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The scientific monograph presents the global trends and prospects of socio-economic development of Ukraine. General questions of economics and enterprise management, regional economics, marketing, modern management, general pedagogy and history of pedagogy, theory and methods of vocational education, general questions of historical sciences, and so on are considered. The publication is intended for scientists, educators, graduate and undergraduate students, as well as a general audience.

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THE CONCEPT OF ENERGY EFFICIENT AND ENVIRONMENTALLY SAFE COMPONENTS OF SUSTAINABLE DEVELOPMENT OF RURAL AREAS AND AGRICULTURAL ENTERPRISES

Dina Tokarchuk[1]

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Abstract. The subject of research is theoretical and applied aspects of energy management of rural areas and agricultural enterprises. The following research methods were used in the work: functional-structural analysis (for the formation of goals and objectives of the study); system analysis (to structure the conditions and key factors, the choice of methods and tools of managerial influence on energy supply); statistical (for systematization, processing and quantitative analysis of information on energy supply); graphic and tabular (to illustrate patterns and trends); monographic (for deep study of economic phenomena and processes related to energy supply of the economy in general and the agricultural sector in particular); empirical method and qualitative analysis (for the study and evaluation of practical aspects of energy management). The aim of the study is to investigate the formation of a concept of energy efficient and environmentally safe components of sustainable development of agricultural enterprises and rural areas as a hole. The results of the study showed that today the energy efficiency of rural areas and energy supply of agricultural enterprises is an important task, the solution of which should be a priority to ensure energy security at the state level. This requires structural reforms in all areas of energy policy: energy efficiency, the formation of competitive energy markets, diversification of energy supply, increasing the share of alternative energy sources and biofuels in the overall energy supply at the level of enterprises and the state.

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1. Introduction

Existing trends in rising world prices for fossil energy resources and further intensification of competition in the world market under the influence of globalization processes have made it urgent to solve the problem of energy resources supply and their efficient use. Therefore, the agricultural sector of Ukraine's economy needs an effective policy aimed at the widespread introduction of energy-saving technologies and organizational and technical measures that increase the efficiency of fuel and energy resources use.

The topical issue of providing the agricultural sector of the economy with energy resources, including renewable ones, is also gaining strategic importance. It is impossible to guarantee sustainable economic development of the country, raising of living standards, solving social problems, establishing and strengthening the economic and political authority of the country in the world community without this.

The issue of alternative energy is increasingly raised when it comes to reducing the cost of ensuring the viability of agricultural enterprises.

The share of bioenergy in Ukraine's energy balance has almost tripled in the last three years alone. Despite the significant number of publications, the issues of energy efficiency in rural areas and energy management of agrarian enterprises using biogas technologies in Ukraine remain insufficiently studied, which led to the urgency of the work.

The aim of the study is to form a concept of energy efficient and environmentally safe components of sustainable development of rural areas and agricultural enterprises.

This aim involves the following tasks:

– substantiation of theoretical principles of energy efficiency and energy supply at macro and macro levels;

– formation of methodical approaches to assessing the effectiveness of energy supply management of enterprises;

– study of the current state of energy supply of Ukraine and the agricultural sector of the economy and strategic ways to improve them.

2. Theoretical principles of energy efficiency and energy supply at micro and macro levels

Today, the definition of energy efficiency is interpreted differently around the world. According to the Law of Ukraine "On Energy Conservation" there

is a definition "energy-efficient products, technology, equipment – products or methods, means of its production that ensure the rational use of fuel and energy resources compared to other options for the use or production of products of the same consumer level or with similar technical and economic indicators" [1]. Moreover, the rational use of fuel and energy resources is defined as one that achieves maximum efficiency.

Actually, fuel and energy resources are treated as a set of all natural and transformed fuels and energy used in the national economy at the current level of development of equipment and technology with a simultaneous reduction of man-made impact on the environment. That is, the energy efficiency of the economy, according to the Law of Ukraine "On Energy Conservation" is "rational use of energy resources compared to other options for use or production of products of the same consumer level or environmental technical and economic indicators".

O.I. Tsapko-Piddubna noted in her work [2] that the mechanisms of energy efficiency policy implementation are a certain type of policy actions or market interventions that reduce energy consumption and encourage the production of energy efficient goods and services. Summarizing the experience of domestic and foreign enterprises, it should be noted that innovation in the country should be carried out through mechanisms for regulating energy efficiency and energy saving policy, including regulatory and information tools, voluntary agreements on energy efficiency and international cooperation and international commitments. Investment and innovation activities in the energy sector are related to the implementation of the basic principles of state policy on energy conservation through a system of appropriate energy efficiency mechanisms.

Energy efficiency is a criterion for the quality of the economic model of the state, coordinated interaction between economic entities, which should help to improve energy efficiency of production, as it directly affects its profitability and, consequently, their profits. The state is interested in improving the efficiency of energy use by the national economy, as it allows it to increase the tax base and reduce government spending on energy budget institutions, to increase its influence in world markets and increase energy security. Increasing energy efficiency for the population, allows to increase the level of income and reduce the cost of purchasing energy services. For society in general, this is a way to approach the level of sustainable

development, which increases the competitiveness of the region and the country as a whole.

State policy on energy efficiency should be aimed at: meeting the needs of society in conditions of both normal and special condition; technically reliable and safe operation of society's energy supply systems; economic efficiency of functioning of energy supply systems and the energy sector of Ukraine in general; energy efficiency of energy use by society and the national economy; environmentally friendly solution to the impact of energy on the environment and climate; the ability of the state to formulate and implement a policy to protect national interests regardless of existing and potential threats of internal and external nature in the energy sector.

The results of the US Department of Energy's Energy Efficiency Working Group proved that "the energy efficiency cannot be expressed by a single indicator, so there are many approaches to its definition or interpretation as a concept:

– energy efficiency is the necessary level of energy resource consumption to achieve a certain level of well-being (for example, economic, social, human life standards, the state of the natural environment and etc.);

– energy efficiency – an indicator of reverse energy intensity;

– energy efficiency is an indicator that refers to energy intensity, it is a complex system of indicators, the interpretation of which depends on the system for which it is calculated, it is important to monitor the dynamics of these indicators, as well as ensure their dynamic improvement through cost-effective mechanisms (technological renewal and the use of resource-saving technologies, and also, what is even more important, replace the basic technologies of fuel and energy resources with fundamentally new)" [3].

European Commission ("Communication on the Energy Efficiency Action Plan") identifies energy efficiency as a reduction of energy consumption without reducing the use of energy by production and equipment, i.e. it means the rational use of energy resources and alternative energy sources and reducing the overall demand for energy resources in certain areas.

Ukrainian scientists Mitrakhovych M.M., Gerasymchuk I.S., Sukhodolya O.M. [4] distinguish in detail the concepts of energy efficiency and energy saving. The concept of "energy efficiency" (national economy) means the quality of the economy, which ensures the rationality and

efficiency of energy use in accordance with the existing level of economic and cultural development, development of machinery and technology, the dominant worldview and the state development priorities. At the same time, the energy efficiency of GDP is the inverse of the energy intensity of GDP and the lower the energy intensity, the greater the energy efficiency of the country's economy.

Energy intensity of GDP is a generalizing macroeconomic indicator that characterizes the level of consumption of fuel and energy resources per unit of gross domestic product. This indicator is one of the fundamental characteristics of energy efficiency of the economy of the region and the country as a whole.

In our opinion, the conclusion of scientists [5] on the essence of these categories from the standpoint of qualitative and quantitative components is important. Thus, given the difference between the concepts of "energy efficiency" and "energy saving" it should be noted that the concept of "energy efficiency" reflects the qualitative characteristics of the national economy, and the concept of "energy saving" – the effectiveness of reducing quantitative parameters of interaction (energy consumption). The energy saving policy is aimed primarily at fulfilling the quantitative task of energy saving. Energy efficiency policy aims to achieve a quality state of the economy, which is reflected in energy efficiency, and in the initial stages requires the realization of energy saving potential.

Thus, in terms of assessing energy efficiency, economies use the energy intensity of GDP as the most adequate criterion. The energy intensity of GDP, although it reflects the relative efficiency of energy use by the country, but is not considered an absolutely accurate criterion.

The indicator of energy intensity of GDP reflects only the trends of the national economy in terms of energy use, and its dynamics tracks the selected type (energy-saving, extensive) and trends in economic development. The reason for this statement is the fact that the energy intensity of GDP is determined not only by the efficiency of energy use in production or provision of services, but also the structure of industrial production, transport system development and geographical location, climate and other factors. The importance of considering this issue is due to the fact that energy efficiency policy, aimed at shaping the quality of the national economy, goes far beyond energy saving (energy saving

policy) and includes tasks not only to realize energy saving potential at all levels, but also tasks on economic, environmental, energy policy, which allows to evolve in the context of the concept of sustainable innovation development.

Thus, based on the role of energy, fuel and energy complex as a whole in society, their direct and indirect links with the economy, the latter should be considered not only as purely industrial or technical systems, but also as part of more complex economic and socio-political systems. Therefore, they are the most important components of the integral properties of higher-ranking systems. The volume and efficiency of energy production and consumption largely determines the level of development of the country and the welfare of its population.

Human energy consumption has increased approximately 2-3 times every 30 years and continues to increase, albeit at a slower pace in the twentieth century. This gives energy a special character as a branch of the national economy, without the development of which it is impossible to solve the problem of economic development and raising living standards [3].

The key role of the fuel and energy complex in the development of all sectors of the economy and ensuring the life of society is directly related to the energy security of the country.

Energy security is guaranteed, reliable energy and fuel supply, necessary for sustainable operation on economically sound grounds of material production and social sphere in normal conditions, as well as their survival in emergencies [6].

The problems of fuel and energy resources are of particular importance for countries that do not have sufficient own energy resources. The stability of markets is also important for energy exporting countries. Therefore, it is extremely important for the sustainable development of the state to economically weigh the country's potential from the standpoint of the presence (absence) of the country. In this case, it is important to adhere to the following principles (Table 1).

Energy efficiency at the enterprise level is a characteristic of equipment, technology, production or the system as a whole, which indicates the degree of energy use per unit of final product. Energy efficiency is assessed both quantitatively (the amount of energy used per unit of final product) and qualitative (low, high) [7].

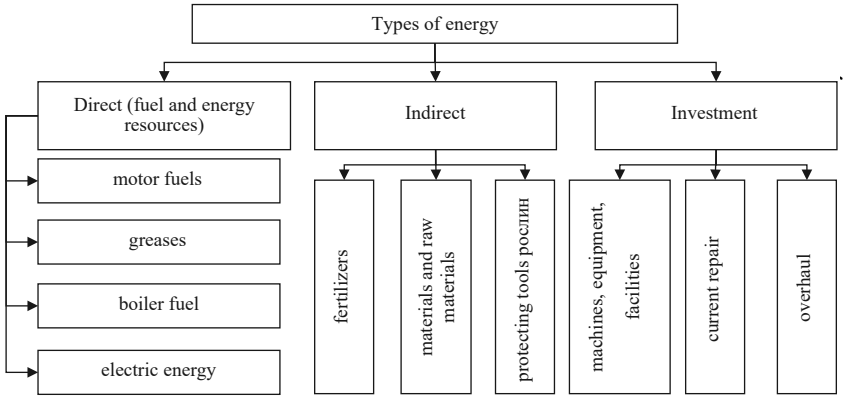

Figure 1. Types of energy used by agricultural enterprises

Source: formed by authors

This classification does not consider natural and climatic energy resources, solar energy, soil energy, etc. Determining the structure of fuel and energy resources makes it possible to identify the main ways to reduce energy consumption. At the same time, the process of efficient energy supply and rational energy consumption should be considered within the functioning of the energy management system of the enterprise.

Energy management is a process aimed at determining and implementing the optimal cost of energy resources and rational ways to achieve them. The purpose of rationalization of energy consumption must meet the following requirements: certainty, clarity, accessibility, compliance with the requirements of objective laws of economic development, compliance with the goals of the highest order [8].

On the other hand, energy saving management is a management system that ensures the operation of the business entity, which consumes only the necessary amount of fuel and energy for production [9].

A.V. Prakhovnyk, V.P. Rozen and O.V. Rozumovsky define energy management as managerial and technical activities of personnel of the facility, aimed at the rational use of energy, taking into account social, technical, economic and environmental aspects [10]. The main goal of energy management is to provide effective ways to implement energy saving strategy of the entity.

Energy management system is part of the overall management system of the enterprise, which includes organizational structure, management

functions, obligations and responsibilities, procedures, processes, resources for the formation, implementation, achievement of energy conservation policy goals [11].

In our opinion, energy management as a component of enterprise management can be interpreted as:

– management actions aimed at ensuring the effective functioning of the energy system of the enterprise and achieving its goals;

– management of the processes of distribution and use of energy resources carried out at the enterprises, providing production of the planned volumes of production (services);

– a way to make management decisions and control their implementation, ensuring the efficient use of energy resources.

The tasks to be solved in the energy management system include: determination of specific goals of energy use of the enterprise; identification of priority of energy use goals, their sequence; formation of the energy strategy of the enterprise; determination of the necessary resources and sources of their provision for the implementation of the energy strategy; establishing control over the implementation of tasks.

In order to formulate management tasks, it is necessary to define the following components: the object of management, the purpose and criteria of management, management influences, constraints on the management process, uncontrolled influences on the object: management tools.

The object of management is the enterprise as a whole, its individual divisions, fuel and energy units (FiEU), as well as the personnel of the enterprise, whose activities are related to the efficiency of energy use, operation, repair and maintenance of equipment. The considered object belongs to the number of complex systems, therefore for its description it is necessary to use not one, but several representations depending on character of the solved problems.

Among the most common representations of this object are:

1. Block diagram of the enterprise, which shows the units of input and output of energy resources (transformer substations, gas distribution points, steam and hot water pipelines), divisions of the enterprise, the largest fuel and energy units, as well as devices for metering and supply of energy resources.

2. Schemes of material flows of the enterprise (flows of energy, raw materials and finished products), which should be presented as oriented graphs, arcs of which are material flows, and devices for their use are the nodes, processing and transportation and storage.

3. Schemes of factory-wide energy and water supply systems, in particular heating, steam supply, gas supply, water supply, electricity supply, air supply, etc.

4. List of the largest FiEU units.

The process of managing energy consumption in an agricultural enterprise is subject to certain restrictions. In the general case, it is necessary to take into account the restrictions of the following nature: planning and production; financial; environmental; technical; regulatory.

The main limitation of the planning and production nature is the actual level of load of the enterprise, which is determined by the availability of product orders and sales. Financial constraints, as a rule, do not allow to fully realize the potential of energy saving at the enterprise, so specific calculations must be performed based on a certain limited amount of funding for energy saving measures. Environmental requirements are imposing stricter restrictions on the volume and chemical and physical composition of products of fuel combustion, water pollution and solid waste, which are inevitable companions of almost any production. As a rule, environmental limitations are an additional incentive for the effective use of energy resources. Technical limitations may be related to compliance with safety and reliability requirements. Management tools include administrative-organizational, technical and program-methodical. Administrative and organizational tools include organizational schemes, orders, job descriptions, provisions on financial incentives for employees and departments, as well as training measures. The technical ones include the following: measurement of computer technology, information transfer, automation of energy and technological processes.

So we can conclude about the importance of energy resources as a driving force of economic development in general and the agricultural sector in particular. Provision of them and their rational use is the key to successful and efficient operation of agricultural enterprises.

3. Methodical approaches to assessing the effectiveness of energy supply management of enterprises

Solving the energy problem, overcoming the energy dependence of Ukraine's economy is closely linked to the successful modernization of the energy supply system, which is considered an integral part of the restructuring of the national economy [12]. One of the prerequisites for the successful implementation of any strategy, including the strategy of energy supply of the enterprise, is a convincing justification for the need for changes in the implementation of this strategy. Management of the strategy implementation process is considered successful if the company achieves strategic goals, planned values of strategic indicators and generally implements a long-term strategic plan.

The development of the strategy of energy supply management of an agro-industrial enterprise should be preceded by an assessment of the quality of management of the enterprise in general and its energy subsystem in particular [9].

In modern economic conditions, rapid changes in the environment, exacerbation of external factors, including macro-level factors, on the level of energy security of enterprises require the construction and operation of quality energy management systems, as it affects the efficiency of these enterprises, their competitiveness and viability. A great role is given to the practical solution of a set of issues of organization, methodology and implementation of new approaches to assessing the quality of energy management system of the enterprise in fulfilling this task, especially in the strategic context.

In determining the purpose and program of analysis of the energy management system the next is taken into account: the essence of the problem to solve which is the analysis (increasing the level of energy security and energy efficiency of the enterprise); features of the object under analysis (energy systems of the agro-industrial complex); availability of a base of comparison (use of foreign experience of energy supply of enterprises or experience of advanced enterprises in the industry); the reality of providing the necessary information; methodological support of analysis; performers of analytical work (personnel and technical support); deadlines, etc.

The results of the analysis are the basis for assessing the materiality of the managerial impact on the performance of the managed object, i.e. the energy supply system of the enterprise, as well as the basis for tactical and

strategic measures to improve management to ensure strategic direction and increase the effectiveness of energy supply management [13].

It should be noted that the efficiency of energy supply management of an agro-industrial enterprise is influenced by both internal and external factors. Of course, the quality of management will be largely determined by the effectiveness of the energy security system formed in the enterprise.

When assessing the effectiveness of energy management of the enterprise, it is impossible to ignore the innovation and investment components of the development of the energy system of the enterprise. I.G. Gurnyak and Z.V. Yurynets even introduce such a concept as "innovative potential of energy saving", which is interpreted as the ability of management to "develop innovative activities for the implementation of projects for technological modernization of enterprises to reduce energy consumption, due to requirements for reliability and energy security" [14]. The use of alternative energy sources is relevant in modern conditions, as noted above, especially for agro-industrial enterprises, which is impossible without the intensification of innovation and investment activities. Thus, the criterion of innovation and investment activity of the enterprise should be used to assess the effectiveness of energy supply management system of the enterprise.

In our opinion, the assessment of the effectiveness of energy supply management is advisable to do on the basis of analyze of the dynamics of the three-component quality indicator of energy supply management, which takes into account such components as internal energy security, the level of threats to the external environment to the energy security of the enterprise, which is expressed by the degree of risk of adverse scenarios of events in the energy market and the level of innovation and investment activity of the enterprise in the field of energy saving.

The three-component indicator of quality assessment of energy supply management of an agro-industrial enterprise is proposed to be determined by functional dependence according to the formula:

$$KES\ P = f\ (B, Z, I) \quad (1)$$

де B – the internal assessment of the level of energy security of the enterprise;

Z – the level of threats to the external energy security of the enterprise;

I – the level of innovation and investment activity of the enterprise in the field of energy saving.

The given three-component complex indicator of an estimation of quality of management of power supply of the enterprise is defined on functional dependence:

$$B, Z, I = 1 \quad (2)$$

if the actual value of indicators *B, Z, I* is greater than or equal to their limit value (sufficient or desired), the value of the indicator is considered sufficient, i.e. the quality of management is satisfactory;

$$B, Z, I = 0 \quad (3)$$

if the actual value of indicators *B, Z, I* is less than their limit value (sufficient or desired), the value of the indicator is considered insufficient, i.e. the quality of management is unsatisfactory [13].

As sufficient or desirable values of indicators in assessing the level of efficiency of energy supply management of the enterprise values can be used that are identified through the study of progressive foreign experience, industry averages, indicators of leading companies in the field of energy saving, indicators defined as strategic guidelines for enterprise.

The energy security system of the enterprise, as mentioned above, is characterized by the complexity and diversity of phenomena and requires the study of a large number of indicators. In such conditions, the level of energy security of the enterprise can be assessed using a set of indicators based on such characteristics as stability, maneuverability, flexibility, reliability, efficiency, controllability.

To determine the basic indicators of the internal component of energy security of the enterprise, we use the list proposed by V.O. Samborsky [15], from which we exclude those indicators, that characterize the level of threats to the external environment to energy security of the enterprise (Table 2).

In the system of energy security assessment, indicators are divided into stimulants, i.e. have a direct impact on strengthening the energy security of the enterprise (for example, self-generation indicator), and disincentives, which have the opposite effect on security (for example, energy component indicator in costs). This means that the higher the level of the disincentive indicator or the higher the rate of its growth, the lower the level of security of the enterprise.

Table 2

Indicators of the internal component of energy security of the enterprise

Indicator	Characteristic
1. Indicators that characterize the state of energy supply and use	
1.1. Indicator of the level of energy losses in the networks of the enterprise	The ratio of the amount of lost energy in the enterprise network to that received from the energy supply organization
1.2. Indicator of the amount of energy supply to the enterprise	The ratio of the actual amount of energy received per month to the planned (declared)
1.3. Indicator of specific energy consumption of products	Indicator of specific energy consumption of products
1.4. Indicator of the level of payment for energy consumption	The ratio of the amount of payment by the enterprise for energy consumed to the amount issued by the energy supply organization
2. Indicators that characterize the structure of energy resources of the enterprise	
2.1.Depreciation indicator of fixed assets of the enterprise that produces and consumes energy	The ratio of the amount of accrued depreciation to the original cost of fixed assets
2.2. Price balance indicator	The ratio of the price index for enterprise products to the energy price index for the period
2.3.Indicator of the energy component in costs	The share of energy costs in the total costs of the enterprise
3. Indicators characterizing the use of energy-saving technologies	
3.1. Self-generation indicator	Share of own generation and secondary sources in total energy consumption
3.2. Indicator of efficiency of energy saving activity	The ratio of enterprise profits to the cost of energy saving measures
3.3. Wear indicator of power equipment of the enterprise	The ratio of the cost of wear of energy equipment of the enterprise to its original cost
3.4. Indicator of the share of costs for energy saving measures	Indicator of the share of costs for energy saving measures
3.5.Indicator of specific CO_2 emissions per unit of output	The ratio of CO_2 emissions to total output

Source: [12]

The next step in diagnosing the level of energy security of the enterprise is to control the compliance of indicators with limit values. Therefore, it is necessary to carry out the procedure of rationing of these indicators using their limit values (normative or desirable).

The rationing of stimulus indicators according to their threshold level is as follows:

$$y_{ij} = \frac{x_y}{x_{e(n)}}, \tag{4}$$

where y_{ij} – the normalized *i*-th indicator in the *j*-th population;

$x_{e(n)}$ – the limit value of the indicator.

The rationing of disincentives according to their threshold level is as follows:

$$y_{ij} = \frac{x_{e(n)}}{x_y}. \tag{5}$$

The rationing of indicators that characterize the level of energy security of the enterprise by the limit values makes it possible to assess the level of effectiveness of management of safety parameters.

The regulatory level will be characterized by zero deviations, i.e. at this level of management efficiency, all indicators that characterize the level of energy security of the enterprise will meet their limits or be better than them. In the absence of generally accepted or industry normative values, the best indicators in the industry or at the given enterprise for a number of years are accepted as the last [16].

The integrated indicator of energy security is determined as follows:

$$I_{ЕБ} = \sum_{i=1}^{n} K_i \times k_{bi} \tag{6}$$

where K_i – the average level of the indicator for the *i*-th group of energy security indicators;

k_{bi} – the weighting factor of the *i*-th group of energy security indicators, determined by experts.

The level of threats to the external energy security of the enterprise can be determined by expert methods or using indicators, such as:

– indicator of the state of the energy balance of the region (the ratio of energy produced or extracted energy resources in the region to that consumed);

– indicator of reliability of energy supply (characterizes the share of restrictions on energy supply in the volume of consumption);

– indicator of the quality of energy supply to the enterprise (relative difference between actual voltage and rated voltage, between actual heat dissipation and rated heat dissipation, etc.);

– indicator of growth of energy tariffs (the ratio of the average energy tariff for the previous period to the current value of the tariff), etc. [16].

The level of innovation and investment activity of the enterprise in the field of energy saving can be assessed by the following indicators:

– indicator of investment activity (the ratio of the amount of investment in energy saving to the amount of net profit of the enterprise);

– indicator of innovation activity (share of expenditures on innovations in the field of energy saving in the total amount of expenditures on energy saving measures);

– indicator of efficiency of investment activity (ratio of savings on energy costs to costs of energy saving measures);

– indicator of efficiency of innovative activity (ratio of saving of expenses on energy resources to expenses on innovations in the field of energy saving), etc.

Analytically processed material obtained during the assessment of the level of efficiency of the energy supply system management of the enterprise, it is advisable to use to identify advanced methods and "bottlenecks" in the management process; development of plans for the development of the management system taking into account the priority areas and the real capabilities of the enterprise; finding out the reasons for inconsistencies and identifying reserves to improve the efficiency of management of the energy supply system of the enterprise; diagnostics of prospects of development of energy supply system of the enterprise and its separate elements.

The application of the proposed methodological approach to assessing the level of efficiency of energy supply management of the enterprise will form an analytical basis for developing an energy supply strategy aimed at improving both energy efficiency and overall efficiency of the enterprise.

4. The current state of energy supply of Ukraine and the agricultural sector of the economy and strategic ways to improve them

The efficiency of fuel and energy resources use in the economy of any country and international comparisons are based on the energy intensity of gross domestic product (GDP). This indicator is determined in kilograms of oil equivalent per $1,000 of GDP. According to the State Statistics Service of Ukraine and the Ministry of Energy, Ukraine has a tendency to reduce the energy intensity of GDP, but , this indicator is quite high being compared to other countries. According to 2020 data, the energy intensity of Ukraine's GDP exceeds the energy intensity of Germany's GDP 4 times, Poland's – 3.2 times, the United States' – 2.8 times, China's and Russia's – 1.8 times, Italy's and Spain's – 4.8 times, Switzerland's – 6.5 times [17].

High energy intensity of GDP inhibits the growth of the country's economy, makes domestic goods and services more expensive and, of course, less competitive. The National Energy Efficiency Action Plan, approved in November 2015, envisages a 9% reduction in Ukraine's energy intensity by 2020. At the same time, Eastern European countries plan to reduce the energy intensity of GDP by 20% over the same period, the United States – by 25%, China – by 33%, Russia – by 40% [18].

About 24% of oil was extracted since Ukraine's initial geological reserves. Due to the fact that a significant part of the explored reserves are heavy to extract, almost 800 million tons of oil reserves remain in the subsoil and can not be extracted by traditional technologies. Great hopes are placed on the waters of the Black and Azov Seas, where unexplored oil reserves with condensate are estimated at 220 million tons. The depth of oil refining at domestic plants is 52-54%. This indicator exceeds 80% in the EU for comparison. Thus, Ukrainian oil refineries are not competitive enough in modern conditions. Their technological base is not able to provide the country with high quality petroleum products in the required volumes. To change the situation for the better, it is necessary to harmonize production with market needs. This requires significant investment [19].

The peak of oil and natural gas production in Ukraine was in 1970–1975. Subsequently, there was a sharp decline in production to 4 million tons of oil and 18-20 billion m^3 of natural gas per year. Since 1995, there has been a stabilization and some increase in production rates.

Providing Ukraine's economy with energy resources is shown in Table 3.

Table 3

Providing Ukraine's economy with energy resources

Type of fuel	2016	2017	2018	2019	2020	2020 to 2016, +/-
Providing Ukraine's economy with its own energy resources ,%						
Coal & peat	68.3	51.3	51.3	52.2	53.6	-14.7
Grude oil	6.9	6,6	7.0	7.4	7.4	0,5
Oil products	0	0	0	0	0	0,0
Natural gas	45.3	46.2	49.2	48.7	47.4	2,0
Production , thousand tonnes of oil equivalent						
Coal & peat	22869	13696	14556	14446	12753	-10116
Grude oil	2304	2208	2341	2478	2476	172
Oil products	0	0	0	0	0	0
Natural gas	15175	15472	16487	16318	15856	681
Total production	40348	31376	33384	33242	31085	-9263
Import, thousand tonnes of oil equivalent						
Coal & peat	10617	12993	13806	13239	11036	419
Grude oil	527	1331	1333	1341	1815	1288
Oil products	9155	9520	10155	10383	10204	1049
Natural gas	8809	11262	8459	9506	7386	-1423
Total import	29108	35106	33753	34469	30441	1333

Source: formed by the author according to [20]

The main factors that determine the high energy intensity of production and life in Ukraine include: inefficient and wasteful consumption of energy resources, in particular, due to non-compliance with current requirements for technology and equipment; obsolescence of fixed assets and communications and unsatisfactory pace of their renewal; significant losses of energy resources, especially natural gas, heat and electricity during their transportation, storage and distribution; low level of introduction of energy efficient technologies and equipment (introduction of new technological processes, in particular, low-waste, resource-saving and non-waste, is carried out by no more than 3% of the total number of industrial enterprises); significant technological lag of Ukrainian industry from the level of developed countries; high level of depreciation of fixed assets in the economy (74.9%) and a corresponding increase in the specific costs of energy resources for the production of a number of important products in the

most energy-intensive industries; insufficient use of industrial processing of waste, in particular solid household waste.

According to the Energy Trilemma Index [21], calculated by the World Energy Council (WEC), Ukraine in 2020 ranked 50th among 108 countries. The WEC index is based on a comparative analysis of the energy situation in the country and is based on three factors: Energy Security, Energy Equity and Environmental Sustainability. Depending on the success in each direction, the country is assigned a rating from A to D. Ukraine's rating is ACB. According to the compilers of this rating, the worst thing in Ukraine is with the environment, as well as with the overall efficiency of the industry. Switzerland became the leader of the WEC ranking. In addition, Sweden, Denmark, France, Austria, Great Britain, Canada, Norway, New Zealand and Spain were in the top ten in terms of energy resistance index. Only eight countries received the highest AAA energy resilience rating – Switzerland, Denmark, Austria, the United Kingdom, France, Germany, New Zealand and Italy.

Exceeding the energy intensity of the Ukrainian economy by three or four times the corresponding indicators of economically developed countries makes Ukraine extremely sensitive to the conditions of natural gas imports and makes it impossible to guarantee normal living conditions for citizens and public institutions.

The main factors that hinder the current decline in energy intensity of GDP are: high degree of physical depreciation of fixed assets and technological backwardness in the most energy-intensive industries and housing and communal services; inefficiency of natural monopolies; high level of energy losses during their transmission and consumption; limited incentives to reduce energy consumption in the absence of meters; low level of introduction of energy efficient technologies and equipment both in industry and among the population.

There is no doubt that without the modernization of the economy on an energy efficient basis in Ukraine there are no prospects. Reducing the energy intensity of the economy should become one of the priority goals of the state policy of our country.

Becoming a full member of the European Energy Community in 2011, Ukraine has committed itself to implementing relevant EU decisions in the energy sector: developing and bringing into line European regulatory

framework, creating an integrated energy market and legislation to strengthen energy security, attracting investment, improving the environment, etc.

Ukraine has adopted a number of Laws: "On the Electricity Market", "On Heat Supply", "On Combined Heat and Electricity Production (Cogeneration) and Use of Waste Energy Potential", "On Energy Conservation", "On Housing and Communal Services", "On alternative energy sources", "Energy Strategy of Ukraine until 2035", which regulate the operation of electricity and heat supply systems.

In pursuance of Directive 2010/75/EU on industrial emissions in 2017, the Cabinet of Ministers of Ukraine approved a National Plan to reduce emissions from large combustion plants [22]. Also, the energy equipment of countries that are or aspire to become members of the European Union must meet the requirements of the European Directive 2012/27/EU on energy efficiency, which recommends the introduction of high-efficiency cogeneration to dispose of waste heat generated in electricity generation [23].

Relevant regulatory measures are being taken by EU countries to implement these directives. Examples of such regulatory measures taken in European countries at the level of central government are:

– adoption of the Federal Law (Germany) on cogeneration, which guarantees thermal power plant owners a surcharge on the price of cogeneration from 0.56 cents per kWh to 5.11 cents per kWh, depending on the year facilities, degree of modernization and size of the installation, as well as the technology used);

– exemption of the power plant from paying the environmental tax on fuel used for combined electricity generation;

– exemption from the environmental tax of own electricity consumption of thermal power plant.

In order to resolve the crisis in the energy system of Ukraine, the Ministry of Energy approved a new Forecast Energy Balance on April 28, 2020. Energy balance involves a proportional reduction in electricity production by all types of generation: nuclear, hydro, thermal. The forecast growth of generation from renewable energy sources has also been adjusted. The share of thermal power plant production, which performs the function of providing heat supply during the heating season, has remained almost unchanged.

The new balance is aimed at:

– Ensuring a safe schedule of nuclear power plants. In conditions of falling demand, the power units of nuclear power plants cannot operate at maximum constant load throughout the day. Until recently, NEC "Urenergo", which performs scheduling functions, was forced to unload them at night, as well as on weekends and holidays. Experiments with regular changes in the load of nuclear power units are extremely dangerous. Therefore, together with the representatives of NNEGC "Energoatom" and NEC "Ukrenergo", the optimal generation rates of nuclear power plants were proposed for the safe operation of nuclear units.

– Ensuring the implementation of delayed repairs of power units of nuclear power plants. In the last 5 years, NNEGC "Energoatom" has been faced with maximum tasks in the production of electricity, which forced the state-owned company to postpone some repairs. Taking into account the service life of Ukrainian nuclear power plants, all delayed repair works must be completed in 2020 so that NNEGC "Energoatom" can continue to fulfill its social obligations under the PSO mechanism during the heating season 2020/2021.

– Ensuring reliable operation of the country's energy system. An important element of the power system is to ensure sufficient balancing power. Recently, due to falling consumption as well as low water levels for hydropower plants, the available amount of shunting power has been critically low. This threatened the emergence of accidents during periods of change in the daily phases of consumption. In particular, according to NEC "Ukrenergo", the gap between the evening peak and the night fall has increased from 4 to 4.8 GW in recent days.

– Ensuring the sustainable operation of the coal sector. Due to the crisis of the industry, warm winters, increased coal imports and the emergence of electricity imports. Consumption of Ukrainian coal was almost non-existent. As a result, a record amount of coal is stored in coal depots, most of the mines have been shut down, about 40,000 miners are in forced downtime, and tens of thousands of families have lost more than half of their income. The coal industry is one of the most important elements of Ukraine's energy independence and therefore it is extremely important to ensure the smooth operation of domestic coal companies [24].

The introduction of an updated Forecast Energy Balance is the first step in overcoming the energy crisis. In its next anti-crisis steps, the Ministry of Energy plans: to reform the PSO system in order to provide NNEGC "Energoatom" with greater opportunities to participate in market segments, to obtain market value for its own electricity; to solve the problem of increasing RES and the burden on SE "Guaranteed Buyer" "green tariff"; to solve the problem of debt in the electricity market and stabilize the work of all its segments.

Providing agro-industrial enterprises with energy resources remains an important issue. Of the total amount of direct energy resources, the agro-industrial complex annually consumes: natural gas – 4.1 billion cubic meters (6% of national gas consumption), including agricultural enterprises – 0.7 billion cubic meters, food industry – 3.5 billion cubic meters of gas; electricity – 4.97 billion kW·hours (4% of national electricity consumption), including agricultural enterprises – 2.85 billion kW·hours, food industry enterprises – 2.12 billion kW·hours; oil products – 1.4 million tons of diesel fuel and 400 thousand tons of gasoline [20].

Thus, we can conclude that the agricultural sector of the country's economy is one of the main consumers of fuel and energy resources. The share of fuel and energy resources in the cost of agricultural products is quite significant (exceeding 12% in the agricultural sector as a whole and 17% in crop production). Moreover, it is constantly rising following rising oil prices. This is in line with global trends.

With the proclamation of Ukraine as an independent state, the use of fuel and energy resources by the agro-industrial complex has decreased (more than twice). This is due to the reduction of sown areas compared to 1990 (almost 20%), technological operations in crop production, truck fleet (from 296 to 133 thousand), tractors (from 495 to 201 thousand) and combines (from 107 to 44 thousand), the reduction of the volume of livestock production, the use of resource-saving technologies, as well as a more careful attitude to the use of energy resources. This has led to some improvement in the efficiency of energy use in the agricultural sector of the country's economy.

The range of fuel for tractor engines on the territory of Ukraine is large. This is due to the fact that with the advent of independence, domestic fuel standards have emerged, while the standards of the Soviet era are in force,

which usually have international status within the CIS countries. In addition, a large amount of fuel is imported from post-Soviet and Eastern European countries (almost 30% of the total), because Ukraine cannot provide for itself due to lack of raw materials (oil).

There has been a slight increase in the amount of diesel fuel used in recent years. This is due to the fact that tillage, sowing and harvesting works use agricultural machinery, which works mainly on diesel fuel. As the gross output of agriculture increases every year, the consumption of diesel fuel by the agricultural sector of the economy is growing accordingly.

According to scientists from the Institute of Agrarian Economics (Ukraine), agricultural enterprises have reduced the use of motor gasoline as a whole and for agricultural work by 12 times compared to 1990.

This was facilitated by three main factors: 1) savings of agricultural enterprises based on the principles of private property, due to radical changes in the attitude to their own costs and reducing the cost of production; 2) development of the practice of involving in recent years in the performance of transport works of third-party organizations, rather than their performance by the enterprises themselves: 3) the spread of the trend of selling the crop on a free-tick, free-elevator, sometimes – free-field. In this case, the transport costs are paid by the buyers of agricultural products.

Table 4

Final energy consumption in Ukraine and in its agriculture, forestry and fishing for 2016–2020

Indicator	2016	2017	2018	2019	2020	2020 to 2016, +/-
Total final energy consumption, thsd. toe	51649	49911	51408	49665	47821	-3828
Agriculture, forestry and fishing, thsd. toe	2143	1847	1880	1882	1671	-472
% of total	4.1%	3.7%	3.7%	3.8%	3.5%	-0.6 p.p.

Source: formed by the author according to [20]

The consumption of fuel and energy resources per 1 hectare of agricultural land has also decreased in 4 times over the last twenty years. Significant increases in fuel prices for both motor gasoline and diesel fuel

(Figure 2) and the development of new forms of ownership have led to increased efficiency in the use of energy resources in agriculture.

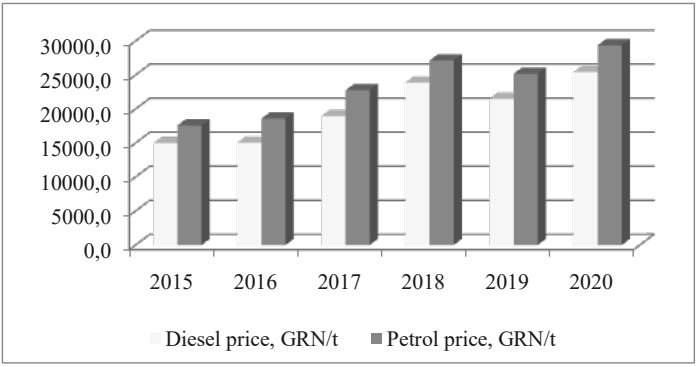

Figure 2. Purchase price of diesel fuel and gasoline by agricultural enterprises of Ukraine, 2015–2020

Source: formed by the author according to [20]

The main difference between gasoline and diesel fuel, which are produced in accordance with domestic standards and specifications, from similar products in the EU and the Russian Federation – is a higher (from 30 to 400%) concentration of lead and sulfur (up to 100%), which negatively affects on environmental performance and engine life. But it should be noted that the production of cleaner fuels is more expensive. The state adjusts their competitiveness by the amount of excise duty. Ukrainian oil refineries produce fuel of weighted fractional composition (UFS brands and others). Its use leads to deterioration of technical, economic and environmental performance of diesel engines. The results of operational experience indicate negative consequences: the specific fuel consumption increases (by 2-4%); costs for maintenance of fuel filters increase (almost 2 times); the service life of engine oils and engine life is halved; smoke (10-15%) and sulfur oxide emissions increase.

Natural gas is a resource on which the well-being of Ukrainians depends. However, obtaining this resource is not easy. Hydrocarbon production requires considerable resources and time. In addition, the situation on the world energy market makes us think about when it is more profitable to

increase production. Natural gas production in Ukraine in 2020 amounted to 20.2 billion cubic meters, which is 1.9% less than in the previous year. Over the past six months, gas prices in Europe have fallen by about 50%. This is one of the sharpest falls in the last decade. The main reason is the increase in the volume of American gas on the European market.

Natural gas is consumed by agricultural enterprises as an energy source and in the technological processes of crop and livestock production. A significant consumer of this type of fuel are elevators, which use it in the process of drying grain. Elevator gas consumption has some nuances. First, it is seasonal and limited to September-December. Second, it is difficult to predict because it depends on factors such as weather. It is in the latter that the biggest nuance lies, as in March 2019 Ukraine switched to daily balancing of natural gas consumption. At the end of April 2019, LNZ Group received a license to supply natural gas in Ukraine and intends to occupy 50% of the market of natural gas consumers in agriculture [25].

The growing use and cost of petroleum fuels and natural gas, on the one hand, and their limited reserves, on the other, have led to intensive searches for new unconventional fuels (alcohols, methyl esters of plant oils, plant oils, biogas, etc.).

5. Conceptual provisions of the strategy of energy efficient and environmentally friendly development of rural areas

General principles, purpose, tasks of the Strategy.

Today, Ukraine has chosen a model of sustainable development, according to which all vectors of socio-economic development are aimed at a harmonious combination of a growing economy with minimal impact on the environment. However, a large number of both socio-economic and environmental issues remain unresolved.

The purpose of the Strategy is to solve current socio-environmental problems of Ukraine, as well as to implement the priority areas of sustainable development of rural areas, namely – energy efficiency and environmental security.

Strategy objectives include:

– determination of directions of waste management at the level of rural areas (communities), which will provide for their energy use to improve the environmental performance of territories and energy supply;

– development and substantiation of the technical and economic basis for the production and efficient processing of organic raw materials, as well as the efficient use of alternative fuels and renewable energy sources in the framework of energy autonomy of rural areas;

– development of energy cooperation in rural areas as a direction of ensuring energy security of rural areas.

Principles of Strategy development:

– hierarchy of waste management of agricultural enterprises, which provides actions for waste management in the following sequence: preparation for reuse; processing of waste in bioreactors with biogas production; use of recycled waste as biofertilizers;

– a precautionary measure stating that, if there is evidence of environmental risk, appropriate precautions should be taken;

– minimizing the impact of the strategy on the environment, which implies that companies will use biofuels as energy, which is more environmentally friendly;

– self-sufficiency, which provides for the creation of an integrated system for meeting the energy needs of rural areas, which will allow it to ensure independent production of energy resources and their consumption.

A brief overview of the problems of rural areas.

Table 5 summarized and specified the main problems of rural areas, as well as areas for their solution in the effective implementation of the model of sustainable development, which have already been studied and covered by domestic scientists.

The most pressing problems of rural development include the organization of rational nature management, energy consumption with minimal negative impact on the environment, careful use of energy resources with reasonable and sufficient satisfaction of technological and household needs of citizens in all types and forms of energy.

Strategic goals and ways to achieve them.

Strategic goal 1. Organization of processing of agricultural waste into biofuels: solid (briquettes, pellets) or biogas.

The attention to the issues of rational waste management in Ukraine by both the authorities and scientific circles has significantly increased in recent years. The solution to the problem is possible through the implementation of effective measures for rapid, safe recycling of waste and obtaining a

Table 5

Comparison of the main problems of rural areas with the goals of sustainable development of rural areas

Modern problems of rural areas	Goals of sustainable development of rural areas
1	2
Lack of adapted education for sustainable development. Lack of motivation and social support for the formation of a modern specialist who is capable of active action, independent decision-making, flexible adaptation to changing conditions and needs of his rural area	Creation and implementation of regional policy, which provides for an effective system of government and administration in the center and in the regions, financial, economic and regulatory support based on the optimal combination of national, regional and local interests
Lack of an effective management system to ensure environmental quality and environmental management.	Reorientation of structural elements of the production potential of the territory and used resources to comply with environmental restrictions (reduction of external damage), development of resource-efficient production and consumption, organization of a stable monetary and financial system, cooperation in the world economic system. relevant institutions and infrastructure on the basis of harmonization of needs for growth and preservation of the environment, taking into account the interests of the parties regarding economic security
Tensions and deteriorating demographics; lack of quality and skilled labor; reduction of social infrastructure and, as a consequence, reduction of accessibility of social and cultural institutions; constant self-liquidation of rural settlements	Increasing the competitiveness of human capital and social development; limited sustainable economic growth based on innovation, taking into account the interests of future generations; environmental sustainability or minimization of environmental risks
Declining employment of the rural population, as a result of which many of the most able-bodied and skilled villagers work only on homesteads, run their own small-scale production or go to work in large cities or abroad.	Stable development of rural settlements and inter-rural areas in terms of increasing agricultural production, increasing the efficiency of agriculture, achieving full employment of the rural population and improving its living standards, rational land use
Wage arrears, unfavorable working conditions and non-compliance with safety, irregular working hours, non-compliance of jobs with sanitary and hygienic standards, lack of social guarantees	Growth, diversification and efficiency of the rural economy, stabilization of the population and increase in life expectancy, full and productive employment of the working population, improving the level and quality of life in rural areas, rational use and reproduction of their natural resource potential

Source: formed by author according to [26]

positive economic and environmental effect from the disposal and reuse of raw materials. Incineration and disposal are among the most commonly used methods of waste disposal in modern conditions As combustion is a rather expensive and dangerous process for the environment, the use of biomass to generate heat and electricity is quite promising today. According to the Law of Ukraine "On Alternative Fuels" biomass is a "biodegradable substance of organic origin that undergoes biodegradation (waste from agriculture (crop and livestock), forestry and technologically related industries, as well as the organic part of industrial and household waste".

At the same time, waste accumulation is increasing day by day with increasing population and consumption, which has a direct negative impact on the environment and the economy. Organic waste from agriculture poses a significant threat to the environment and the population [27]. Thus, the management of organic waste is very important given the growing demand for energy and the deteriorating environmental situation [28].

For the successful implementation of these documents, it is necessary to develop regional waste management plans in order to adapt national policies to the scale of regions and the needs of communities. A special place in the effective areas of waste management in the Strategy and National Plan is their use for energy production, as it is a way to energy-independent communities and reduce energy dependence of Ukraine. Agricultural waste and household waste have significant energy potential.

Of interest from the point of view of biofuel and energy production are wastes from both crop and livestock industries [29-31], taking into account the potential of agricultural enterprises and households, as they can be shared in the implementation of bioenergy projects at the community level.

Obtaining biogas from agricultural waste makes it possible to partially solve a number of problems facing the country's agro-industrial complex: economic – increasing the competitiveness of agricultural products by reducing energy costs in its production; energy – own fuel production, ensuring energy independence of agricultural enterprises; agrochemical – obtaining environmentally friendly fertilizers; ecological – utilization of organic waste that harms the environment; financial – reducing the cost of disposal of organic waste and the purchase of traditional energy, social – creating new jobs.

The use of biogas for energy production displaces the use of fossil fuels and thus helps to reduce emissions of greenhouse gases and other pollutants.

Strategic goal 2. Creating efficient systems for the use of alternative energy sources in rural areas

Territorial communities, especially in rural areas, have significant prospects for the introduction of renewable energy technologies. After all, the development of RES leads to the creation of jobs at the local level and the involvement of both men and women in various professions, the development of social infrastructure [32].

The range of renewable energy sources that can be obtained and used in rural areas is quite wide [33].

– Solar energy. The global success of the solar industry is due to many factors. One of them is the leadership in the cost of electricity generated, which continues to improve endlessly. Another is universality: solar energy covers a wide range of electricity consumption at various levels – from very small housing systems to large enterprises, from individual stand-alone systems to integrated solar solutions in apartment buildings or agricultural greenhouses. There are also mobile photovoltaic systems and stand-alone solutions for rural electrification. More and more attention is paid to non-network systems – small photovoltaic installations, autonomous systems and mini-networks. These will also be GW-scale markets with double-digit growth rates in the coming years. Finally, no other power plant can be designed and built as quickly as any solar photovoltaic plant.

– Wind energy. Most wind farms under construction in Ukraine are mostly large and provide electricity to entire settlements. The capacity of the Overyanivsk wind power will be enough to provide electricity to 44,000 households, and the average capacity of new wind turbines commissioned in the first half of 2021 is 3.8 MW. But along with large wind farms also use small-generation wind turbines up to 10-20 kW. They can be used to provide electricity to small communities, making them energy independent.

– Bioenergy. In many countries around the world there is a real boom in fuel production from bioresources. There is also a growing interest in the use of non-traditional energy sources by government, business and academia, as well as by agricultural producers in Ukraine.

It is especially important to study the possibilities of using non-traditional and alternative energy sources in agriculture and in the agro-industrial complex as a whole, as such sources are available in Ukraine and

their use is still minimal (1-2% of the total energy balance). A special place in the structure of possible alternative sources of energy is occupied by biomass, the potential of which in Ukraine is quite large, but not yet fully understood, which forms a wide field for research in this area.

From the ecological point of view, bio-production in the agro-industrial complex will reduce greenhouse gas emissions, increase soil fertility and improve water quality, as well as contribute to the gradual revival of biodiversity. However, it is always necessary to compare the economic efficiency of energy and food use of agricultural products. It is obvious that the production of biofuels is not always an effective direction of its use, especially for countries that have problems with food security. Rising energy prices and growing demand for agricultural products from the food, feed and energy industries will determine the level of prices for energy products such as grain, oilseeds, sugar beet roots and related products – bard, meal, husks. molasses, pulp, etc.

This problem is quite difficult, because on the one hand, providing the population with food is a priority for every government, and on the other – the energy independence of the state is the basis of its sovereignty. Therefore, the analysis of the possibilities of growing bioresources for biofuels should be carried out taking into account the real situation with both the existing needs in the food sector and the available sources of traditional energy resources.

Establishing biofuel production in rural areas will significantly reduce their energy dependence and provide social infrastructure with cheaper energy resources.

Strategic goal 3. Development of energy cooperation in rural areas.

At the present stage, in conditions when the dynamics of rising prices for energy resources, in particular for household consumption, is not actually rising in relation to the income coverage of ordinary citizens, the peasants are the first stakeholders in energy cooperation. Therefore, every year the motivational potential in the realization of the potential of energy cooperatives grows, especially in the system of renewable sources [34].

Thus, the advantages of creating energy cooperatives are increased economic activity of citizens; creation of added value; ecological utilization of agricultural waste; attracting investments for rural development; creation of additional jobs; increase tax revenues in local budgets; increasing energy independence and ensuring energy autonomy of agricultural enterprises [30].

State support for the establishment of energy cooperatives and the adoption of best European and world experience in creating energy communities are important.

7. Conclusions

1. The energy efficiency of the economy is rational use of energy resources compared to other options for use or production of products of the same consumer level or environmental technical and economic indicators.

2. Energy supply of the enterprise is defined as the availability of all types of energy, which is necessary for the efficient operation of the enterprise. Types of energy in a broad sense, used by agricultural enterprises include: direct (fuel and energy resources), indirect (fertilizers, materials and raw materials); investment (machinery, equipment, maintenance and overhaul). At the same time, the process of efficient energy supply and rational energy consumption should be considered within the functioning of the energy management system of the enterprise.

3. The possible way of solving the problem of energy saving and efficient energy supply by implementing the energy management system is substantiated and the indicators of the internal component of energy security of the enterprise are determined.

4. It is proved that the agricultural sector is one of the main consumers of fuel and energy resources. It ranks second after industry in terms of their volume. With the declaration of independence in Ukraine, the use of fuel and energy resources of the agro-industrial complex has more than halved. This is due to: 1. reduction of sown areas, technological operations in crop production, truck fleet, livestock production; 2. the use of resource-saving technologies, as well as a more careful attitude to the use of energy resources. The volume of purchases of diesel fuel and gasoline in agriculture remains quite high, their cost is significant, due to annual price increases.

5. It is substantiated that the most adequate response to current threats in the energy sphere for Ukraine should be structural reforms in all areas of energy policy: energy efficiency, formation of competitive energy markets, diversification of energy supply, increasing the share of alternative energy sources and biofuel. Biogas technologies are of particular importance to provide agricultural enterprises with energy resources due to the high energy potential of this type of biofuel, as well as the available residues

of crop and livestock in agriculture (raw material base), favorable climatic conditions, relatively inexpensive labor.

6. The priority areas of modernization of the energy supply system in Ukraine include: diversification of the energy supply system; renewal and technical modernization of fixed assets of enterprises and their infrastructure; introduction and stimulation of rational use of fuel and energy resources; introduction of effective incentives to stimulate innovative development of existing at the local (regional) level as traditional (natural) minerals; and alternative (renewable) fuel and energy resources.

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