import-substituting industries;
Industrial policy	Encouraging highly productive industries and withdrawing capital from low-productive industries, which will lead to a change in the structure of production;
	Increasing government spending on research to stimulate high-tech industries;
Reduction of the physical volume of the consumption of energy resources	
The field of energy production	Stimulation of the technological renewal of the equipment of producers of energy resources;
	Implementation of new production methods based on the principles of the energy-saving use of resources;
	Increase in costs for geological exploration works;
	Extraction and use of methane from coal deposits as an alternative type of fuel;
	Implementation of integrated heat and electric energy production technologies;
The field of transportation of energy resources	Repair and improvement of energy networks;
	Development of small thermal power generation with high efficiency and low transport losses;
The sphere of use of new energy sources	Priority development of alternative energy with simultaneous implementation of the policy of high prices for energy resources;
	Implementation of electric heat storage heating technologies and technologies involving the use of heat pumps;
	Use of thermal energy of the sun and geothermal energy;
The sphere of energy consumption	Tax benefits and fines;
	Grants, soft loans for energy-saving projects;
	System of standardization and energy labeling of buildings and equipment;
	Use of automation systems for heating, lighting, energy accounting, etc.;
	Creation of favorable conditions for the attraction of domestic and foreign investments in the field of energy efficiency and energy saving with the aim of optimizing the structure of the energy balance, reducing the volume of the emissions of pollutants;
	Performing the structural restructuring of enterprises, aimed at reducing the material and energy intensity of production;

1	2
	Legislative settlement of issues related to reducing the level of energy intensity of GDP and optimizing the structure of the energy balance;
	Activation of international cooperation within the framework of implementation of the energy security strategy of the state;
	Implementation of measures to popularize the effective and frugal consumption of fuel and energy resources among the general population through the mass media, include relevant issues in the programs of educational institutions, and create regional public information centers.

Energy Efficiency, Competitiveness" is still in force, which makes it appropriate to choose this time period.

The transition from individual indicators to the determinants and criterion of energy efficiency of the national economy in the construction of the functional dependence model was made by the index method, according to which, the state of energy efficiency is characterized by a multidimensional vector of individual determinants for crude oil with condensate, natural gas (including other types of gas in gaseous and liquefied form), coal, petroleum products, peat, biomass and waste, secondary fuel and energy resources, thermal energy and electricity:

$$\overrightarrow{EE} = \left\{ d_e, d_{op}, d_c, d_{bp}, d_{col}, d_b, d_{ng} \right\} \quad (1)$$

d_e – by electricity,
d_{op} – by oil products
d_c – for coal
d_{bp} – behind the peat
d_{col} – for crude oil and condensate
d_b – by biomass
d_{ng} – by natural gas.

At the absolute level of energy efficiency, each of the determinants will have a value approaching "1", and energy dependence will be observed when the values approach "0".

The results of calculating the normative values of energy efficiency determinants and their thresholds, which determine the critical level of the overall energy efficiency indicator for the national and regional economies, are presented in Table 2.

The overall level of the national economy's energy efficiency indicator, calculated using the multiplicative convolution, is close to insufficient, and its level is half of that determined earlier according to the additive convolution (Table 3). However, the energy efficiency of the national economy under additive convolution, as well as under multiplicative convolution, is sufficient (Table 3). Additionally, the determinants for peat and natural gas are approaching the standard values, showing an upward trend.

A comparison of the results of the energy efficiency study according to the additive and multiplicative convolutions for the national economy is presented in Table 4.

Table 2. Normative assessment of the energy efficiency of the Ukrainian economy (by additive convolution)

Tabela 2. Normatywna ocena efektywności energetycznej ukraińskiej gospodarki (przez splot addytywny)

Determinants of energy efficiency	Ukraine			
	2023	2025	2030	2035
By electricity	0.210	0.240	0.260	0.280
By petroleum products	0.061	0.067	0.071	0.075
By coal	0.237	0.237	0.227	0.221
By peat	0.005	0.010	0.015	0.020
By crude oil and condensate	0.050	0.047	0.048	0.052
By biomass and waste	0.022	0.044	0.061	0.087
By natural gas	0.270	0.238	0.221	0.207
By thermal energy	0.148	0.157	0.164	0.170
By secondary fuel and energy resources	0.019	0.036	0.063	0.094
Energy efficiency of the national economy	1.023	1.076	1.131	1.205
Danger	0.256	0.269	0.283	0.301
Insufficient	0.511	0.538	0.565	0.603
Sufficient	0.767	0.807	0.848	0.904
Safe	0.920	0.968	1.018	1.085
Absolute	1.023	1.076	1.131	1.205

Table 3. Normative assessment of the energy efficiency of the Ukrainian economy (by multiplicative convolution)

Tabela 2. Normatywna ocena efektywności energetycznej ukraińskiej gospodarki (przez splot multiplikatywny)

Determinants of energy efficiency	Ukraine			
	2023	2025	2030	2035
By electricity	0.900	0.945	0.959	0.976
By petroleum products	1.000	1.000	1.000	1.000
By coal	1.000	1.000	1.000	1.000
By peat	1.000	1.000	1.000	1.000
By crude oil and condensate	1.000	1.000	1.000	1.000
By biomass and waste	0.997	0.993	0.990	0.986
By natural gas	1.000	1.000	1.000	1.000
By thermal energy	1.000	1.000	1.000	1.000
By secondary fuel and energy resources	1.000	1.000	1.000	1.000
Energy efficiency	0.896	0.939	0.950	0.963
Danger	0.179	0.188	0.190	0.193
Insufficient	0.359	0.375	0.380	0.385
Sufficient	0.583	0.610	0.617	0.626
Safe	0.807	0.845	0.855	0.866
Absolute	0.896	0.939	0.950	0.963

Table 4. Results of the assessment of energy efficiency of the national economy of Ukraine

Tabela 4. Wyniki oceny efektywności energetycznej gospodarki narodowej Ukrainy

Years	Convolution	2023	2025	2030	2035
2017	additive	insufficient	insufficient	insufficient	insufficient
	multiplicative	insufficient	insufficient	insufficient	insufficient
2018	additive	sufficient	insufficient	insufficient	insufficient
	multiplicative	sufficient	sufficient	sufficient	sufficient
2019	additive	sufficient	sufficient	sufficient	sufficient
	multiplicative	sufficient	sufficient	sufficient	sufficient
2020	additive	sufficient	sufficient	sufficient	sufficient
	multiplicative	sufficient	sufficient	sufficient	sufficient
2021	additive	sufficient	safe	sufficient	sufficient
	multiplicative	sufficient	sufficient	sufficient	insufficient

The results of the application of additive and multiplicative convolution, regardless of the quantitative difference and the adjustments made, are identical relative to the calculated normative values (Table 4). However, the additive convolution enables the consideration of the possibility of fuel substitution, taking into account the influence of individual determinants and criteria when determining the overall indicator of energy reliability and safety, and the multiplicative convolution is not exempt from the need to adjust functional dependencies at values of partial indicators close to zero.

Therefore, when studying the energy efficiency of the national and regional economy, it is advisable to use a combination of multiplicative and additive approaches.

The modernization of boiler houses, the construction of individual heat points and block mini-boilers, and the implementation of autonomous heating would enable a reduction in the losses and expenses of FER for transformation, non-energy and final consumption, which is especially relevant now during military operations with Russia.

A significant threat to energy security is the growing (increasing) deficit, the insufficient efficiency of the use of existing renewable energy sources, the low growth rates of energy production from renewable sources due to ineffective energy policy and regulatory inconsistency, and the unbalanced development of Ukraine's fuel and energy complex.

The visualized model of the organization of the process of the rational use of energy resources proposed by us enables the accelerated introduction of effective technologies and equipment, innovative energy-saving projects, the development of regional programs based on the principles of the market economy and encouraging the population to save energy resources in the industry and the housing and communal sphere, provided that investments are profitable or that costs are saved.

The incentives offered by us include: the equalization of domestic tariffs and prices for energy resources with world prices; the setting of domestic prices for energy resources at a level not lower than the costs of their production and investment costs in the modernization and

reconstruction of production facilities; the stimulation of the introduction of modern effective systems of accounting and control over the consumption of energy resources due to tariff regulation; the cessation of providing subsidies to the population to pay the cost of communal services; the provision of preferential loans to the population and enterprises for the implementation of energy-saving measures and the transition to the use of alternative types of fuel; the restoration of the "green tariff" for enterprises using alternative energy sources; the stimulation of the reduction of non-productive losses of FER due to the progressive reduction of specific norms and the increase of fees for exceeding them; the loan of condominiums for the implementation of energy-saving measures; the stimulation of competition in energy markets and strict antimonopoly regulation; the transition to prepayment for the consumption of FER for all categories of consumers due to the introduction of automatic crediting by commercial banks; the provision of preferential state financing for the implementation of energy-saving projects, which provide for the saving of energy resources and an increase in the volume of production; the cancellation of double examinations of equipment when the manufacturer (supplier) obtains permission for its use and the employer – for use in production, which leads to double costs; exemption from taxation of part of the profit obtained due to the introduction of energy-efficient and energy-saving technologies, etc.

Conclusions

A model of the organization of the process of rational use of FER has been proposed. It has been found that the organization of the process of the rational use of the national economy's energy resources is determined by the Energy Strategy of Ukraine and the tactics of ensuring energy security, which is reflected in the totality of state, branch and target regional programs on energy efficiency and energy saving. They define the main indicators by which threats and opportunities for energy security and the development of the country's energy system are monitored.

In the proposed model of organizing the process of FER`s rational use of energy resources, we combine three institutional and functional levels of organizational and legal regulation of activity in the field of energy efficiency and energy saving: national, branch and regional. Each of these is characterized by its own defined architecture and structure, which includes supervisory bodies and energy saving entities. Subjects of regulatory and supervisory activity, their functional interrelationships and influences regulated by current legislation are presented within each level.

The possibility of accelerating the introduction of effective technologies and equipment, innovative energy-saving projects, the development of regional programs based on the principles of a market economy or encouraging the population to save energy resources in the condition of profitability of investments or cost savings is substantiated. The incentives offered by us include:

the equalization of domestic tariffs and prices for energy resources with world prices; the setting of domestic prices for energy resources at a level not lower than the costs of their production and investment costs in the modernization and reconstruction of production facilities; stimulation of the introduction of modern effective systems of accounting and control over the consumption of energy resources as a result of tariff regulation; the cessation of the provision of subsidies to the population to pay the cost of communal services; the provision of preferential loans to the population and enterprises for the implementation of energy-saving measures and the transition to the use of alternative types of fuel; restoration of the "green tariff" for enterprises using alternative energy sources; stimulation of the reduction of non-productive losses of FER due to the progressive reduction of specific norms and the increase of fees for exceeding them; the loan of condominiums for the implementation of energy-saving measures; the stimulation of competition in energy markets and strict antimonopoly regulation; the transition to prepayment for the consumption of FER for all categories of consumers through the introduction of automatic crediting by commercial banks; the provision of preferential state financing for the implementation of energy-saving projects, which provide for the saving of energy resources and an increase in the volume of production; the cancellation of double examinations of equipment when the manufacturer (supplier) obtains permission for its use and the employer – for use in production, which leads to double costs; exemption from taxation of part of the profit obtained as a result of the introduction of energy-efficient and energy-saving technologies, etc.

It was determined that the strategic directions of increasing energy efficiency and realizing the energy potential of Ukraine remain the technological and structural restructuring of the economy, social infrastructure, and the creation of economic, managerial and legal mechanisms for the implementation of the state energy efficiency policy.

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Efektywność wykorzystania zasobów paliwowych i energetycznych Ukrainy: ocena, symulacja i prognozowanie

Streszczenie

Niniejsza praca koncentruje się na założeniu, że realia dzisiejszej ukraińskiej gospodarki wymagają nie tylko ożywienia, ale także zwiększenia wielkości produkcji wyrobów wytwarzanych przez przedsiębiorstwa energochłonne w przemyśle do poziomu sprzed kryzysu, który stymulowały następujące czynniki: wzrost popytu na paliwa i surowce energetyczne (FER); wzrost kosztów importowanego gazu ziemnego i ropy naftowej, który stał się nadmiernym obciążeniem dla krajowych podmiotów gospodarczych i budżetu państwa oraz doprowadził do zwiększenia zależności od geopolitycznych wpływów Federacji Rosyjskiej; osłabienie pozycji Ukrainy na światowym rynku energetycznym jako przewoźnika surowców

energetycznych; wzrost konkurencji na światowych, krajowych i regionalnych rynkach FER pod wpływem wzrostu ogólnego popytu itp.

W wyniku analizy potwierdzono, że priorytetem polityki państwa w dziedzinie bezpieczeństwa energetycznego Ukrainy będzie nadal stymulowanie wdrażania środków oszczędzania energii i poprawa efektywności wykorzystania FER poprzez przyciąganie wszelkich możliwych zachęt na wszystkich poziomach zarządzania. Zaproponowano wizualizację modelu, który umożliwi systematyczne zarządzanie procesami efektywnego wykorzystania FES; opracowano algorytm działania, który pozwoli na rozwiązywanie problemów pojawiających się w zmieniających się środowiskach zewnętrznych i wewnętrznych, upraszczając procedurę podejmowania decyzji dotyczących efektywności wykorzystania FER i zmniejszając ich specyficzne koszty.

Ocenę i prognozowanie efektywności energetycznej gospodarki Ukrainy przeprowadzono przy użyciu splotów addytywnych i multiplikatywnych, co umożliwiło prognozowanie wskaźnika efektywności energetycznej do 2035 roku zgodnie z przyjętą strategią energetyczną państwa. Ustalono, że strategicznymi kierunkami zwiększania efektywności energetycznej i realizacji potencjału energetycznego Ukrainy pozostają technologiczna i strukturalna restrukturyzacja gospodarki, infrastruktury społecznej oraz stworzenie mechanizmów ekonomicznych, zarządczych i prawnych niezbędnych do realizacji państwowej polityki efektywności energetycznej.

Słowa kluczowe: zasoby, efektywność energetyczna, model, ocena, gospodarka narodowa