

ECONOMICS ENERGY EFFICIENCY: PROBLEMS OF NOWADAYS AND OF THE FUTURE

Edited by Kseniia Chichulina

Within the framework of a project EU Erasmus +:
"The challenges of energy efficiency:
cooperation of Ukraine with the EU",
№ 599740-EPP-1-2018-1-UA-EPPJMO-MODULE

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Monograph

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The collective monograph is devoted to the actual issues of economics energy efficiency in Ukraine and EU.

The goal of the monograph is the analysis of the National and European experience in energy conservation sphere; research of energy conservation conditions and energy efficiency in different branches of Ukrainian economy; observation of strategy direction to increase energy efficiency and realize energy conservation opportunities.

To achieve the aim and tasks the following research methods used in the monograph: system approach, historical approach as for historical aspects of energy conservation and energy efficiency in Ukrainian economy and in EU economy; analysis and synthesis method to summarize worlds scientific methods of economic efficiency; statistical method and modelling method to develop schemes, diagrams and additions; generalization method to develop basics and to observe the main directions in the research; scientific abstraction method of the economic-mathematical modeling and econometric analysis to define the main factors effecting Ukraine and EU energy conservation.

The authors of the monograph formed recommendations for Ukrainian energy conservation increase. Offered strategies can be used by local and regional public authorities while elaborating of territory development programs. Besides, the monograph materials can be used by teachers of higher educational establishments to prepare for lectures, special study courses and manuals in the sphere of energy conservation.

Some abstract theories, methodological approaches, recommended practices and implications can be used in enterprises, organizations etc.

Keywords: energy efficiency, problems, Ukrainian and EU economy, conservation, energy strategy.

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INTRODUCTION

Since ancient times energy has been an important factor that defines the development of the country economy, increase of people's prosperity and life quality. Energy efficiency is the priority in the development of EU countries which have practical experience in energy efficiency. Solution to energy saving problems by EU countries creates bases for economy restructuring in general. Implementation of the proven experience of energy efficiency by the European countries will make for a swift development of the economy in Ukraine. Hence, it is up-to-date nowadays to study the European experience of transition from managing energy intensity of economy to energy saving and energy efficiency; implementation of European legislation in the field of energy saving, and practices of application of modern energy and resource saving materials, structures, devices and equipment. Effective implementation of energy conservation technologies into Ukrainian economy needs in-depth observations and modern approaches used by EU. The rapid increase and renovation of scientific-technic information in energy conservation, rapid change of materials, constructions, technologies, engineering solutions, system of government in Europe requires the selection of the most efficient ways of testing EU countries experience in domestic experience. Solving problems is possible if all population have the newest knowledge in energy conservation.

The monograph «Economics energy efficiency: problems of nowadays and of the future» was prepared by a professors team of National University «Yuri Kondratyuk Poltava Polytechnic» (Within the framework of a project EU Erasmus +: "The challenges of energy efficiency: cooperation of Ukraine with the EU", № 599740-EPP-1-2018-1-UA-EPPJMO-MODULE). The aim of the project is to popularize energy efficiency in Ukrainian society and familiarize students with the practice of effective application of energy resources. The course is worked out for students of economic and technical specialties, managers and enterprise executives.

The monograph is aimed at the formation competence in the issues of the rational usage of renewable resources; deepening of their practical knowledge of energy efficiency and ecology; research of the sources and instruments of energy efficiency projects resource supply in the EU and ability to adapt them in Ukraine. Moreover, the monograph presents improved argumentation methods of the efficiency and expediency of realization of energy saving projects which have a considerable energy saving potential

The authors of the monograph formed recommendations for Ukrainian energy conservation increase. Offered strategies can be used by local and regional public authorities while elaborating of territory development programs. Besides, the monograph materials can be used by teachers of higher educational establishments to prepare for lectures, special study courses and manuals in the sphere of energy conservation.

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ENERGY CONSERVATION STRATEGIES AT UKRAINIAN ENTERPRISES

Energy development has a decisive influence on the state of the economy in the country and the standard of living of the population. The aim of the welfare state, which, according to the Constitution, is Ukraine, is to provide conditions for increasing the well-being of citizens.

One of the most important components of well-being in civilized states is to provide citizens and companies with the necessary energy resources. The key to achieving this goal should be reliable, economically sound and environmentally friendly meeting the needs of the population and the economy in energy products [1].

Instead of providing the extensive development that Ukraine's economy has been moving through for decades, the energy sector should move to effectively ensure sustainable economic development. Maintenance of the economy and social sphere of the country with the main types of energy resources and raw materials for the needs of the chemical and metallurgical industry rests on the fuel and energy complex of Ukraine.

An energy strategy is an integrated model of state action aimed at achieving national security goals and meeting the energy needs of society at the lowest total cost, while being economically justified. Thus, the Energy Strategy of Ukraine is intended to determine the vector of development of energy sectors of the country in accordance with the goals and objectives of the fuel and energy complex. The objectives of the Energy Strategy are [2] (Fig. 1):

Realization of these goals will create conditions for intensive development of the economy and raising the standard of living of the population of the country.

The main directions of implementation of the Energy Strategy are (Fig.2):

Changes in approaches to the formulation of states' energy policy are taking place in the world: the transition from the outdated model of functioning of the energy sector to the new model. The old model was dominated by large producers, inefficient networks, flawed competition in the markets of natural gas, electricity, and coal. The new model creates a more competitive environment that balances development opportunities and minimizes the dominance of one of the types of energy production or sources and / or fuel delivery routes

At the same time, it is preferable to increase energy efficiency and the use of energy from renewable and alternative sources. Climate change prevention and adaptation is also one of the priorities of global energy development [2].

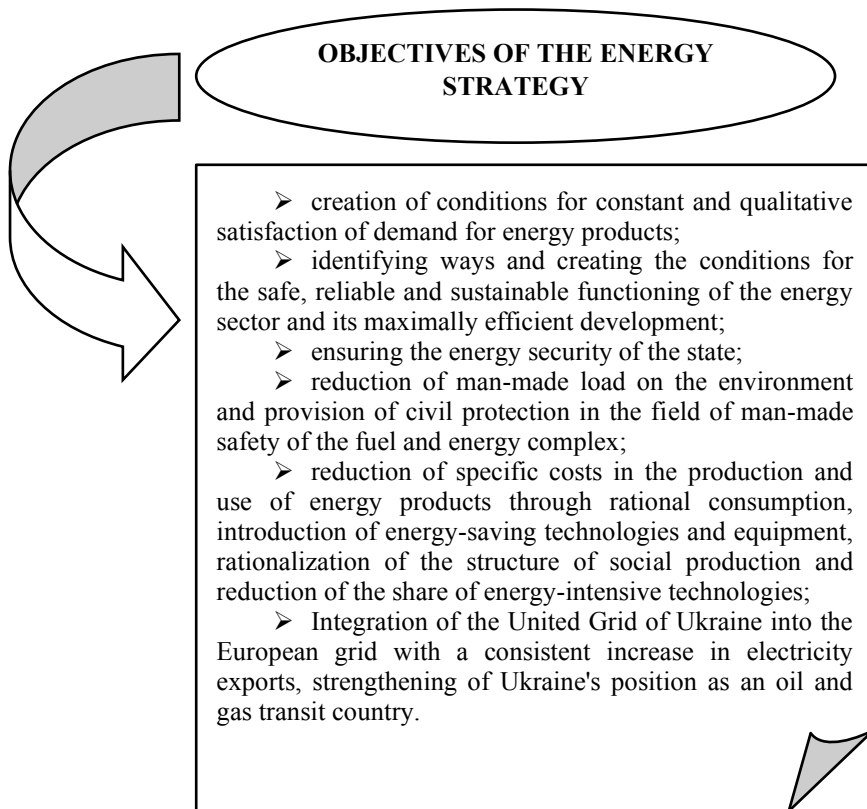


Fig. 1 – Objectives of the Energy Strategy

This poses new economic and technological challenges for Ukraine, but at the same time opens up new opportunities for finding and implementing innovative developments in the field of production, processing of fossil fuels, production, transformation, supply and consumption of energy, which necessitates the formation of a new energy policy of the state.

Strategic guidelines for the development of the fuel and energy complex of Ukraine for the period up to 2035 are outlined in the document "Energy strategy of Ukraine for the period up to 2035 "Security, energy efficiency, competitiveness".

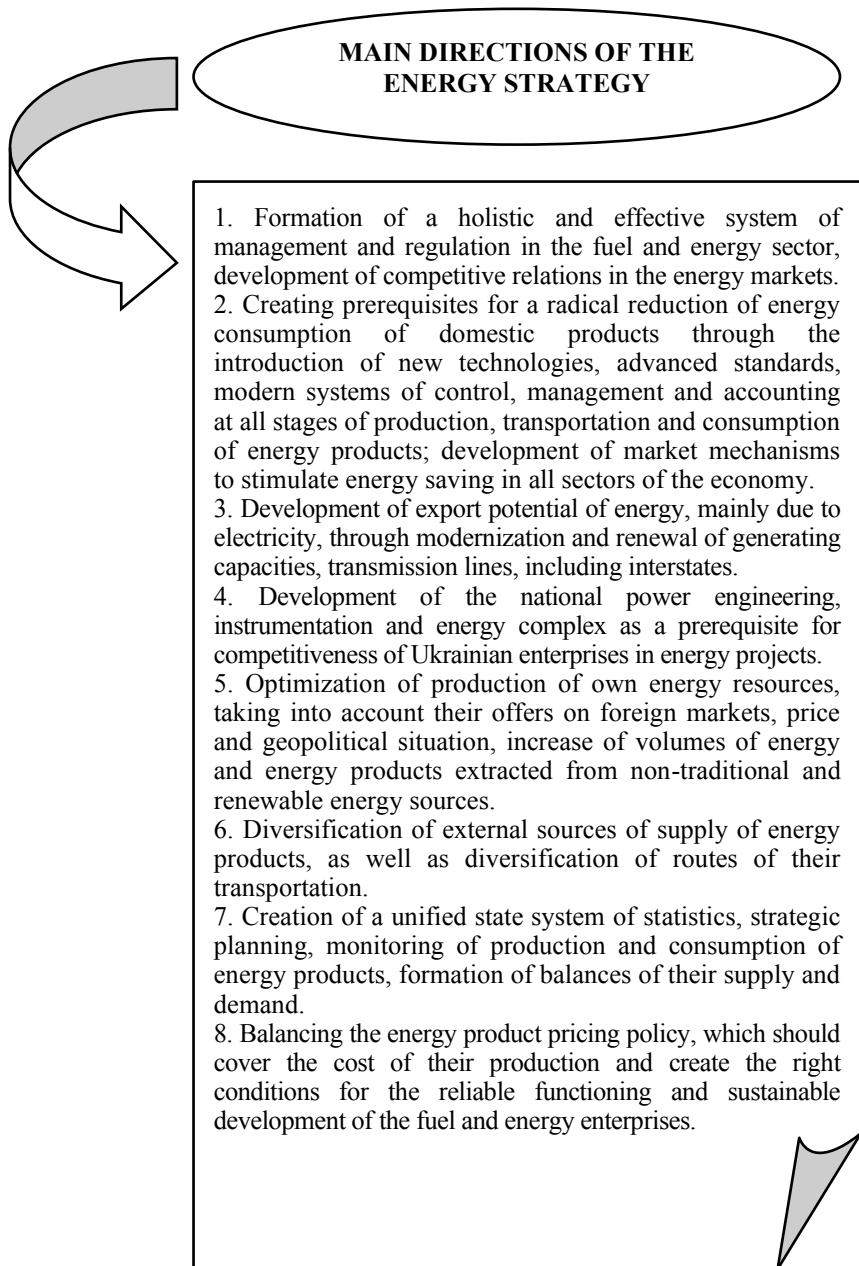


Fig. 2 – Main directions of implementation of the Energy Strategy

It envisages that by 2025, the reform of Ukraine's energy complex will be largely completed, priority targets for safety and energy efficiency will be achieved, and its innovative renewal and integration with the EU energy sector will be ensured. The main directions of increasing the energy efficiency of the Ukrainian economy have been identified (Fig. 3) [2].

Structural change will have a decisive impact on the overall energy efficiency of the economy. However, measures of general economic impact are also needed, which require separate analysis within the framework of the state's economic strategy. Taking into account the current situation in the field of energy efficiency, the main tasks for the economy as a whole and in the economic sectors for the defined strategic planning period have been defined (Fig. 4) [2].

Energy efficiency and energy conservation are the means of ensuring the efficiency of both business and the state as a whole [3].

Energy conservation is a complex of organizational, legal, industrial, scientific, economic, technical and other measures aimed at rational use and economical consumption of fuel and energy resources [3].

Priority directions and measures for improvement of energy efficiency and energy conservation in Ukraine are [4]:

- reduction of unit costs for energy unit production;
- reduction of the share of energy losses during transportation to consumers per unit of output;
- reduction of energy and energy consumption per unit of output;
- saving energy and energy consumption.

Consider the essence of the main concepts of the strategy of energy saving in the Ukrainian economy sectors (Table 1):

- fuel and energy complex;
- industry;
- housing and communal services;
- transport;
- construction;
- agriculture.

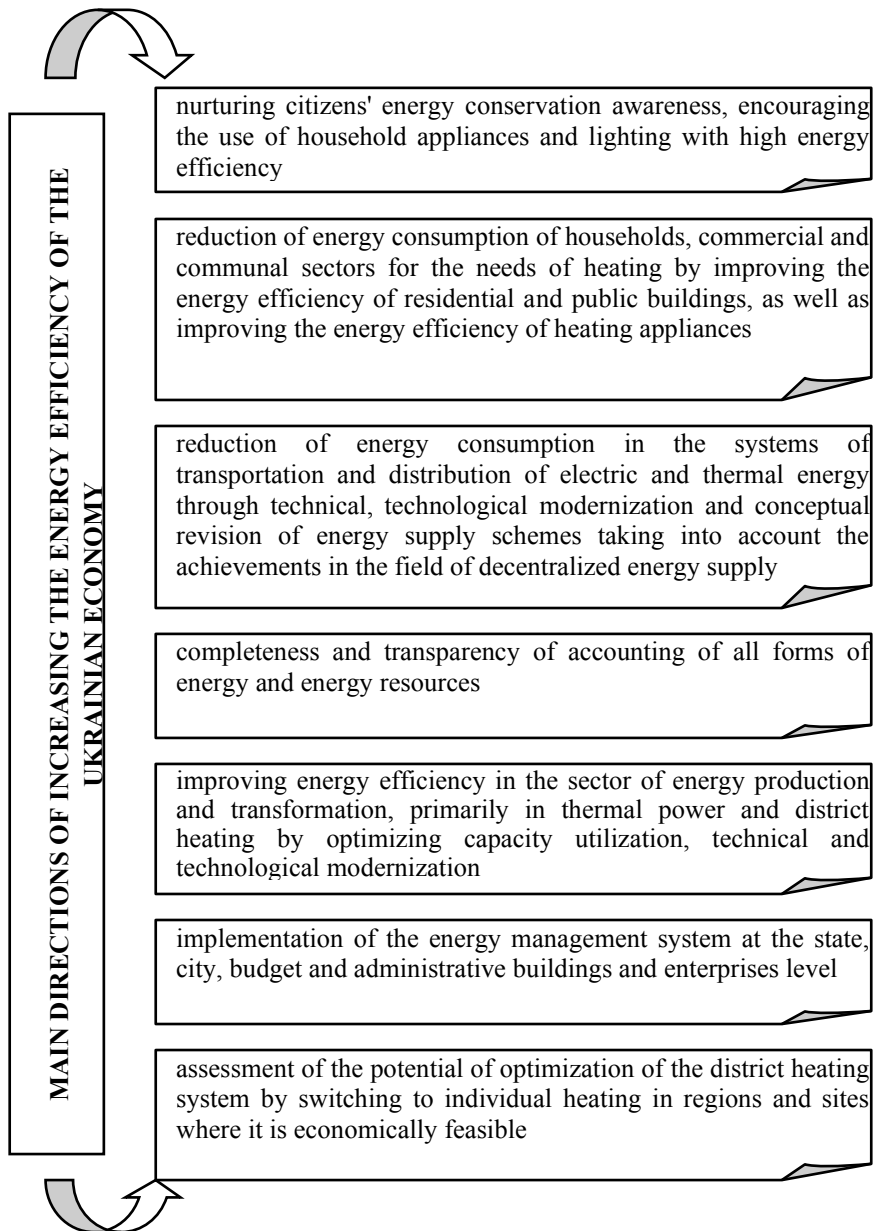


Fig. 3 – Main directions of increasing the energy efficiency of the Ukrainian economy

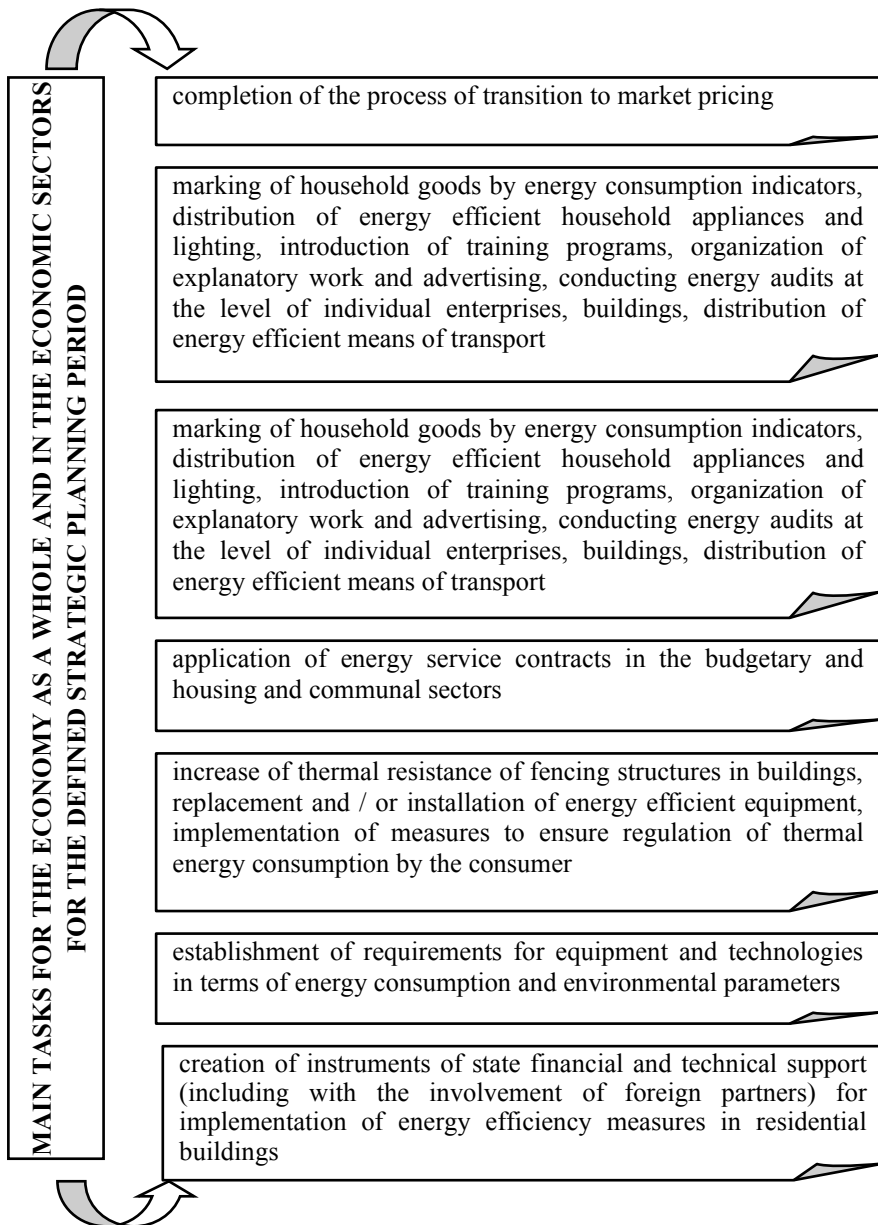


Fig. 4 – Main tasks for the economy as a whole and in the economic sectors for the defined strategic planning period

Economics Energy Efficiency: Problems of Nowadays and of the Future

Table 1 – Main directions of energy conservation strategy

THE ECONOMY OF UKRAINE	MAIN DIRECTIONS OF THE ENERGY RESOURCES CONSERVATION STRATEGY
Fuel and energy complex, by directions:	generating the required amount of energy and energy resources while reducing unit costs
Electricity	introduction of new technologies of energy production; forecasting the balances of produced and consumed energy; clear implementation of power system operating modes; organizational measures
Coal industry	reducing the cost of transporting coal to consumers; introduction of new technologies for coal production; forecasting the balance of coal produced and consumed; clear implementation of technological regimes of coal production; organizational measures
Oil and gas industry:	reducing the cost of transporting oil and gas to consumers; introduction of new technologies of oil and gas production; forecasting the balance of production, purchase, processing and consumption of oil and gas; clear implementation of technological modes of transportation and production of oil and gas; organizational measures
chemical and petrochemical industry	reduction of energy consumption and energy resources per unit of output
Industry, by directions:	reduction of energy consumption and energy resources per unit of output; forecasting the development of economic sectors; implementation of state programs in the most promising sectors of the economy; introduction of new energy-saving technologies of production and provision of services; organizational measures aimed at saving energy resources and types of energy; total accounting of energy use and energy resources; the widespread use of energies produced by non-traditional methods
metallurgy	a significant reduction in the use of energy and energy resources per tonne or hryvnia produced
building materials industry	reduction of energy and energy costs in the production of cement, masonry, precast concrete, concrete structures and other products; increasing the degree of recycling of secondary energy resources; introduction of modern systems of accounting and control of energy resources

Continuation of Table 1

Utilities	reduction of specific heating costs of 1 cubic meter. buildings and 1 cubic meter. consumption of cold and hot water
Transport	use of highly efficient motor fuels and their alternative types; improvement of the road economy, in particular motorways and railway tracks; improvement of the transportation system
Building	reduction of energy consumption and energy resources by 1 sq.m. commissioned housing, through the introduction of new energy-conservation technologies and materials; transition to energy efficient construction and energy conservation structures; changes in the typology of buildings and structures to ensure qualitative changes in construction and a sharp reduction in the energy intensity of the industry
Agronomy, by directions:	reduction of energy and energy consumption per tonne of product produced and use of non-traditional and renewable energy sources
plant growing	improving the structure of tractors and self-propelled machinery; rationalization of their energy supply levels; expanding the use of combined machines and units; the transition from traction to traction-driven cars, etc.
stockbreeding	expand the use of energy-conservation technologies and equipment for the preparation and distribution of feed; the use of refrigeration high-efficiency heat exchangers for the primary processing of milk and the creation of a microclimate in the premises, as well as economic lamps and irradiators of animals

It is proposed to use new and unconventional energy sources - wind, sun, biogas plants for the production of electrical and thermal energy [4].

The main result of the implementation of the strategy in the above sectors is to reduce the use of electricity and energy per unit of production or the hryvnia spent.

The analysis of the process of developing and implementing energy saving strategies at Ukrainian enterprises has shown the following.

The choice of the energy saving strategy of an enterprise is influenced by both internal factors of the enterprise (its internal environment, including available resources and competences), and the state of the external environment (macro and micro environment) [4].

The energy conservation strategy of an industrial enterprise is formed under the influence of many factors, which can be divided into two groups (Table 2).

Table 2 – Factors influencing the energy conservation strategy of an industrial enterprise

FACTORS INFLUENCING THE ENERGY CONSERVATION STRATEGY OF AN INDUSTRIAL ENTERPRISE			
External		Internal	
Macro environment factors	Microenvironmental factors		Strategic potential of the enterprise
<ul style="list-style-type: none"> ➤ economic, ➤ natural, ➤ scientific and technical, ➤ political, etc.; ➤ possibilities of state support of implementation of energy saving measures of the enterprise 	<ul style="list-style-type: none"> ➤ consumer requirements for products, ➤ politics of energy conservation competition, ➤ conditions of supply of energy resources and energy saving equipment 	The concept of enterprise development, its strategic goals defined by the overall corporate strategy	<ul style="list-style-type: none"> ➤ raw material resources, ➤ production, ➤ labor, ➤ investment, ➤ innovative, ➤ organizational and managerial, ➤ financial

Based on the methodology of the Plan-Do-Check-Act (PDCA) continuous improvement cycle, which is provided for in the International Standard ISO 50001: 2018 Energy management systems - Requirements with guidance for use, an important step in choosing an energy saving strategy is to conduct a strategic energy analysis. This analysis will include studies of external and internal factors that influence the energy consumption and energy efficiency of the enterprise [5].

With the rest of the rocks, you will have to nudge on the need for an energetic audit of industrial production. Its purpose is a technical and economic survey of the systems of transportation and consumption of energy resources and water in order to identify and economically justify the technical, organizational, economic, operational ways of reducing the consumption of primary energy resources. This will maximize the transition to secondary and alternative energy sources, enabling the company to achieve real and significant cost conservation and reduce environmental footprint on the environment. [5].

The implementation of the strategy in concrete actions is possible through a qualitative system of programs, projects and energy saving plans. The implementation of the planned energy conservation measures requires the use of technical, economic, organizational, legal and other methods.

The enterprise must ensure that energy efficiency indicators are monitored, measured and analyzed. Based on them, conclusions are drawn about the effectiveness of the chosen strategy, carry out corrective actions, revise the overall development strategy and energy policy if necessary.

Achieving the system of goals within the chosen energy saving strategy will ensure the most efficient use of energy resources, will contribute to the stable functioning of the industrial enterprise. These are the priority areas for shaping its economic security [5].

In the majority of Ukrainian enterprises, the development of energy efficiency and energy conservation is low in legal, economic, organizational and technical codes [6].

It is not possible to clearly classify them, because they are interconnected and have a causal nature. Therefore, it is proposed to conditionally distinguish the following obstacles: financial, social, industrial, market (Fig. 5) [7].

It should be borne in mind that high energy consumption during production, energy security issues, ever-changing energy prices, the need to switch to a resource-saving business model pose risks and problems for energy efficiency for businesses [6].

Among the main ones are:

- deterioration in financial performance as fuel and energy prices rise;
- decline in production in case of unreliable supply of energy;
- deterioration of the reputation of the company, which did not live up to expectations in the field of energy efficiency;
- additional costs for compensation of penalties.

Nowadays, Ukrainian enterprises are at different stages of adaptation to the risks associated with energy efficiency [6]. Modern monitoring and response tools have already begun to be used in energy-intensive industries.

The consequences of energy-related events (eg sudden tariff hikes, power outages, poor energy performance) can be critical for companies in different sectors of the economy.

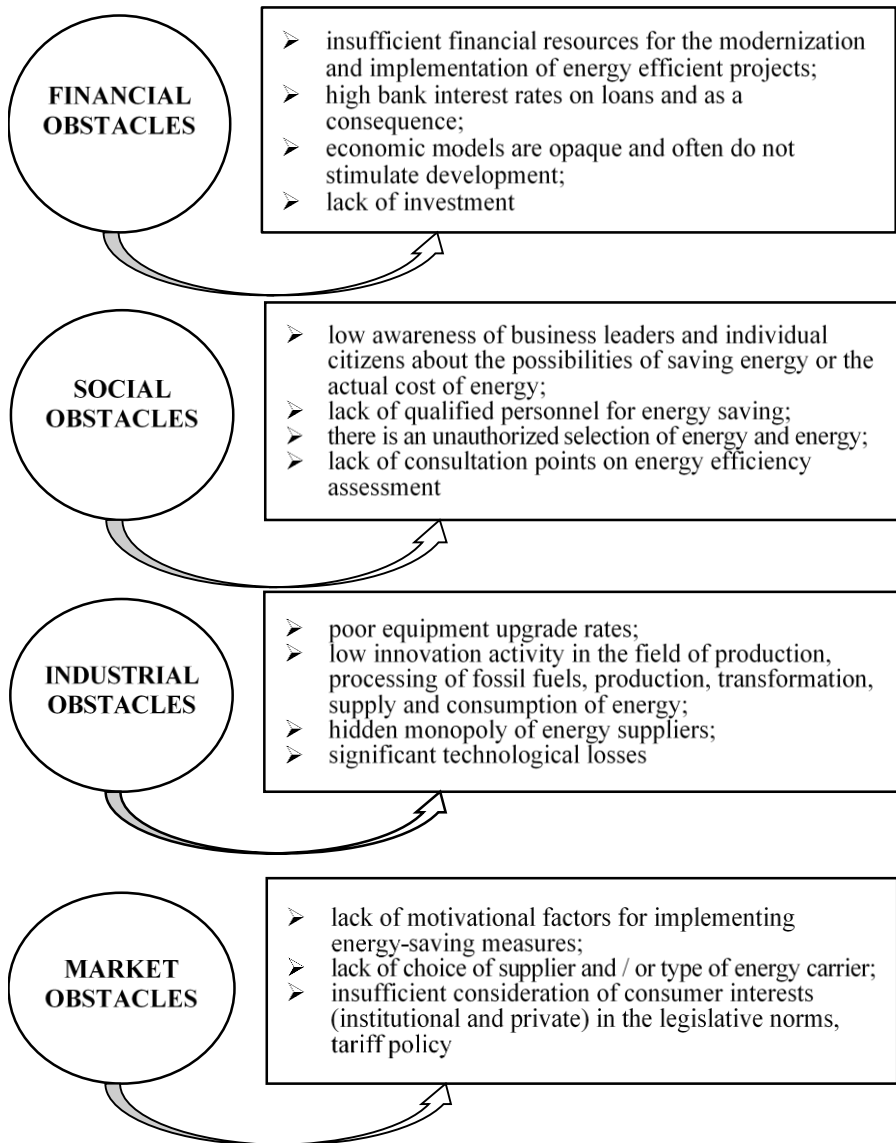


Fig. 5 – The main obstacles to improving energy efficiency in Ukrainian enterprises

Issues of energy efficiency left unattended pose a serious threat to the normal functioning of the business [6].

Having a detailed energy strategy, including an action plan, and optimal project financing schemes, will help Ukrainian businesses respond to energy challenges and minimize risks associated with energy supply and energy efficiency [3].

Reforms, de-monopolization, transparency and improvement of legal and regulatory mechanisms should be a prerequisite for attracting energy-saving investments [7].

So, for Ukraine today, the issue of conservation energy is a top priority. The construction industry was no exception. In the face of an acute shortage of energy resources in Ukraine, the need to reduce energy consumption in the construction and operation of buildings and structures is a top priority at various state levels.

The construction industry is an energy intensive industry, especially in the construction materials sector. Energy conservation in construction plays an important role, as reducing electricity and heat consumption will reduce the cost of purchasing resources. To date, energy conservation contributes to the improvement of the ecological situation, both in our country and around the world [3].

Energy intensity of production is the amount of energy and fuel consumption for the basic and auxiliary technological processes of production, performance of works, provision of services on the basis of a given technological systems.

The problems of research of energy saving policy in the field of construction are devoted to the work of both domestic and foreign scientists. On the basis of study, analyses, rethinking of their developments, scientific aspects of this problem were formed. Modern concepts for the selection and implementation of effective energy-saving measures in the construction industry are presented in different approaches and directions. This problem is reflected in the writings of many scientists. The theoretical propositions justified by them are a methodological basis for bringing energy consumption in the field of construction to the present world level [3].

Analysis of energy saving trends in construction industries confirmed that the main purpose of construction enterprises is to identify energy saving resources. For this purpose, a comprehensive or partial energy survey of enterprises is conducted with the creation of sound ways to improve the energy efficiency of construction production. In the face of a constant shortage of fuel resources in Ukraine, the problem of reducing energy consumption in the construction and operation of buildings and structures is a state task.

In the current conditions of functioning of the enterprises of the construction industry there is an urgent need to develop a new approach to the management of energy-saving technologies. The construction complex of Ukraine has significant basic resources for implementing an innovative energy-saving policy [3].

Energy conservation in construction is reduced to rational use of energy, reducing unproductive losses.

The main reasons for the low energy efficiency of construction industry enterprises are (Fig. 6).

Today, there are three main types of energy-conservation measures: organizational measures (internal energy audit, compilation of the energy passport of the enterprise, development of energy-conservation measures and increase of efficiency of technological processes, etc.); technological measures (introduction of energy efficiency standards in the use of industrial buildings, industrial equipment, etc.); investment measures (transition to alternative sources of energy supply and use of modern energy-conservation production technologies) [3].

The choice of one or another energy conservation strategy depends on the goals of the enterprise and its potential capabilities to implement the strategy. One of the main criteria for choosing an energy conservation strategy is to evaluate the cost-effectiveness of the activities undertaken.

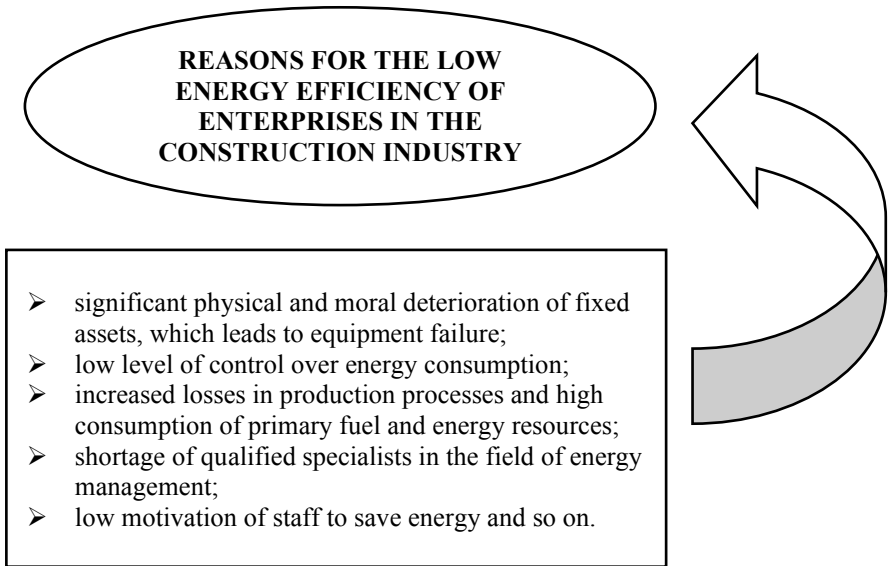


Fig. 6 – The main reasons for the low energy efficiency of enterprises in the construction industry

The implementation of an energy-conservation strategy will help the enterprise to gain a competitive advantage over other entities. The strategy chosen for implementation should be the basis for effective management of energy saving processes in the enterprise.

The expected effects from the implementation of the energy conservation strategy of a construction company may be (Fig. 7).

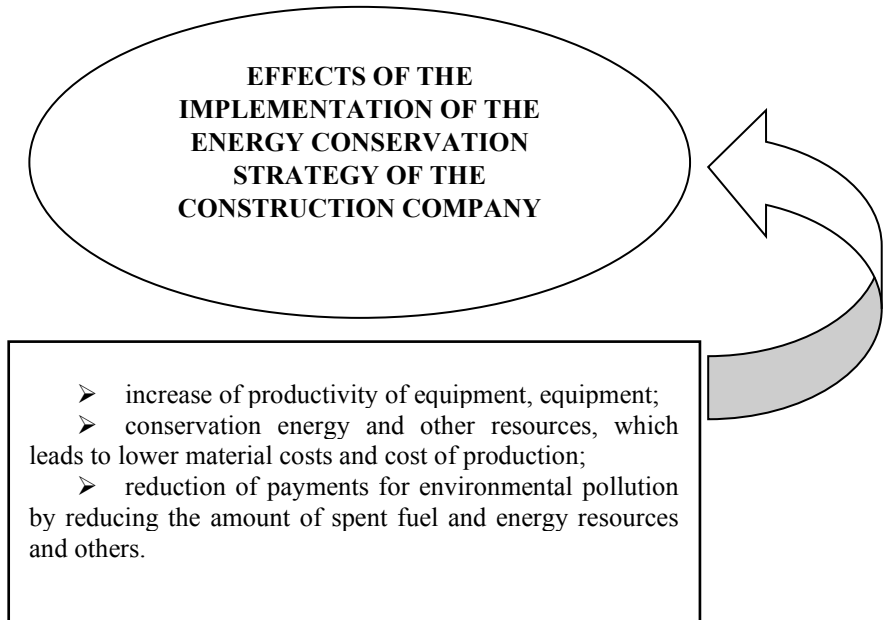


Fig. 7 – Effects of the implementation of the energy conservation strategy of the construction company

But these positive results can be accompanied by negative ones for the company. Namely, the increase in the total volume of fixed assets of the enterprise, material costs (despite the conservation of energy resources), operating costs for the maintenance of energy-conservation equipment, the number of service personnel, etc. [5].

The process of implementing an energy conservation strategy at a construction company should foresee the following steps (Fig. 8) [3].

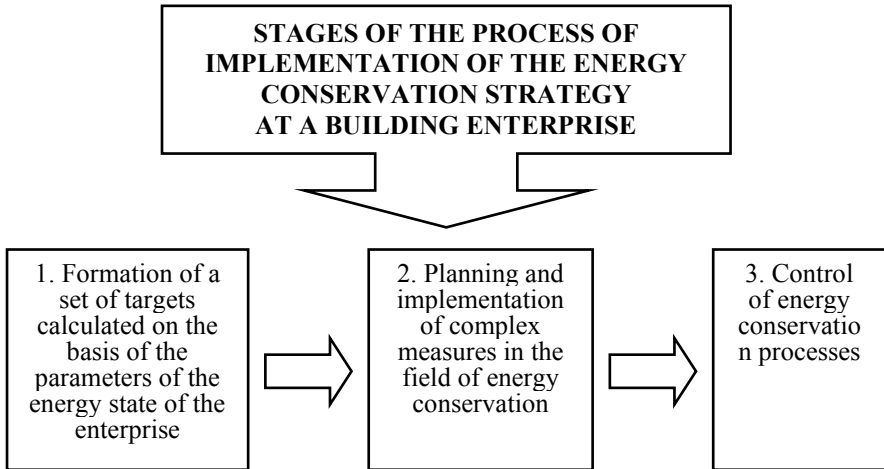


Fig. 8 –Stages of the process of implementation of the energy conservation strategy at a building enterprise

In order to determine the efficiency of use of energy resources in modern construction companies conduct energy audit. According to its results, energy-saving technologies are implemented, which ensure the implementation of organizational, legal, technical, technological, economic and other measures aimed at reducing the amount of energy resources [8].

However, in order to achieve the goals of state energy conservation programs and increase the level of energy efficiency in construction, it is advisable to use energy efficient control.

The information generated in the process of energy-efficient control provides an opportunity not only to assess the current state of energy efficiency of a construction company, but also to make effective management decisions to improve energy efficiency.

Implementation of energy-efficient control at construction enterprises is based on the use of the most modern and effective methods and tools, which requires scientific substantiation of organizational and methodological issues [8]. The most actual methodological problems of introduction of energy efficient control have been identified (Fig. 9) [8].

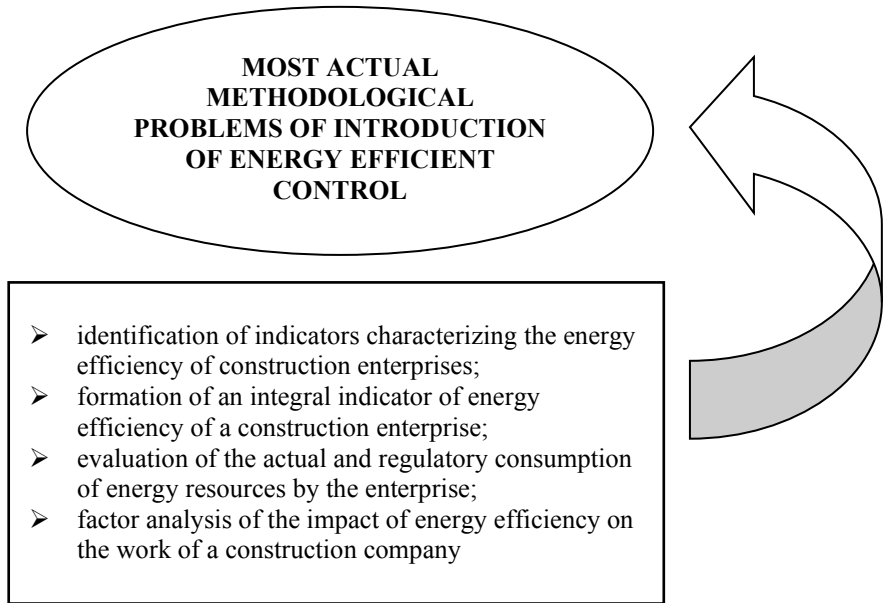


Fig. 9 – The most actual methodological problems of implementing energy-efficient control at a construction company

In order to increase the level of energy efficiency of domestic construction companies, it is advisable to develop effective mechanisms for motivating staff, which will increase their competitiveness [9]. Therefore, construction companies in Ukraine need to not only develop and implement energy-efficient production technologies, but also appropriate systems to motivate staff to positively perceive energy-efficient changes and save energy in manufacturing activities.

Effective stimulation of construction companies to efficient use of energy resources and positive perception of energy-efficient changes requires a direct link between the results of activities of all categories of personnel, taking into account energy conservation at each stage of the construction cycle, the use of energy-conservation technologies and tangible and intangible assets.

The system of motivation of the personnel of construction enterprises for energy conservation and implementation of energy efficient projects should contain various elements, which make it possible to meet the wide range of needs of the modern worker and develop in him the qualities necessary for the successful functioning of the enterprise. It is suggested to take into account when constructing a model of staff motivation for energy conservation communication and patterns, which are the most important from the point of view of the subject of motivation [9].

An innovative component of the energy-conservation activity of the building complex is the activation of the introduction of new energy-conservation

technologies, the development of scientifically sound means of organizing and managing the energy-conservation construction process. The choice of efficient energy-conservation technologies and measures, the study of the factors that influence the conservation of energy resources, can only be assessed by the resource provision of innovative energy-conservation activities. This will allow to form an energy conservation strategy for each technological process of a construction enterprise [9].

The analysis of obstacles on the way to efficient energy use in Ukraine has made it possible to determine that the main obstacle is the lack of motivation of all economic entities of the state, control of enterprises and households for energy efficient activities, explaining to citizens the issues of stimulating energy conservation, energy audit and energy management. Therefore, it is advisable to consider the identified threats when developing national and regional development strategies for the future [7].

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THE ORGANIZATIONAL-ECONOMIC CONCEPT FORMATION OF ENTERPRISE ENERGY SAVING

The main guideline for the development of energy resources in the modern world is the optimization of a complex balanced system of four "E": energy, economy, energy efficiency, ecology.

One of the criteria for an effective energy strategy and energy policy should be reliability and security of energy supply, environmental efficiency and profitability. However, the undisputed facts are that:

- reserves of minerals on Earth are gradually being depleted;
- environmental pollution occurs as a result of human activity;
- nuclear power still does not provide an adequate level of security;
- renewables cannot fully meet the needs of mankind.

The growth of opportunities and aspirations is increasingly confronted with some of the most important laws of the economy nature – the law of resource scarcity or the law of relative scarcity of resources, including energy.

The problem of energy saving has grown from an economic and technological component into a political and social one. Political this problem is because it requires the implementation of state policy in the field of energy efficiency and energy saving, and on the other hand, social, because it requires a change in the principles of human behavior and the adoption of new views, guidelines of society and energy use.

The functioning of the mechanism of implementation of the state policy in the field of energy saving is ensured by the following methods (the use of regulatory legal acts, state programs of energy saving, sectoral and regional programs, etc.), levers – economic and financial (system of prices and tariffs, tax and credit privileges, economic stimulation and financing of energy-saving measures, etc.), instruments (setting standards for the consumption of fuel and energy resources, energy expertise of projects, energy consumption standards, etc.) [1].

If we analyze and summarize the experience of domestic and foreign enterprises, we should pay attention to the fact that innovation activity in the country must be carried out through the mechanism of regulation of FER. The investment market in Ukraine is unstable, but given the steady increase in energy prices and maintaining competitiveness in the world market, energy consumption can be reduced through the realization of investments. Such investments bring a number of positive results (Fig. 1).

Energy saving policy is implemented in many countries due to the functioning of the state-private partner. Three main components of an effective energy conservation policy:

- stimulating to save and save energy;
- compulsion to save energy;
- conducting energy conservation programs and events.

To track the issue of energy efficiency, a National Agency has been set up, the main task of which is to ensure effective strategic management in the field of efficient use of energy resources and to coordinate cooperation with local authorities on issues of energy efficiency and energy saving [2].

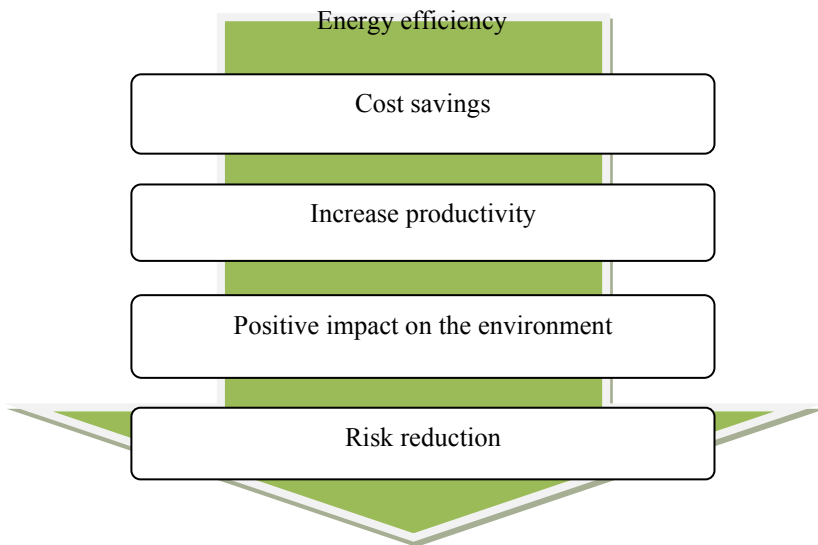


Fig. 1 - Benefits of investing in the development of renewable energy
Source: Developed by the author

The implementation of the energy saving policy is associated with the formation of both positive and negative trends (Fig. 2).

The positive trends of energy saving policy are:

- orientation towards increasing the production of energy resources;
- increasing the use of non-traditional and renewable energy sources;
- implementation of high-efficiency technologies;
- maximal attraction of energy saving potential;
- adaptation of national legislation to EU norms and standards.

The negative trends in energy conservation policy include:

- continued use of morally and physically outdated fixed assets;
- deepening the dependence of domestic energy on imported energy;
- slow pace of energy intensity economy reduction.

Fig. 2 – Positive and negative trends in energy saving policy

Source: Developed by the author on the basis of [3]

For Ukraine, energy efficiency is a key goal of sustainable development. It can be argued that for our country, energy efficiency is not only energy saving, but also optimization of the ratio of effect (utility, quality, cost, quantity of products produced, quality of life, social comfort) and energy costs required by the energy produced. On September 24, 2010, Ukraine signed the “Energy Community Application Agreement” and on February 1 became a legal member of that Community. By signing this agreement, the country undertakes to:

- realization of landmarks in a certain area;
- the development of an adequate regulatory framework and the liberalization of the energy market in accordance with the terms of the contract.

Having full rights and obligations to the community, Ukraine must fulfill the tasks assigned to it, namely the Directive [4], namely the Electricity Promotion Directive (Table 1).

Therefore, according to the results of the analysis of scientific and legislative sources, it is advisable to formulate the main directions of energy saving:

- refinement and improvement of the current legislation, standardization of energy efficiency of renewable energy sources and fuels;
- optimization of the structure of the energy balance of the state;
- conducting energy audits of energy consumers and energy resources in order to implement energy-saving measures;
- correction of the mechanism of pricing for FER;
- improving the methodology for calculating energy efficiency indicators;
- implementation of mechanisms to support the introduction of FER accounting devices;
- Ukraine's participation in international agreements, projects on energy efficiency issues, attracting significant and long-term investments to ensure

modernization, sustainable development, security and competitiveness of energy saving;

- development of measures to stimulate the spread of energy management systems in energy-intensive industries;
- improving the methodology for facilitating access to energy auditing services;
- timely payments on the "green tariff";
- adaptation of government mechanisms to the principles and requirements of EU law [6].

Table 1 – Activation factors for state regulation of energy saving in Ukraine

Factors of activation of the energy saving state regulation in Ukraine	Directions of implementation
The prospect of further growth of domestic energy prices	"Roadmap for the implementation of the Energy Efficiency Directives"
The need to increase the competitiveness of the Ukrainian economy in the context of increasing tariffs and prices of final products at the expense of frequent consumption of energy	The Law of Ukraine "On Energy Efficiency" is the setting of priorities of energy efficiency in accordance with the Compilation of the basic norms and requirements of the European Union on energy efficiency, as well as the main national energy laws, including the Energy Strategy of Ukraine.
Tariff growth is a powerful destabilizing influence on the social and political sphere, and a decrease in energy consumption for energy savings can be seen as a factor that offsets the rise in energy costs	Law of Ukraine "On Energy Saving in Buildings", which must comply with the Directive on Energy Efficiency of Buildings
The threat of a critical impact of energy shortages, to overcome which is one of the most priority and effective mechanisms is to improve energy efficiency	Discontinue consumer price support as a negative factor hindering the implementation of energy efficiency measures while developing a safety net for vulnerable consumers
Ukraine acts as an attractive market for the sale of technologies and equipment in the field of energy saving and improving energy efficiency (the market for energy-saving technologies in the world has already emerged)	

Source: developed by the author based [5, 10]

The introduction of energy-saving measures at the enterprise is explained by the fact that the entrepreneurs seek to profit from these measures, as well as additional funds from the state and foreign investors. Reasoning for this is that the

reduction of electricity consumption and natural gas will have a positive effect on the enterprise's income. At the same time, the company will immediately see a significant number of competitive advantages, namely:

- competitiveness with increased energy costs;
- productivity of production;
- the enterprise's dependence on energy prices becomes less and, accordingly, lower the risks of the company;
- Reduction of energy consumption also leads to a reduction of emissions into the atmosphere, thus enhancing the ecological state of the image.

In the future, in the context of the identified areas of energy saving, it is advisable to form an organizational and economic concept of energy saving.

Today, improving energy efficiency of production is one of the main tasks of increasing productivity and reducing cost.

Energy efficiency management is a combination of legislative framework and funding mechanisms, institutional organization and coordination functions, all of which are aimed at supporting the implemented energy saving strategy, policies and programs.

The main objective of an effective energy-saving policy, as an auxiliary element of production, is to ensure that all the conditions of the enterprise's plans are fulfilled.

The effectiveness of energy saving and energy use policies is characterized by the dynamics of relevant indicators.

The factor of effective energy conservation policy is a certain action (a set of measures similar in its orientation), which causes a change in the state of the basic elements of production (change of technology, technology, organization of production, labor and management, qualification of employees and use of qualification skills) as a consequence, to positive or negative changes in energy consumption. All the factors that determine the level of energy saving development and energy efficiency policy are divided into external and internal, relative to the consumer enterprise (Table 2).

One of the most significant factors that focuses on energy consumption is the change in the volume of production of certain types of products. With the increase in the number of products produced, the consumption of energy resources most often increases. However, this is not the case in all cases. The influence of this factor cannot be considered separately from the factor of the structure of manufactured products. With the increase in production of less energy intensive products, the value of the main indicator of energy consumption - energy intensity - will decrease, and with significant structural changes the amount of consumed energy resources may decrease.

Table 2 – Classification of factors for effective energy conservation and energy efficiency policies

		Complex	Partial
		Internal factors	Increasing the technological level of enterprise production
Increasing the technological level of enterprise production	Optimization of the structure of consumption of energy resources; optimal distribution of energy loads; the use of secondary energy resources; improving the regulation, accounting and control of energy consumption; improvement of the system of economic stimulation of rational use of energy		
Improvement of the organization of production and labor of the enterprise	Improving the organization and structure of production; maximum load of power consuming equipment; change in production of certain types of products; reducing costs of marriage; improving the organization and improving the quality of repair of energy-consuming equipment		
External factors	Improving legislative regulation of energy consumption; strengthening of influence of bodies of State supervision on energy consumption; strengthening market influence; enhancing the social and environmental importance of energy savings; uninterrupted power supply		

Source: Developed by the author on the basis of [7 – 9].

Motivational factors are part of the mechanism of interest in achieving maximum economic and social performance. These may be factors of different origins, under the influence of which motivational action takes place. One of the main factors for stimulating the enterprise is the introduction of alternative energy sources, a sharp increase in natural gas prices and price volatility in the gas market, fuel and oil resources.

Increasing the price of fuel and energy resources drives the company to implement energy-saving measures and an energy-saving system.

The mechanism of development of the concept of energy saving taking into account the characteristics of agricultural enterprises is considered on the example of Kalashnik Private Enterprise.

An analysis of the energy resources used by the Kalashnik Private Enterprise is given in Table 3.

Table 3 – Volume of fuel and energy resources used Kalashnik Private Enterprise for 2016 – 2018.

Product	The volume of purchased resources in 2016		The volume of purchased resources in 2017		The volume of purchased resources in 2018	
		Cost (excluding grants and VAT), UAH.		Cost (excluding grants and VAT), UAH.		Cost (excluding grants and VAT), UAH.
Natural gas, thousand m ³	159	1097026	51	387090	74	892411
Petroleum products, t:	430	6977927	472	9729898	464	10302592
petrol	79	1616476	68	1762281	60	1815345
diesel fuel	351	5361451	404	7967617	404	10121047

Source: Developed by the author

Control over the volume of consumption of fuel and energy resources is carried out by the planning and economic department, which deals with the regulation, planning and accounting of fuel and energy resources. Of great importance is the personal interest of employees in saving energy, and therefore one of the factors may be the existence of a system of economic incentives for rational use of resources and an effective policy of energy conservation and energy use.

When choosing energy-saving measures at an enterprise, it is necessary to explore ways to reduce energy supply. In order to optimize the energy saving potential, the main directions of energy efficiency improvement at the enterprise are taken into account.

Energy-saving measures can minimize unnecessary energy losses, which is now one of the priority areas not only at the state level but also at the level of each individual enterprise. This is due to the scarcity of major energy resources, the rising cost of production, and global environmental problems.

The introduction of energy-saving technologies into the business activities of enterprises is one of the important steps in solving many environmental

problems – climate change, atmospheric pollution, depletion of fossils, resources and more.

Improvement of energy saving in Ukraine will be accompanied by reduction of energy consumption, conservation of fuel and energy resources, reduction of carbon dioxide emissions, as well as tendencies to decrease the price of electricity for enterprises.

Each state tries to adhere to the benchmarks in order to achieve the Sustainable Development Goals. The SDG was based on the energy security of the state, which in turn consists of the following tasks:

- accelerated development of traditional domestic energy sources (coal, oil, gas) to reduce import dependency;
- reduction of energy consumption by increasing energy efficiency, development of energy-saving technologies;
- development of clean energy technologies, development of alternative energy;
- ensuring the stability of the development of the national energy economy with a reasonable combination of market relations with state regulation, including prospective planning of the development of its industries;
- creation and systematic maintenance of appropriate volumes of strategic reserves of fuel and energy resources in case of various crises and force majeure circumstances [11].

On the basis of the analyzed scientific works, the main goals of sustainable development of the enterprise in ensuring the effective implementation of energy-saving technologies were identified (Fig. 3).

Implementation of energy-saving measures for a company can be conditionally divided into several types according to the sphere of operation:

- energy saving measures in production;
- energy saving measures in transport;
- energy saving measures of individual consumption;
- energy saving measures of general consumption [12].

From the above list of energy-saving measures, we distinguish those measures that can bring maximum effect in certain technological and economic conditions, at moderate costs of the enterprise. In order to get energy saving effect, it is possible to modernize the energy saving system and improve the existing technological processes.

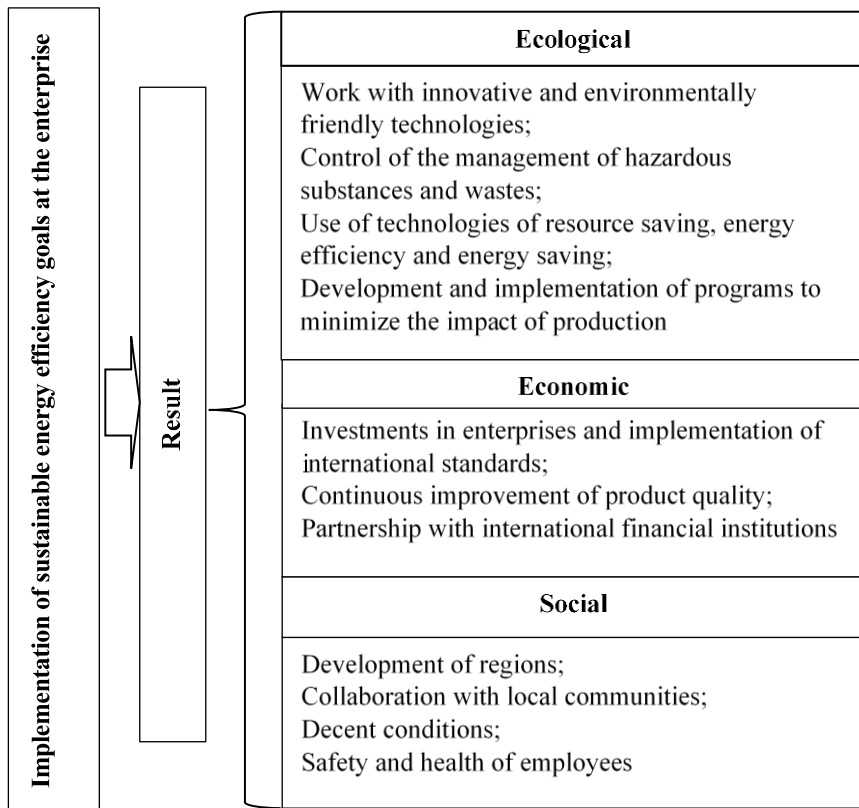


Fig. 3 – Sustainable energy development goals at the enterprise
 Source: Developed by the author

The development of the energy saving program of Kalashnik PE is based on the above calculations (Table 4) and includes the definition of the purpose of implementation, deadline and responsible persons.

Today, in the agrarian sector, the issue of increasing production volumes and increasing crop yields is a top priority. At the same time, agricultural production can be considered as highly efficient, which can be achieved by reducing costs, improving the quality and competitiveness of products. The basis of this method of management can be the efficient and rational introduction of the latest technologies and modern technology in production, namely zero tillage.

Table 4 – Energy Saving Measures Implementation Program at Kalashnik Private Enterprise

Activities	Implementation term	Responsibilities
Implementation of "zero tillage" of land, no-till technologies, which is accompanied by increased yields, reduced costs of fuel and lubricants, reduction of depreciation and depreciation of basic equipment	3-5 years	Chief engineer, agronomist, agronomist-chemist
Refurbishment of a gas boiler, using biomass, which will provide heating to the office space, which will reduce energy costs	1 year	Chief engineer, boiler manager

Source: Developed by the author

One of the important steps towards implementation is the diffusion of energy-saving agriculture technologies that will enable:

- to improve the quality of soils, which will be manifested in the restoration of their structure and content of humus, in the elimination of erosion processes, normalization of water and air regimes, the ecological environment;
- to save labor costs, investments and running costs;
- to obtain larger volumes of agricultural products with reduced land use.

For implementation, innovative resource-saving technologies in agriculture were proposed, namely (Table 5):

- precision farming;
- organic farming;
- zero technology;
- minimal technology.

The basic precision agriculture is a system that aims at obtaining from a certain land area the maximum amount of quality and cheaper products by creating a level playing field for all plants of this area without violating environmental standards. Precision farming involves the dosing of fertilizers, water into the soil according to the needs of the plants and the quality of the land.

Because there are heterogeneities within the same field, they are based on the latest technologies. Precise farming requires sophisticated technological support, based on the latest developments in electronic devices and satellite surveillance, and requires various sensors.

Soon organic farming is gaining popularity, namely, organic farming is a system that is mainly based on agroecosystem management, ie not only focused on production management, but also on the implementation of a set of measures that directly affect it in order to achieve economic, environmental and social effects.

Table 5 – Resource-saving technologies in agricultural production

The name of the technology	Characteristics of technology
Precision agriculture	Dosage of fertilizers, plant protection products, must be taken into account the local characteristics of the soil
Organic agriculture	Complete rejection of the use of GMO, antibiotics, fertilizers, agrochemicals. Apply natural fertilizers, mechanical pest control
Zero technology	Mineral application, cultivation, sowing, crop treatment with plant protection products
Minimal technology	Sowing with the introduction of mineral fertilizers, crop treatment with plant protection products, collection

Source: developed by the author [13].

However, agriculture is not only a production system, but also a way of life for the rural population in certain environmental conditions that make up the agro-ecosystem. This system takes into account the potential detrimental effects on the environment and humans of such synthetic additives as mineral fertilizers and pesticides, genetically modified organisms, and the like. All these methods lead to changes in organic agriculture, namely the preservation of soil fertility, preventing the spread of pests and the growth of diseases. Organic agriculture provides an opportunity to harmonize and harmonize environmental, economic and social goals in the agricultural sector in the future.

The basic principle of organic production is the rejection of genetically modified organisms, antibiotics, agrochemicals and mineral fertilizers. It is thanks to the abandonment of chemical components in the cultivation of the land can improve the biological fund of acreage, restore the balance of nutrients and increase the competitiveness of products on the market. At present, eco-products without the use of nitrates and phosphates are in high demand in the world.

Quite often in advanced agricultural enterprises used the minimum (Mini-till) and zero (No-till) cultivation technology. It is thanks to these two technologies of cultivation of acreage that the enterprise can partially or even completely refuse from mechanical tillage of the soil. Its main principles are:

- formation of crop rotation with minimal costs and increase of soil fertility;
- an integrated approach to weeds, pests and plant diseases;
- the use of higher reproduction seed materials, which cooperate with the latest technologies.

By implementing such innovations, it is possible to reduce the cost of depreciation, the cost of fuel and lubricants. After all, for 1 ha of cereals, with a complete cycle of sowing area is spent at zero cultivation of 40-35 liters, depending on the available equipment.

When choosing the parameters of technological solutions directly involved in agricultural production, where one of the components of the natural-land reclamation geosystem is soil, it is very important to strictly adhere to the technological discipline of minimizing its impact. NO-TILL creates conditions for preserving soil fertility:

- the right solution for sowing, a technical solution to the problem of NO-TILL technology, as poor crop yields in most cases can not be compensated, even by effective weed control;

- for NO-TILL technology the tractor must have a powerful motor and hence strong hydraulics (HTZ-17021, HTZ-150-05-09) to provide combined machines for continuous sowing with a lifting force of not less than 2100-2800 kg and causing extensive damage to the soil by running gear;

- Chemical solutions in NO-TILL technology include activities (weed control) to replace the lack of mechanical tillage.

- with NO-TILL tillage, crushed crop residues are evenly crushed in the process of combining in the field, the soil is untouched until the next crop sowing, which allows to retain more crop residues compared to other minimal cultivation.

Therefore, NO-TILL tillage technology is the basis of soil-protective agriculture, which can suspend soil degradation. The main reason for abandoning the intensive farming system in the leading countries of the world was the spread of erosion of agricultural land due to mechanical cultivation. Studies of leading domestic scientists indicate that in our country annually the area of degraded soils increases by 70.0 thousand hectares. Under these conditions, it is necessary to minimize mechanical tillage, where NO-TILL technology occupies a leading position (Table 6).

Table 6 – List of main types of agricultural work and their impact on the destruction of soil cover

Types of agricultural work	NO-TILL technology	Traditional technology
Tillage	-	+
Cultivation with unambiguous harrowing	-	+
Sowing	+	+
Caring for plants	+	+
Harvesting	+	+
Harvesting of post-harvest residues	-	+

Source: Developed by the author on the basis of [13]

In order to evaluate the economic feasibility of implementing a NO-TILL tillage system, it is necessary to compare it with the traditional and minimal tillage system.

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Enterprises that use such processing technologies have been researched and analyzed. Energy-saving soil tillage technologies are used by: «Olimp» Limited Liability Company of Kamyanskyi District, «Kyshchenci» Limited Liability Company of Mankovsky District, «Khatsky-Agro» Private Enterprise of Cherkasy District, «LNZ-Agro» Stock Company «Shpola-Agro-Industry» of Shpolyan district and others. These enterprises use «zero» (NO-till) and minimum (Mini-till) tillage technology (Table 7).

Thus, the price of selling 1 ton of grain in «LNZ-Agro» in the analyzed period is higher by UAH 573.86, in «Shpola-Agro-Industry» by UAH 390.94; profit per 1 oz of grain increased by 477,23UAH.

Table 7 – Economic efficiency of grain production in agricultural enterprises

Indicator	Kalashnik Private Company (Traditional)	LNZ-Agro Company (Mini-till)	ShpolaAgro-Industry Company (No-till)	Deviation from Kalashnik Private Company	
				LNZ-Agro Company	ShpolaAgro-Industry Company
Sown area, ha	2357,3	5185,0	3263	+2827,7	+905,7
Production of grain, c	200565	399437	164864	+198872	-35700
Productivity, kg / ha	85,1	77,0	50,5	-8,1	-34,6
Production cost of 1 c, UAH	111,12	198,52	221,03	+87,40	+109,9
The total cost of 1 c, UAH	115,11	211,75	256,91	+96,64	+141,80
The selling price of 1 c, UAH	167,55	741,41	558,49	+573,86	+390,94
Profit per c, UAH	52,44	529,67	301,58	+477,23	+249,14
Profitability level, %	45,6	250,1	117,4	+204,5	+71,8

The introduction of innovative tillage technologies will result in significant savings of resources (PMM, fertilizers, labor and time costs, reduction of depreciation and other deductions); to increase the profitability of agricultural production; to preserve and restore the fertility of the soil layer (improvement of its chemical, physical and biological qualities, increase of organic matter content in

the soil); reduce soil erosion (no need to spend extra money to solve this problem); reduce the dependence of the crop on weather conditions; increase crop yields.

The study also showed that through the use of innovative tillage technologies, it is possible to achieve:

- increase of economic effect in grain cultivation and its production;
- the introduction of zero tillage can stabilize the production and competitiveness of grain products;
- introduction of NO-TILL technology of cultivation of sowing allows to prevent land degradation, to preserve and restore soil fertility, to improve ecological state of the environment;
- increasing the popularity of the use of resource-saving technologies in the production of cereals.

The issue of rational use of energy in the context of constantly increasing prices for the main types of energy resources, which have a significant external dependence on suppliers, is particularly relevant. Energy efficiency is generally characterized by high economic efficiency. The savings from the implementation of energy saving measures, as a rule, significantly exceed the cost of the implemented measures already in the medium term. Therefore, the introduction of energy-saving technologies in all spheres of life of the enterprise should become a strategic direction for the development of the economy and social sphere, the transition from traditional types of energy to alternative ones, the introduction of heat generators using biomass [14].

According to the analysis of the company, it was found that energy-saving measures are aimed at technological re-equipment of the energy supply system, and not at modernization of the heating system. Therefore, the use of energy-saving technologies is quite advisable, because the monthly increase in gas tariffs and the unstable situation in the country, prompts the company to use alternative energy sources, inexhaustible fuels, crop waste, especially straw [15].

The main activity of the company is plant growing, growing, harvesting and selling products. A large area is occupied by crops of cereals and legumes, which makes it possible to use their biomass rather than burn it in the field or sell it. To implement this energy-saving measure, it is necessary to consider the sowing area of Kalashnik PE (Table 8).

When harvesting, a large amount of straw is left in the fields, in this case it is not only wheat straw, but all the stems and leaves of cereals and agricultural plants after threshing. Such wastes occur annually in large volumes, but are limited to use as litter or roughage in livestock, roofing material or raw materials for building materials, in folk crafts.

Table 8 – Sown areas of cereals and legumes of Kalashnik PE for 2016 – 2018

Product	Production output 2016		Production volume in 2017		Production volume 2018	
	Collection area, ha	Produced products, c	Collection area, ha	Produced products, c	Collection area, ha	Produced products, c
Winter wheat	779	32683	838	401491	818	41810
Spring barley	526	16456	483	18412	392	12415
Winter barley	-	-	47	1851	62	1940
Oat	25	657	38	1212	38	865

Biomass is a biodegradable organic matter that is biodegradable, waste from crop and livestock, forestry and technologically related industries, as well as the organic part of industrial and household waste.

That is, the definition of biomass means its most common varieties, including crop residues of agricultural production (straw, leaves, shavings, etc.) and the forestry industry (firewood, wood chips, etc.); raw materials of energy crops (energy willow, miscanthus, etc.) and agricultural production (silage of corn and other cereals) [16].

For the enterprise, bioenergy is one of the strategic directions for the development of the renewable energy sector, as there is dependence on imported energy sources (Table 9).

Table 9 – Main potential of vegetable waste

Kind of fuel	Energy potential, million tp / year
Cereal straw (without maize)	5,6
Stem, corn cobs on grain	2,4
Stem, sunflower husk	2,3

Source: Developed by the author

Vegetable crops and agricultural production, which are a source of energy, must be attributed to non-traditional sources and varieties of energy raw materials, according to legislative documents. Agricultural production is a powerful source of waste generation, which is biomass suitable for energy production [17].

The main varieties of this biomass are straw of different crops, waste of sunflower, corn and some others. Biomass energy has the potential of cereal and rapeseed straw, stalks, baskets and sunflower husks, corn stalks and corn seed kernels. The use of straw to produce heat is a rational way of disposing of its surplus, which is not used for other agricultural purposes. Straw is CO₂-neutral and therefore an environmentally friendly source of energy. In the process of straw

growth, the same amount of CO₂ released during its combustion is absorbed, straw is a local fuel, fairly common in agricultural areas, and a by-product of grain production, and is therefore a relatively inexpensive fuel compared to traditional ones. The money paid for the supply of gas, while burning straw, remains in the area and contributes to its development [13].

The widespread use of straw as a feedstock for biofuels contributes to the creation of a new generation of heating devices, namely heat generators, with an Efficiency Ratio ranging from 80 to 90 percent.

Straw-fired boilers are state-of-the-art heat generators in which reliable automation ensures the heating and hot water supply. The straw heat generator is an insulated (thermos), ready-to-operate installation with automatic equipment, providing the optimum mode of combustion of fuel and obtaining hot water with the necessary parameters and providing the required air temperature in the room, the installation of which requires no additional work on the preparation and construction of structures, except for the preparation of the foundation, the installation of the chimney and connection to the existing boiler heating system as the main or backup energy source [18].

Direct combustion technology is the most obvious way to release energy from biomass. It is simple, well-researched and commercially available. There are many types and sizes of direct combustion systems that can burn different types of fuel, including straw bales. In the chemical sense, combustion is the conversion of all organic materials to carbon dioxide and water in the presence of oxygen (usually atmospheric).

The main principle of using the UTEM RAU-2-600 heat generator is the use of biomass, namely straw. Modern heat generators in which reliable automation provides the process of heating and hot water supply. The automation of the boiler provides the necessary parameters of hot water and the required room temperature, as well as the optimum mode of combustion of fuel. In the presence of bale straw with the help of these heat generators it is possible to provide heat to all production facilities. Table 10 shows the characteristics of the heat generator.

The advantages of heat generators include low power consumption (about 0.5% of thermal power). When the foundation for the heat generator and thermal networks is ready, installation, installation and adjustment of the installation is carried out within one day.

The calculation of the required capital costs for the installation and adjustment of the equipment is given in Table 11.

The total cost was UAH 2602500. In order to calculate the feasibility of installing a boiler, it is necessary to determine the cost of thermal energy, namely the cost of 1 Gcal. In order to replace 1000 m³ of gas, it takes 3 tons of straw, the cost of 1 ton of straw is 280 UAH.

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Table 10 – Characteristics of the heat generator of the UTEM brand RAU-2-600 using biomass

№	Options		Units measurement.	UTEM RAU-2-600
				Value
1	Rated thermal output		kW	600
2	Recommended weight of one download		Kg	1000
3	Straw moisture recommended, up to		%	25
4	Maximum straw consumption per season (180 days)		T	900
5	Maximum water temperature,		C	90
6	Overall dimensions	Heat generator assembly	M	5,10*3,6
		Balls	M	2,8*3,0
7	Height to spillway of overflow of expansion tank		M	7,8
8	Diameter of pipes of direct and return network water		Mm	100
9	The surface area of heat exchange in the heat generator		M2	58,0
10	Total water capacity of the heat generator		L	41000
	Weight of the heat generator without water		T	14,2
	Electricity consumption		kW * year / day	6,0-10,0
11	Effectiveness factor		%	82
12	Topic gas temperature when leaving the heat generator		C	250

Source: developed by the author based [19]

Table 11 – Capital costs for equipment installation and commissioning

Costs	Cost, UAH
Organizational and administrative	10000
Design and approval	300000
Zero Cycle Works	32500
General construction work	130000
Supply of equipment	725 000
Delivery + state duty	80000
Installation of basic equipment	25000
Commissioning	50000
Auxiliary equipment	250000
Total	2602500

Source: Developed by the author

The calculations showed that the cost of 1Gcal of pure heat is 0.378t or 105.84 UAH. Knowing how much will cost 1 Gcal, you can calculate the cost of thermal energy, taking into account all the costs (table 12).

Table 12 – Calculation of cost of thermal energy

Costs	Cost, UAH
Fuel Raw Materials	105,84
Electricity	74,2
Diesel fuel	10,5
Individual entrepreneur	214,1
Amortization	40,1
Other	35,0
Total	479,49

Thus, the calculation showed that the cost of heat is 479.49 UAH / Gcal. To calculate the efficiency of implementation, it is also necessary to calculate the cost of gas. The tariff for natural gas is 9078.00 for industrial enterprises and other consumers as of June 1, 2018. The calculation showed that 1000m3 of gas is 3,892 Gcal, and the cost of 1 Gcal of energy for gas will be 2332,48 UAH / Gcal.

In order to provide fuel during the heating period 477 tons of straw is needed, if translated into the value, the amount is 133 560 UAH.

The most common indicators for evaluating the effectiveness of project decisions are the following indicators: net reported income, profitability ratio, payback period, internal rate of return [20].

Consider their essence:

Net income *NPV* is the difference between the present value of the net cash flow over the life of the investment project and the amount of investment costs to realize it. It is calculated by the formula:

$$NPV = \sum_{t=0}^n \frac{CF_t}{(1+i)^t} - \sum_{t=0}^n \frac{IC_t}{(1+i)^t} \quad (1)$$

CF_t – the amount of net cash flow at separate intervals of the total period of operation of the investment project;

IC – the amount of investment costs for the implementation of the investment project;

i – discount rate used;

n – the number of intervals in the total billing period t.

Profitability Index (*PI*), which is understood as the ratio of the present value of the net cash flow over the life of the investment project to the amount of investment costs for its implementation. It is calculated by the formula:

$$PI_0^A = \frac{\sum_{i=1}^n \frac{CF_t}{(1+i)^n}}{\sum_{i=1}^n \frac{IC_t}{(1+i)^n}}. \quad (2)$$

Payback period (*PP*) is the interval of time from the beginning of the project implementation, during which the total revenues from the project implementation and the total project costs are achieved and beyond which the resulting profit remains positive.

$$PP = \frac{IC}{\left(\frac{\sum_{i=1}^n \frac{CF_t}{(1+i)^n}}{n} \right)}. \quad (3)$$

The internal rate of return (*IRR*) is defined as the discount rate at which the value of the realized proceeds from the sale is equal to the amount of the project cost. *IRR* describes the rate of return on capital invested in a project. It is calculated by the formula:

$$IRR = i_1 + \frac{NPV_1 \times (i_2 - i_1)}{(NPV_1 - NPV_2)}, \quad (4)$$

NPV_t – the amount of net cash flow at separate intervals of the total period of operation of the investment project;

n – the number of intervals in the total calculated period t .

The discount rate for this project will include a forecast inflation rate for 2018 of 14%, taking into account fluctuations in demand, supply disruption, and poor management of operational processes. In general, we accept a discount rate of 14% per annum, which will characterize the dynamics of the decrease in the real value of future cash flows and bring them to the initial year of investment, namely 2018.

Calculation of net present value NPV at a discount rate of 14% by the formula 1: $NPV = 3385302$ UAH

Profitability Index determined by the formula 2:

$$PI = 3973031/2602500 = 2,3$$

Payback period is calculated by the formula 3:

$$PP = 10/2,3 = 4,3 \text{ years}$$

Internal rate of return is defined by the formula 4:

$$IRR = 14 + ((3385302 * (26 - 14)) / (3385302 - 1370531)) = 14 + 20,16 = 34,16\%$$

Calculations of key performance indicators for the implementation of an energy-efficient investment project are summarized in Table 13.

Table 13 – Performance indicators for the implementation of an energy-efficient investment project

Investment indicators of the project	Indicators	
Estimated time	Years	10
IRR Internal Rate of Return	%	34,16
Net present value NPV at a discount rate of 14%	UAH	3385302
Net present value NPV at a discount rate of 26%	UAH	1370531
Payback period	Years	4,3

Source: Developed by the author

The analysis of the main indicators of the effectiveness of the implementation of the investment project of Kalashnik PE has made the following conclusions:

- net present income at a discount rate of 14% per year is UAH 3385302 thousand. for a project implementation period of 10 years;
- net adjusted income at a discount rate of 26% per year is UAH 1370531 thousand. for a project implementation period of 10 years;
- the index of return on investment at a discount rate of 14% per year is 2.3;
- payback period – 4 years 3 months from the moment of project implementation;
- internal rate of return of 34.16%.

Thus, the implementation of the investment project – replacement of the boiler is appropriate for the formation of an effective policy of energy saving of the enterprise, which will reduce energy consumption and have a positive economic effect.

Let us determine the correlation dependence of the energy intensity of the implemented measures as a resultant indicator of cost effectiveness on the indicators of their formation. Yes, we will take the energy intensity indicator as an effective sign – Y. In theory, the factors that can affect the result should reflect both the efficiency of the formation processes and the efficiency of using the enterprise costs. In our opinion, the most influential factors will be:

- yield t / ha;
- mechanization of labor, which characterizes the ratio of the total book value of machines and mechanisms and the average number of employees;
- cost level for 1 UAH of production.

Denote the identified factors respectively as X_1, X_2, X_3 . To summarize the output, we summarize them in Table 14.

Table 14 – Baseline data for correlation-regression analysis based on performance of Kalashnik PE

Functional variable indication	Years		
	2016	2017	2018
1	3	4	5
Energy intensity of production (Y)	225,95	399,56	798,04
Yield t / ha. (X_1)	4,82	5,11	4,7
Mechanical Labor UAH / UAH (X_2)	302,31	228,85	263,27
Cost of 1 UAH of production, UAH / UAH. (X_3)	0,41	0,40	0,49

In this case, the linear model looks like this:

$$y_i = \beta_0 + \beta_1 x_{1i} + \beta_2 x_{2i} + \dots + \beta_m x_{mi} . \tag{5}$$

For sample volume n we have a system of linear equations:

$$\begin{aligned} y_1 &= \beta_0 + \beta_1 x_{11} + \beta_2 x_{21} + \dots + \beta_m x_{m1} + \varepsilon_1, \\ y_2 &= \beta_0 + \beta_1 x_{21} + \beta_2 x_{22} + \dots + \beta_m x_{m2} + \varepsilon_2, \\ y_3 &= \beta_0 + \beta_1 x_{31} + \beta_2 x_{32} + \dots + \beta_m x_{m3} + \varepsilon_3, \\ &\dots \tag{6} \\ &\dots \\ y_n &= \beta_0 + \beta_1 x_{1n} + \beta_2 x_{2n} + \dots + \beta_m x_{nm} + \varepsilon_n, \end{aligned}$$

ε_i – a random variable having a normal law of distribution with numerical characteristics $M(\varepsilon_i) = 0$, $D(\varepsilon_i) = M(\varepsilon_i^2) = \sigma_\varepsilon^2$ and $K_{ij} = 0$. In a vector-matrix form the system takes the following form:

$$\vec{Y} = X\vec{\beta} + \vec{\varepsilon}, \tag{7}$$

$$\vec{y} = \begin{pmatrix} y_1 \\ y_2 \\ \dots \\ y_n \end{pmatrix}; \quad \vec{\beta} = \begin{pmatrix} \beta_0 \\ \beta_1 \\ \beta_2 \\ \dots \\ \beta_n \end{pmatrix}; \quad \vec{\varepsilon} = \begin{pmatrix} \varepsilon_1 \\ \varepsilon_2 \\ \dots \\ \varepsilon_n \end{pmatrix}; \quad X = \begin{pmatrix} 1 & x_{11} & \dots & x_{1m} \\ 1 & x_{21} & \dots & x_{2m} \\ \dots & \dots & \dots & \dots \\ 1 & x_{n1} & \dots & x_{nm} \end{pmatrix}.$$

The size X matrix $(m+1) \times n$ is called a regression, and the elements x_{ij} of this matrix are called regressors. The equation parameters are constant but unknown. These estimation parameters are statistical point estimates $\beta_0^*, \beta_1^*, \beta_2^*, \dots, \beta_m^*$ that are obtained by processing the sampling results and are random variables. Thus, the equation corresponds to a statistical estimate:

$$y_i = \beta_0^* + \beta_1^* x_{i1} + \beta_2^* x_{i2} + \dots + \beta_m^* x_{im} + \varepsilon_i. \quad (8)$$

The statistical estimate for the vector \bar{y} will be determined by the vector

$$\bar{y} = X\bar{\beta}^* + \bar{\varepsilon}, \quad (9)$$

$$\bar{y} = \begin{pmatrix} y_1 \\ y_2 \\ \dots \\ y_m \end{pmatrix}; \quad X = \begin{pmatrix} 1 & x_{11} & \dots & x_{1m} \\ 1 & x_{21} & \dots & x_{2m} \\ \dots & \dots & \dots & \dots \\ 1 & x_{n1} & \dots & x_{nm} \end{pmatrix}; \quad \bar{\beta}^* = \begin{pmatrix} \beta_0^* \\ \beta_1^* \\ \beta_2^* \\ \dots \\ \beta_m^* \end{pmatrix}; \quad \bar{\varepsilon} = \begin{pmatrix} \varepsilon_1 \\ \varepsilon_2 \\ \dots \\ \varepsilon_n \end{pmatrix}.$$

The vector of errors will be equal to:

$$\bar{\varepsilon} = \bar{y} - X \cdot \bar{\beta}^*. \quad (10)$$

The least squares method is used to determine the vector $\bar{\beta}^*$ components (statistical point estimates of the vector components $\bar{\beta}$).

The matrix X contains m linearly independent column vectors, which means that its rank is m and the determinant $|X'X| \neq 0$. Therefore, the matrix $X'X$ is inverted.

The variances of the statistical estimates $\beta_0^*, \beta_1^*, \beta_2^*, \dots, \beta_m^*$ are determined using a correlation matrix for the vector $\bar{\beta}^*$, $K(\bar{\beta}^*) = M(\bar{\beta}^* - \bar{\beta})(\bar{\beta}^* - \bar{\beta})'$.

As $(X'X)^{-1}(X'X) = E$, we get it:

$$\vec{\beta}^* = \vec{\beta} + (X'X)^{-1} X' \vec{\varepsilon}. \quad (11)$$

Then we have:

$$\vec{\beta}^* - \vec{\beta} = (X'X)^{-1} X' \vec{\varepsilon}, \quad (12)$$

$$(\vec{\beta}^* - \vec{\beta})' = ((X'X)^{-1} X' \vec{\varepsilon})' = (\vec{\varepsilon})' X (X'X)^{-1}. \quad (13)$$

So we have:

$$K(\vec{\beta}^*) = \sigma_{\varepsilon}^2 (X'X)^{-1}. \quad (14)$$

Since σ_{ε}^2 it is an σ_{ε}^2 unknown quantity, it is instead substituted for a point unbiased statistical estimate by analogy with (13).

$$S_{\varepsilon}^2 = \frac{\sum (\varepsilon_i^*)^2}{n - m - 1}, \quad (15)$$

where n is the number of observations and m is the number of estimated parameters of multiple linear regression.

The tightness between the signs Y and X , where $X = (x_1, x_2, \dots, x_m)$, is measured by the multiple correlation coefficient R , which is a generalization of the paired correlation coefficient r_{ij} and is calculated by the formula:

$$R = \sqrt{1 - \frac{\sum \varepsilon_i^2}{\sum (y_i - \bar{y})^2}}. \quad (16)$$

The closer R is to ± 1 , the better the regression function is selected

$$y = \alpha(x_1, x_2, \dots, x_m).$$

In this case $\sum (y_i - \bar{y})^2 = \sum y_i^2 - n(\bar{y})^2$, and since $\sum (y_i)^2 = (\bar{y})' \bar{y}$, then we finally have:

$$R = \sqrt{1 - \frac{(\bar{y}^*)' \bar{y} - (\bar{\beta}^*)' X' \bar{y}}{(\bar{y})' \bar{y} - n(\bar{y})^2}}$$

Using the MS Excel spreadsheet, we calculate the regression parameters. The matrix of endogenous variables:

$$X = \begin{vmatrix} 1 & 4,82 & 302,31 & 0,41 \\ 1 & 5,11 & 228,85 & 0,4 \\ 1 & 4,7 & 263,27 & 0,49 \end{vmatrix}$$

The matrix of exogenous variables:

$$Y = \begin{vmatrix} 225,92 \\ 399,56 \\ 798,04 \end{vmatrix}$$

We find the product of an endogenous matrix and a transposed endogenous matrix:

$$X^T = \begin{vmatrix} 1 & 1 & 1 \\ 4,82 & 5,11 & 4,7 \\ 302,31 & 228,85 & 263,27 \\ 0,41 & 0,4 & 0,49 \end{vmatrix}$$

$$X^T * X = \begin{vmatrix} 3 & 14,63 & 794,43 & 1,3 \\ 14,63 & 71,4345 & 3863,927 & 6,3232 \\ 794,43 & 3863,927 & 213074,8 & 344,4894 \\ 1,3 & 6,3232 & 344,4894 & 0,5682 \end{vmatrix}$$

Let's calculate the estimation of least-squares methods:

$$(X^T * X)^{-1} = \begin{vmatrix} 4,01E+15 & -5,58E+14 & -1,95742E+12 & -1,79164E+15 \\ -5,58E+14 & 7,746E+13 & 2,71918E+11 & 2,48889E+14 \\ -1,96E+12 & 2,719E+11 & 954524195,9 & 8,73685E+11 \\ -1,79E+15 & 2,489E+14 & 8,73685E+11 & 7,99692E+14 \end{vmatrix}$$

$$X^T Y = \begin{vmatrix} 1423,52 \\ 6881,474 \\ 369837,2 \\ 643,4908 \end{vmatrix}$$

$$B=(X^T * X)^{-1} X^T Y = \begin{vmatrix} -3712 \\ 96 \\ -2,5625 \\ 5888 \end{vmatrix}$$

So the regression equation will look like this:

$$Y = 3712 + 96 * X_1 - 2,5625 * X_2 + 5888 * X_3.$$

You also need to calculate the strength of the relationship between the group of factors and the result, Pearson's multiple correlation coefficient (determination). To do this, we use formulas (16) and (17).

With the help of MS Excel editor we will calculate. The theoretical values of the results for 2016 – 2018 have the following vector:

$$Y_{teor} = \begin{vmatrix} -1609,86938 \\ -1452,66813 \\ -1050,30938 \end{vmatrix}$$

Error $\hat{\epsilon} = Y - Y_{teor}$ has the following vector:

$$\hat{\epsilon} = \begin{vmatrix} 1835,7894 \\ 1852,2281 \\ 1848,3494 \end{vmatrix}$$

The multiple correlation coefficient is calculated by the formula 17:

$$R = \sqrt{1 - \frac{\sum \epsilon_i^2}{\sum (y_i - \bar{y})^2}}.$$

According to the calculation, we obtain that the Pearson correlation coefficient for multiple regression equals:

$$R = 0,816494 \text{ or } 81,64 \%$$

Therefore, the power of connection is quite high, that is, it is legitimate to assume that the factors selected cumulatively affect 81.64% of the result.

For practical application of the constructed model it is necessary to check its adequacy - to determine the statistical significance of the coefficient of determination and the model as a whole using the Fisher test, where the calculated value is determined by the formula:

$$F = \frac{R^2}{1-R^2} * \frac{n-m-1}{m}, \quad (18)$$

R^2 – coefficient of determination,
 n – the amount of data observed,
 m – number of independent variables.

For a given reliability α and degrees of freedom m and $(n-m-1)$, we find the critical value of the Fisher distribution, using a built-in mathematical integrator in MS Excel. If F is $> F$ critical, then the reliability α can be considered to be statistically significant and the factors included in the regression explain the stochastic dependence of the result sufficiently.

According to the results of calculations we get:

$$F_{calc.} = 3,499924.$$

Using the built-in Fisher inverse distribution function, for a given reliability $\alpha = 0.85$ (probability of adequacy of the economic-mathematical model to the real environment) and $n = 12$, $m = 4$, we have:

$$F_{crit.} = 2,9959.$$

Because the requirement $F_{calc} > F_{crit}$, then it is legitimate to claim that the model is adequate and with a probability of 85% reflects the reality of the economic environment.

The level of regression shows that yields increase, but not at the expense of technical upgrades, and the soil tillage technology itself provides this result; mechanization of labor will be reduced, which will allow to reduce costs a little and to increase energy efficiency.

Investigating a fairly large area of acreage, attention was paid to a sufficiently large number of inputs in the production of cereals of different types of fertilizers and rather significant costs for fuel and energy resources. An energy-saving measure has been proposed to implement the transition from "traditional" tillage to "zero" tillage.

It is possible to achieve the following result by introducing zero cultivation of acreage:

- reduce the cost of fuel and energy resources in the treatment of acreage;
- reduce wear and tear by reducing load and reducing agricultural work;
- allows to grow environmentally friendly products, which in the future will allow to enter a new market of sales;
- reduces the cost of labor, equipment and fuel;
- cultivation of self-sowing material of the highest grade;
- not to spend additional money for the renovation of the technopark.

Another proposed energy-saving measure at the plant is the replacement of a gas boiler with a UTEM RAU-2-600 brand heat exchanger using biomass, namely straw. To reduce the cost of natural gas, it is advisable to use straw as biofuel.

After calculating the key performance indicators for the implementation of an investment project for Kalashnik PE, we can draw the following conclusions:

- net present income at a discount rate of 14% per year is UAH 3385302 thousand. for a project implementation period of 10 years;
- net adjusted income at a discount rate of 26% per year is UAH 1370531 thousand. for a project implementation period of 10 years;
- the index of return on investment at a discount rate of 14% per year is 2.3;
- payback period – 4 years 3 months from the moment of project implementation;
- internal rate of return – 34.16%.

Thus, the implementation of the investment project is appropriate for the formation of an effective system of energy saving of the enterprise and will allow to reduce the level of energy consumption, to obtain a positive economic effect [21].

Therefore, it is through the implementation of the energy conservation program at Kalashnik PE that it is possible to achieve a reduction in the cost of fuel and energy resources, to achieve a positive economic effect and to reduce the impact of technical means on soil degradation, which will be quite positive for the sustainable development of the enterprise, as social, economic and environmental.

On the basis of the analysis of the program of improvement of energy-saving policy of a private enterprise, the prospects of development of the agricultural enterprise were formed taking into account economic, political, social and natural-climatic conditions. Table 15 presents the main prospects and risks of energy efficient enterprise development.

Economics Energy Efficiency: Problems of Nowadays and of the Future

Table 15 – Prospects and risks of energy efficiency PE «Kalashnik»

Prospects	Risks
Economic	
1. Domestic agricultural producers have the opportunity to occupy a niche in the global food market, namely the niche of organic production. 2. Ensuring the internal market for agricultural products.	1. The low level of competitiveness of the domestic agricultural sector in the world food market. 2. Poor development of market infrastructure of domestic food markets. 3. Lack of effective control over the use of funds. 4. Domination of intermediaries.
Political	
1. Political support for agricultural enterprises. 2. Development of a legal framework for the agricultural sector.	1. Low level of legal protection of agricultural enterprises in comparison with foreign countries. 2. Imperfect tax system. 3. Changes in the electronic VAT administration system for agricultural enterprises.
Social	
1. Financial aid to kindergarten, school, home for the elderly, football teams villages Kalashniki, Ploske and others.	1. Professional, cultural and spiritual degradation of the rural population. 2. Low social living conditions in rural areas.
Natural and climatic	
1. Favorable natural conditions. 2. The presence of black soil.	1. Instability of natural and climatic conditions. 2. The use of living organisms.

Source: Developed by the author

The analysis made it possible to evaluate the efficiency of implementation of the energy conservation program and its main components, namely the readiness of the personnel of the enterprise to interact with the management in order to achieve the set goal, measures for the technological and technological equipment of the production process.

The research showed that through the use of innovative tillage technologies, it is possible to achieve:

- increase of economic effect in grain cultivation;
- the introduction of zero tillage can stabilize the production and competitiveness of grain products;
- introduction of NO-TILL technology of cultivation of sowing allows to prevent land degradation, to preserve and restore soil fertility, and to improve ecological state of the environment;
- increasing the popularity of the use of resource-saving technologies in the production of cereals.

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FORMATION OF ENERGY SAVING POLICY FOR AGRICULTURAL ENTERPRISES ON THE BASIS OF EUROPEAN EXPERIENCE

1. European experience of energy saving policy formation in agricultural enterprises

The development of the Ukrainian economy largely depends on the solution of the problem of providing energy carriers. The insufficient volume of its own energy resources forces the Ukrainian government to make decisions on significant imports. Today, the world is trying to solve the problem of energy carriers on the basis of new approaches, which are based on: first, improving the technological process in terms of energy intensity of production; second, developing energy conservation; and third, expanding energy production through renewable sources. In economically developed countries, the share of energy produced from renewable sources is growing. Ukraine is an energy-deficient country that imports 75 % of natural gas and 85 % of oil and petroleum products. This structure of the fuel and energy balance is critical and unacceptable from the point of view of energy security.

Efficient use of energy is one of the integral indicators of the development of the economy, science and socio-cultural development of the nation. According to this indicator, Ukraine is among those States where the stagnation of the existing situation can provoke a serious economic crisis with subsequent large-scale social upheavals. One of the largest consumers of energy in the national economy is agricultural production. Thus, the agro-industrial complex of Ukraine consumes 35 million tons of conventional fuel per year, half of which is in the form of scarce liquid fuel. Therefore, in the coming years, it is necessary to improve the energy base of agricultural production, and first of all, to provide heat and energy for housing and communal needs. However, these tasks are still being solved without proper economic justification.

The experience of advanced foreign countries in energy saving is difficult to borrow, because energy and agriculture have developed behind other economic

schemes, which means that the technological level of agricultural production is significantly lower than the world [1]. With regard to crop production, the following areas of economy and rational use of fuel and energy resources can be identified [2]:

1. Development and implementation of a system of measures to improve soil fertility and crop productivity.
2. Improvement, development and implementation of energy-saving production technologies.
3. Improving the management system by developing and implementing organizational, technical and economic measures that reduce losses and save oil products.
4. Development of normative-technological and methodological documentation for mechanized processes and technical means.
5. Improvement and development of new energy-saving equipment.
6. Use of non-traditional energy sources.

The first direction includes the preparation and improvement of fields, land reclamation, increasing soil fertility, introduction of high-yielding resistant varieties of crops, and seed preparation. This area is very important and requires a comprehensive solution, but the mechanization of work in it is not decisive. The second direction covers minimizing tillage, combining technological processes, transferring some technological processes to a hospital, replacing energy-intensive processes with less energy-intensive ones, and other measures. The third direction provides for optimizing the structure of acreage; optimizing the structure of machine-transport mechanisms; improving maintenance and repair of machine-transport mechanisms; rational aggregation of agricultural machinery; improving storage, transportation, refueling and accounting of petroleum products; improving the incentive system for employees to save oil products; rational organization of the use of machine-tractor units; improving the organization of cargo transportation [3].

The fourth direction covers standardization of the assessment of fuel and energy costs for technologies and technical means; development of standards for the consumption of petroleum products; development and implementation of methods for assessing fuel and energy costs in agricultural production technologies; development of methods for calculating the required amount of petroleum products at various levels. The fifth direction involves the creation of technical types of energy saving, namely engines with lower specific fuel consumption (up to 190 ... 200 g / kW.h); increasing the share of production of crawler tractors; equipment for all tractors with devices for determining the optimal engine operating modes; introduction of computers to optimize engine operating modes; reducing the impact of propellers on the soil by using low-pressure tires and rubber-metal tracks; introduction of mobile power tools that run on gas and using alternative fuels; development of energy-saving equipment, improving the reliability of equipment, etc. Universalization of tractors can reduce

energy consumption by 20 ... 25%. The use of combined machine-tractor units will help to reduce energy consumption for soil preparation and sowing by 15 ... 20%.

The sixth direction includes the use of solar energy, wind, heat from underground sources, and agricultural waste to produce biogas. This area also includes measures and projects to replace petroleum products with other types of fuel that are manufactured on the basis of crop production (alcohol, oil, and others) [3]. In the process of using the machine and tractor fleet, special attention should be paid to the second and third directions, which can be implemented directly in farms and provide up to 55% of the relative improvement in fuel efficiency. Analysis of factors and limits of changes in the proportions between economic growth and energy consumption confirm that now the driving force of energy saving in Ukraine is the transition to a resource - and energy-saving type of economic growth [5].

There are no sufficient own resources to cover energy-intensive production. It is impossible to solve the problem by increasing the exploitation of labor and actually reducing wages, since this will mean a narrowing and collapse of the domestic market, which creates conditions for bankruptcy. At the same time, step-by-step and consistent energy saving can save up to 1/3 of energy resources. The saved funds can be used to update outdated technical base, develop new technologies, and raise the standard of living of the people.

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There are no sufficient own resources to cover energy-intensive production. It is impossible to solve the problem by increasing the exploitation of labor and actually reducing wages, since this will mean a narrowing and collapse of the domestic market, which creates conditions for bankruptcy. At the same time, step-by-step and consistent energy saving can save up to 1/3 of energy resources. The saved funds can be used to update outdated technical base, develop new technologies, and raise the standard of living of the people.

Priority development of agriculture has always been one of the main economic tasks of the EU. Previously, this task was solved by implementing appropriate policies within individual States. The growing problem of energy and competition and strengthening the connection of politics with the economy has put the issue of energy security of the EU countries at the European level. Western politicians and businesses see the solution to the energy problem in strengthening

integration processes in the sphere of energy supply for the economy and socio-cultural sphere on a single organizational and legal basis. The creation of a pan-European energy market was started in the 90s with the adoption of relevant directives. The main documents regulating the new EU energy policy are the Energy Charter and the Energy Charter Treaty.

These documents pursued such strategic goals as strengthening the EU's energy security, increasing the competitiveness of the economy of the NATO countries, preventing the monopoly pressure of energy exporters on importers, improving the environment, and reducing energy prices.

Documents defining the General rules for the functioning of the domestic electricity and gas market, which were based on the unity of legal instruments, transparency of companies' activities in the energy market, free access to it for new participants, and prevention of monopolization. The EU's energy policy is developed by all EU governing bodies, but the main role is played by the European Commission. Operational issues are handled by the Directorate General for energy and transport. In 2003, at the initiative of the European Commission, new important decisions were adopted, which were enshrined in directives 2003/55/EC and 2003/54/EC. They define liberalization as the main means of optimizing the market, and broad access to the capital market with the supply of energy services and lower prices for such services as a promising goal of liberalization.

The documents defined the principles of market functioning that would ensure free competition, company development, and consumer interests. There were difficulties regarding the requirement to separate vertically integrated companies. In 2006, the so-called "Green book" was published, which outlines the main approaches to the essence of the new energy policy, its main tasks and means of solving these problems. The book highlights the need for a stable supply of energy to the EU from energy exporting countries, the importance of market liberalization, the need to save energy resources and develop new technologies in the energy sector, and the strengthening of environmental requirements for energy consumption. The EU's specific targets in the energy sector are to reduce energy supply by 13 % by 2020, bring the share of renewable energy sources to 20 %, and reduce carbon emissions by 20 %. In January 2007, an integrated package of actions was adopted to reform the energy sector and form a unified energy system [5].

The main tasks defined by the new document are infrastructure development, reducing the external vulnerability of the European Union countries, and combating negative climate change. The attitude towards nuclear power, which is now considered an important factor in enhancing energy security, is changing, and scientific research on the possibilities of using hydrogen as energy is being intensified. The legal, informational and organizational work carried out gave the experts reason to believe that the middle of 2007 was the time when the liberalization of the European Union market was formally completed. The formal reaction to the decision on further liberalization was more than positive – 13 States out of 27 opened

their markets ahead of schedule. Relevant changes were also made to the legislation. However, it should be noted that there is a different vision of the essence of liberalization and the ways of its implementation among EU members.

Thus, in small countries where there are no super-powerful multinational companies, there were no reservations about the policy of liberalization. A different position was taken by countries such as Germany, France, and Italy, where powerful energy companies are built on the principle of vertically integrated [5].

These corporations did not accept the European Commission's demands to liquidate their structures as fair. They pre-empted new m & a decisions by the stronger and the weaker, and thus defended their positions at the national level. In addition, they regarded the actions of the European Commission as discriminatory. There was a categorical disagreement with the intentions of European Union officials to achieve the separation of the transport sector from the production sector into an independent one. The long search for a compromise led to an adjustment of the energy policy. In September 2007 The European Commission submitted the so-called third energy package, adopted in April 2009, for consideration by EU members. The package included a number of legal acts, namely:

- Proposal for a Regulation of the European Parliament and of the Council establishing an Agency for the Cooperation of Energy Regulators);

- Proposal for a Directive of the European Parliament and of the Council amending Directive 2003/55/EC of the European Parliament and of the Council of 26 June 2003 concerning common rules for the internal market in natural gas;

- Proposal for a Directive of the European Parliament and of the Council amending Directive 2003/54/EC of 26 June 2003 concerning common rules for internal market in electricity;

- Proposal for a Regulation of the European Parliament and of the Council amending Regulation (EC) № 1775/2005 on conditions of access to the natural gas transmission networks;

- Proposal for a Regulation of the European Parliament and of the Council amending Regulation (EC) № 1228/2003 on conditions of access to the networks for cross-border exchanges in electricity.

The documents of the third package allow the "parent" company to keep the distribution network Manager under its control, provided that he is independent in management matters. An important aspect of the third package is the third-country regulation, which obliges foreign corporations that are admitted to the European distribution system to comply with the EU market rules. This means that the exporter will not be able to arbitrarily set prices in a particular country based on subjective wishes. However, this does not mean that the problems have been solved and there will not be a political, subjective or other factor in the European energy market. It is necessary to take into account that today in the European market, consumers actually enter into relations with the energy exporter at the level of national States [5]. It is necessary to take into account that today in the European

market, consumers actually enter into relations with the energy exporter at the level of national States [5].

The issue of free choice of an external supplier is problematic in the current conditions. Thus, the EU's legislative activity in this area, without relying on real diversification, remains declarative. It should also be added that the EU's energy policy can be considered as having two vectors-internal and external. If there is a certain unity of understanding of energy problems and ways to solve them in the interaction of EU countries within the Union, there is no such unity in the understanding of the foreign economic strategy on energy issues. It is obvious that the current state of Affairs has developed according to the action of a number of reasons. First of all, it should be noted that the EU countries have different levels of energy supply with their own energy resources. If Norway and Denmark are relatively provided with primary energy sources, and Poland and the United Kingdom have significant reserves of coal, which reduces the severity of energy problems, then for such States as Austria or the Czech Republic, the import of energy resources is a matter of survival; secondly, European countries differ in their geographical location [5].

States located in the North of Europe require more energy resources. At the same time, they have limited opportunities to use solar energy. Southern countries consume less energy in the residential sector and have broader prospects for solar energy development. In addition, the geographical position of Maritime powers allows them to solve the issue of energy supplies, using a tanker fleet, which is denied to continental countries. The distance between countries and energy exporting countries is also different; third, EU countries differ in their structure and scale of production, which is also a factor in energy consumption. The level of production is also different, which means that the opportunities for energy efficiency are different; fourth, each of the countries formed its own energy balance based on established economic relations in this area with other countries. If, for example, Germany has five independent and sufficiently reliable sources of energy supply, the Czech Republic is limited to one; fifth, the mechanism for meeting energy needs in the EU is market relations and competition, for which regulatory policy is limited [5].

Based on the new energy policy, the EU attaches great importance to energy conservation. The importance of energy saving is explained by the fact that thanks to it, significant hydrocarbon resources are saved, consumers' financial resources are saved, and carbon dioxide emissions are reduced.

In October 2016, the European Commission presented an updated energy saving action plan, which set strict energy efficiency standards for 23 product groups.

Special energy-saving controls relied on lighting devices for street and household use. The development and monitoring of plans to improve the energy efficiency of artificial lighting systems is entrusted to a special working group created in early 2007 – ROMS (Roll out Member States).

Energy savings will also be facilitated by the introduction of new European lighting standards in the design of lighting installations: EN 12464-1 (Lighting of work places in premises); EN 15193-1 (energy assessment of buildings. Energy requirements for lighting-assessment of electricity needs for lighting). According to article 12 of the ESD (Energy Services Directive) The European Commission has delegated a mandate to the European Committee for standardization in electrical engineering (CENELEC) to develop special standards for energy conservation.

Such standards should provide for agreed methods for calculating the energy efficiency characteristics of buildings as a whole and of individual products, installations and systems in a complex of engineering equipment.

In December 2008, the European Commission decided to abandon incandescent lamps. According to the adopted document, light sources that consume a lot of electricity will be gradually replaced until September 2016. According to experts, such measures will reduce electricity consumption by 3-4 %. The energy saved as a result of the introduction of new lighting devices in offices and residential areas will be enough to provide lighting for a country like Romania.

On December 9, 2008, the governments of the EU member States and the European Parliament adopted a bill on increasing the use of renewable energy sources by 20% until 2020, reducing the use of electricity and greenhouse gas emissions by the same amount. The document provides for an increase in the share of biofuels in the EU energy sector to 10 %, as well as an increase in spending on research in the energy sector by 50 %. Energy saving programs are implemented by all EU countries. In this regard, the experience of those companies that have made the most progress in energy conservation is valuable [6].

Denmark is one of the European countries whose experience in energy saving is the most systematic and long-lasting. In the 60s of the last century, the Danish economy experienced a significant recovery. The basis of the energy potential was oil and petroleum products, which accounted for almost 90 %. The energy crisis of the seventies and the sharp rise in prices for hydrocarbons forced the country's authorities to rethink state policy in the energy sector and make significant adjustments. The first step in this direction was the creation of a national energy supply planning system. The tasks of energy supply were solved in stages with the accumulation and use of the potential of the previous stages.

At the first stage, an energy plan was developed, which was put into effect in 1976. The main task of implementing this plan was to ensure a reliable power supply. The implementation of tasks envisaged implementation of measures for diversification of energy supply, creation of legislative base of energy supply, introduction of energy taxes, drawing up maps and schemes of power supply of certain areas of the country. In 1981, the second energy plan was put into effect, aimed at consolidating the results achieved and developing energy conservation. Taking into account high oil prices, state authorities are consistently reducing its

share in the country's fuel balance, increasing the consumption of biogas, straw, wood shavings, household and agricultural waste, and agricultural waste heat. Practice has shown that combined heat and electricity production, as well as the use of district heating networks with high-tech thermal insulation, proved to be the most effective from an economic point of view.

Denmark is one of the leading countries in the world in terms of the share of Central heating. Almost all cities have Central heating, covering about 50 % of Denmark's homes. In 1990, the third energy plan was adopted, which was a continuation of the previous stages and took into account the aggravation of environmental problems. Since the country's heat supply structure was currently well developed, the main efforts were focused on reducing carbon emissions into the atmosphere. This task is also being addressed at this stage within the European Union. The peculiarity of heat supply in Denmark is that the owners of the heat supply company through the municipality are all consumers who are connected and use the system. Due to this, the population is interested in improving the efficiency and reliability of heat utilities, as well as in reducing the price for providing services for thermal energy [6].

The realization of this goal is facilitated by the fact that consumers have wide opportunities to account for and regulate heat consumption, which in practice leads to significant savings in energy resources. It is also important to note that heat energy producers have the technological ability to switch from one type of energy consumption to another, depending on market conditions. This provides flexibility in the operation of the system, its reliability and economy. In addition, the presence of "peak" boilers in the heat supply system makes it possible to switch to a backup source in the event of accidents or any serious problems without disrupting the supply. From a technological point of view, the operation of heating networks in a relatively low temperature and pressure mode is of interest, which significantly reduces energy costs. The temperature of the direct-flow water is 80 C, the reverse flow is 40 50 C. Denmark effectively forms its fuel and energy balance, with oil accounting for 43 %, gas for 24 %, coal for 21 %, and renewable energy sources for 12 %. Of the restorative energy sources, the use of wood sawdust is 44 %, wind energy is 27 %, straw burning is 27 %, and biogas production is 6 %.

In addition, geothermal installations and energy obtained from waste incineration are used. The effective use of electricity is facilitated by the existing ownership system in the industry. Power plants and infrastructure are controlled by companies that own power lines, as well as by major companies E2 and Elsam. Companies that distribute electricity are controlled by large and small groups of consumers, municipalities, and in some cases private investors [5]. Municipalities have large heating systems, while small ones are consumer associations organized on the model of cooperatives where consumers choose a Board of Directors. Such planning, according to the authorities, ensures a more rational use of energy. The

state ably regulates the production of hydrocarbons. So, the extraction and processing of oil is performed by private companies, but the transport system is in state ownership.

The success of Denmark in the field of energy conservation is evidenced by the fact that having had a 50% increase in agricultural production since 1970, the country has not increased its energy consumption by a single percent during this period. Taking into account the worsening environmental situation, as well as trends in the global energy market, the Danish Ministry of transport and energy in 2005 developed a long-term strategy for the country's energy development for the period up to 2025. The beginning of energy saving in Germany was laid by the "law on priority of restoring energy", adopted in 1991. The task of improving energy efficiency in Germany is solved through the Ministry of the environment and partly the Ministry of economy, the Federal Ministry of transport, construction and urban development. Each of the ministries has its own tasks and corresponding powers [5].

The specifics of solving problems is that the focus is on specific aspects of the problem in the absence of such a separate document as the energy concept. At the same time, it should be noted that there is unity in General views on energy development. This unity takes place to reduce carbon dioxide emissions into the atmosphere, preserve the environment, develop renewable energy, strengthen the safety of existing nuclear power plants and prohibit the construction of new ones. According to existing views, specific work is being carried out to save energy and increase the energy efficiency of systems, machines, devices and mechanisms.

During the period 2000-2003, the German authorities invested at least 200 million euros annually in the development of renewable energy and energy saving. During 2003-2005, the funding for such projects was increased to 360 million euros. And since 2006, the growth of annual investment in renewable energy has become even more significant and amounted to about 1 billion euros.

The government actively attracts private capital to participate in new projects, using such means as organizing and conducting competitions for the implementation of energy-saving loans, providing tax incentives and obtaining loans. The German energy Agency (DENA) limited liability company, which is a Federal structure, takes an active position in conducting energy saving competitions. DENA's founders are the state and the credit Agency for renewal and development (KfW).

The Agency is engaged in a wide range of tasks such as monitoring energy consumption, analyzing the country's fuel and energy balance and the dynamics of energy prices, developing a strategy for the construction of electric installations using renewable energy sources, planning the modernization of existing power plants, trading emission quotas, organizing joint implementation of the latest projects, advising authorities on the effective use of energy, conducting active advocacy and explanatory work among the population. Wind power and the use of solar energy are becoming widespread in the country [7].

In Germany, solar power plants produce more than 3000 million kWh of electricity annually. In Berlin, it is planned to switch all swimming pools to solar energy. Private investors are given the opportunity to place more than 100,000 square meters on the roofs of public buildings. install solar panels and feed the resulting energy to the city grid. Since 2007, the Berlin administration has been buying only cars with reduced gasoline consumption in urban transport mode for its needs. Electrical appliances and equipment are marked depending on the level of energy consumption.

The procedure for gradually replacing the use of devices and equipment that have a level of expenditure within the established standards is defined. Germany is one of the countries of the European Union where modern energy saving technologies and alternative energy sources of solar energy, wind energy are most actively used. Poland has been implementing an energy saving system since 1991. On several points of the energy saving policy of this country, it is worth dwelling. First of all, it should be noted that the Polish authorities have harmonized national legislation with EU legal documents. There are practically no contradictions between national and local legal acts [7].

The institutional and organizational support of the energy saving policy is being successfully formed. The country has established effective and purposeful work of state and local authorities, financial and commercial structures, business entities to carry out energy saving measures in the residential sector, the effective use of local resources and electricity, the introduction of solar energy, biogas production, waste disposal, heat and electricity generation from the burning of straw and other plant waste. Poland has a positive experience of mixed financing of energy projects (funds from the European Union, international donor funds, environmental funds, and the budget), where the system of tax incentives is skillfully used. The government is trying to use state levers to expand the range of creditors for such energy-saving measures, which require significant funds and are designed for the long term.

In Poland, there is a special communal Fund, the funds of which are accumulated through fees from the population and are used for implementing low-cost energy saving projects, improving the quality of heating, and current repairs. Energy consumption is based on signing and fulfilling the terms of the contract [8].

This allows you to avoid red tape associated with the licensing system, prevent monopolization of the sphere, improve the quality of services through competition, reduce prices and simplify audit. Energy saving policies of other countries are also of interest. In particular, the Netherlands is one of the leaders in the development of wind energy and energy using biofuels. Significant advances have been made in the development of cogeneration systems and heat pumps. Great Britain adjusts its energy policy, directing it on the one hand to the economical use of energy, on the other, to increase the efficiency of energy supply. In order to improve the country's energy supply, a decision was made in mid-2008 to unfreeze its nuclear

energy development program. The first step in resolving this issue was an agreement with the French company Electricite de France SA to acquire British Energy, which produces up to 30% of all electricity in England and Scotland.

With the completion of the deal, the French company will begin construction of new nuclear power plants in the UK.

Sweden's experience in passive energy conservation is also valuable. It is believed that passive energy saving will make it possible to reduce energy consumption for heating by a third. In the Swedish city of Brogaden, a passive conservation project is being completed, where municipal apartment buildings built in 1970 and listed for major repairs are being reconstructed. The project is funded by the Swedish energy Agency and is implemented as part of a 20% reduction in energy consumption. The EU has achieved some success in optimizing relations within the Alliance on the issue of energy security. Legal instruments have been developed and put into effect to improve the energy climate in Western, Central and South-Eastern Europe. At the same time, the existing differences between the EU States do not allow this organization to pursue a single, comprehensive energy policy, especially in relations with energy exporters.

In these circumstances, energy policy may be limited and only concern issues related to further optimization of energy supply within the Union: infrastructure development; optimization of pricing policy; setting regional energy consumption standards in housing and utilities, transport; creating energy-efficient and energy-saving consumer appliances; developing new, more efficient energy sources. The policy of saving energy resources in the market conditions will stimulate energy-efficient policies in industrial and agricultural production [8]. A single comprehensive energy policy of the EU is possible only in the conditions of functioning of the economies not as national, but as a single economy of the Alliance, as a superpower with all the consequences for the functioning of the financial system, tax collection, formation of the annual budget for unification in General, regions, territories and cities in particular, restrictions on the activities of monopolies. A certain step in this direction is the creation of a unified electric power system.

The energy policy of the EU countries in the field of energy saving is proving to be effective and therefore should be used by our state. Implementation of energy saving programs requires changing the algorithm of work in the organizational, financial, legal and information spheres. Energy policy in the state should be based on the need to ensure the reliability of energy supply and its availability for the citizens of the country. The imbalance of these principles inevitably leads to the collapse of the entire policy.

Organizational energy saving can be implemented if the consumer is directly interested in the efficient use of energy. This interest is best shown when the energy consumer can influence energy saving elements (heat generating stations, heating networks, buildings). This requires optimizing the ownership system, for example, in Denmark. Effective energy conservation occurs when a

country has an effective body that develops energy policy, advises the government, develops legal documents, monitors their implementation, and assists firms and individuals in implementing energy-efficient work. Germany has the best experience in this regard [5].

Currently, the EU countries have achieved significant results in energy conservation policy, it has become rational, socially-oriented and progressive. The introduction of numerous innovative projects in the field of energy conservation and the transition to the use of renewable energy occurred mainly due to the following principles:

1. Compliance with system approaches. It is worth noting that the energy saving policy is a separate important functional component of the state economic, industrial and social policy. Energy-saving measures are systemically interoperable (awareness-raising companies, financial mechanisms for implementing energy-saving projects, regulatory and regulatory acts and state standards on energy conservation, voluntary agreements between the public, private and public sectors).

2. There is a General energy saving strategy. Most EU countries have detailed programs for implementing energy conservation policies that define specific goals and methods for achieving them. Some European States carry out functional inspections and systematically review their energy-saving programs. Moreover, many of them have special framework legislation regulating energy conservation. However, in most Central European countries such programs are only being developed, although there is already an awareness of the need to implement effective energy-saving policies.

3. Effective pricing policy. Almost all countries of Central and Eastern Europe, including Ukraine, have not yet implemented pricing reforms in the field of agricultural energy. In most of them, energy prices do not reflect the real market cost, so there is an acute problem of non-payment. In the EU countries, pricing policy is based on market principles, while it contains a flexible system for stimulating energy saving. In addition, there are also special "green" tariffs for electricity that is generated from renewable sources.
4. Effective institutional policy. In the EU member States, most energy conservation bodies operate as government bodies or departments of a Ministry. Such bodies have an extensive regional infrastructure, are provided with appropriate state financial and resource support and an appropriate legislative and regulatory framework.

5. Efficiency of energy saving policy. The introduction of energy-saving policies in the EU countries during the 70-90 years of the twentieth century made it possible to reduce the growth rate of energy consumption and significantly reduce the energy intensity of the GDP of European countries. This was achieved through the use of mainly market mechanisms, effective pricing policy, and modernization of basic energy-consuming technologies and equipment [9].

2. Energy saving in the system of management of development of agricultural enterprises

Agriculture is a complex of technologically and organizationally interconnected industries that together form a balanced, integrated and structurally complete system, the functional component structure of which is subordinated to a stable increase in food production of agriculture and animal husbandry. Each branch of agricultural production is a set of enterprises that produce certain types of homogeneous products or provide services that meet certain needs of the population in food, and industry-in raw materials [10].

In recent years, agricultural production has undergone great deformations. The transition from a planned to a market economy, the reform of collective and state farms, the development of new economic structures, deindustrialization, disincentives and especially agricultural production, reduction of agricultural means of production and objects of labor, excessive increase of prices, violation of material maintenance of farms, the destruction of agrochemical service, the absence of agrochemical service has reduced the productivity of the economic efficiency of the agro-resource potential and a decrease in the production of gross output of agriculture [6].

Agriculture is one of the most important branches of the economic complex of Ukraine, which plays an important role in strengthening the economy of our country, improving the living standards of the population and solving socio-economic problems. However, the level of development of its productive forces significantly lags behind the national economic problems. The country does not yet produce enough grain, sugar beets, potatoes, vegetables, fruits, berries, grapes, meat, milk, eggs and other products. Therefore, the problem of accelerated development of agricultural production and stable growth of its products is gaining particular importance [10].

According to statistical data for 2017 [11] agriculture of Ukraine provides 8.2 % of gross value added, employs more than 3 million people, uses fixed assets worth more than 100 billion UAH, operates almost 56.5 thousand economic entities using 21.6 million hectares of agricultural land. Produced in agriculture, 1 hryvnia of products allows you to get more than 12 hryvnia of products in other industries. Rural areas are a place for improving the health of the country's inhabitants, and the rural population is a talisman of national customs and traditions. Agricultural enterprises produce 44.9 % of gross agricultural output, including 45.1 % of crop production and 44.7 % of livestock production. Farms of the population produce most of the gross agricultural output-55.1%, including crop production-54.9 %, livestock-55.3%. In the structure of production, crop production makes up 58.4 %, livestock production-41.6 %.

The leading place in the production of agricultural products is occupied by Poltava region. Although it occupies the 7th place in Ukraine, it also occupies the 3rd place in terms of gross agricultural production. The population is

1445,0 thousand people, including urban-894 thousand people (62%), rural – 551 thousand people (38%) [11].

Low profitability of production hinders its modernization, introduction of new technologies, updating of material and technical base. Investments in the development of the social sphere of the village now amount to only 7.6 billion UAH, which is much lower than the need for them. As a result, the quantitative and qualitative characteristics of demographic processes in rural areas are deteriorating.

The development of production will require more and more energy resources, which makes the issue of energy conservation and energy efficiency extremely relevant. Therefore, it is necessary to introduce a comprehensive energy saving policy at the enterprise.

Complex energy saving is understood as a comprehensive coverage of economically justified technically achievable energy saving and energy efficiency measures that contain costly, low-cost and organizational measures aimed at maximizing the potential of energy saving. It is mandatory to implement integrated energy saving, use alternative energy sources, diversify and optimize energy supply, use modern science and technology to reduce the environmental burden on the environment, which will lead to economic growth of the enterprise. To determine the potential of energy saving and the impact of energy saving policy on the development of an agricultural enterprise, the first step is to form a scheme of energy consumption of the enterprise and determine the directions of energy saving potential formation (figure 1).

Under the development of the enterprise, we consider the process of natural change, the transition from one state to another, more perfect; the transition from the old qualitative state to the new, from simple to complex, from lower to higher; the degree of consciousness, enlightenment, culture. In [12] propose to define enterprise development as a long-term set of processes of quantitative and qualitative changes in the enterprise that lead to the improvement of his condition by increasing the potential of enterprise, adaptation to the external environment and internal integration, thereby increasing the ability of the company to counter the negative effects of the environment and its vitality.

The development of the agricultural enterprise will be considered as a set of long-term quantitative and qualitative changes, which lead to an increase in demand for products, increasing organized at all structural levels, the growth of the scale of activity of the enterprise, improve product quality and environmental friendliness of production, increase the competitive potential of the enterprise, the ability to resist negative external influences and economic stability in General. First of all, energy saving is the basis for increasing the potential of the enterprise, the ability to counteract negative manifestations of the external environment, and improving the quality of products and working conditions of employees.

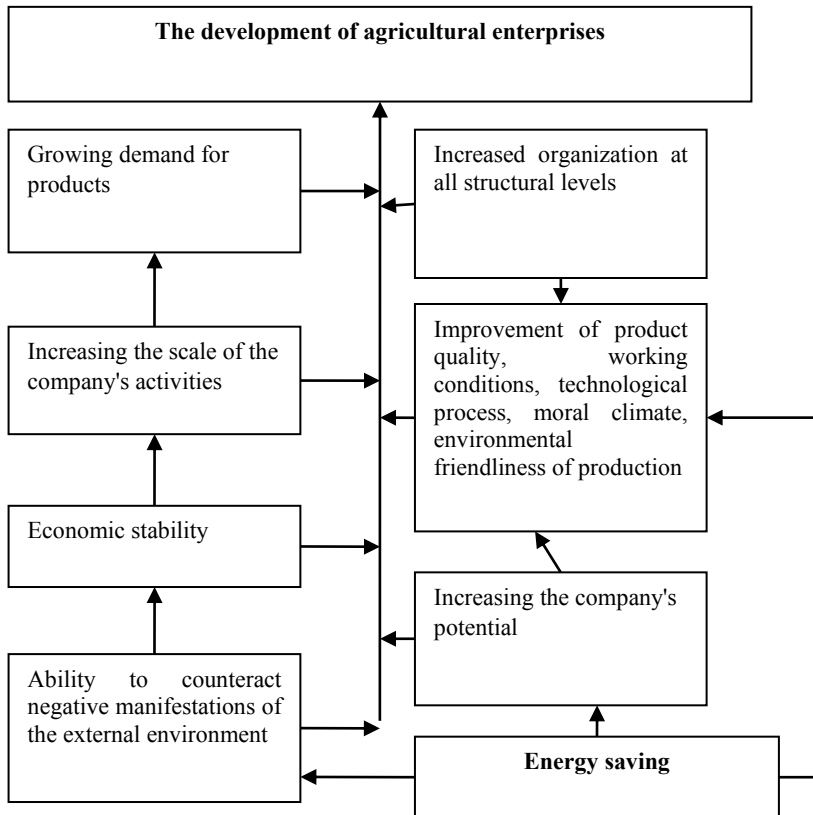


Fig. 1 – The scheme of development of the enterprise and the role energy saving in it

In turn, these factors lead to economic stability, increased organization, growth in the scale of enterprise activity and demand for products. The development of the enterprise should be based primarily on energy development. The formation of an energy development plan of the enterprise as a component of the overall development plan of the enterprise is shown in figure 2.

The priority direction of energy development of agricultural enterprises is the choice of investment solutions, sources of financing and the cost of capital. Investment decisions can be aimed at updating existing equipment and technological elements of the enterprise or at their modernization. Usually, upgrades will require significantly more money than upgrades, so the vast majority of investment decisions are aimed at upgrading. Modernization refers to improving properties, replacing individual components, increasing energy efficiency, and other positive changes in the objects of modernization.

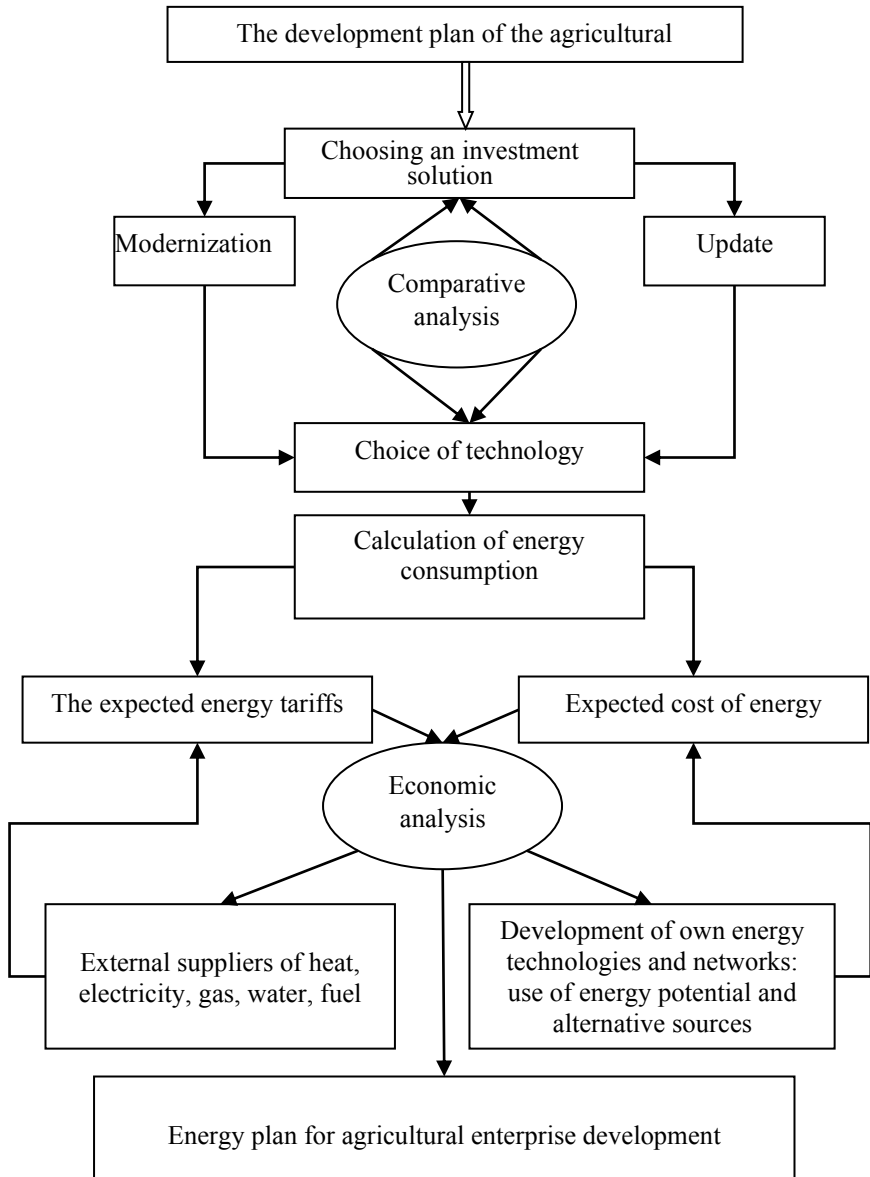


Fig. 2 – Formation of an energy plan for the development of an agricultural enterprise

On the basis of comparative analysis, the choice of energy development technologies is made and energy consumption is calculated, after a set of energy-saving actions is carried out. Based on the expected (projected) values of energy resources obtained from the energy potential and energy saving potential and projected energy tariffs from third-party suppliers, economic analysis and modeling is performed. Economic analysis allows you to clarify the cost of energy resources and energy tariffs, taking into account all possible consequences of investing in energy conservation. The result of refined calculations and economic analysis is a plan for energy development of the enterprise, which consists of a set of actions of organizational, economic and technical-technological directions aimed at implementing the energy saving policy at the industrial enterprise.

The energy development plan of the enterprise is the basis for the formation of an organizational and economic mechanism for energy saving [7].

You can imagine a typical scheme of energy consumption of a powerful agricultural enterprise. The main sources of energy resources (heat, fuel, electric energy, gas) are the fuel supply system (pipelines, tanks, warehouses for storing solid fuel), the gas supply system (pipelines, automation devices, compressor stations, storage tanks), water intake (pumping stations, pipelines, facilities for improving water quality), the power supply system (power lines, transformer stations). Conversion units - thermal power plants, boilers, compressor stations, gas distribution stations, converting energy and oil into convenient forms for consumption.

A number of transformations occur with the energy and resources that enter the territory of the enterprise: changes in form, condition, accumulation, distribution, losses and hits to the final consumers. After using the heat resources in the form of waste air, water, and gases, they pass through the recycling plants and partially return to the power supply system. The energy balance is made up in a material and synthetic form. The synthetic balance in conventional fuel allows us to determine the ways of energy saving and the direction of replacing some types of fuel with others [13].

For the analysis of material and synthetic balances, a graph of energy flows is formed, the centers of consumption, generation and losses are determined. The initial information for the formation of balances is contained in the following documentation of the enterprise: forms of statistical reporting; norms of specific expenditures of heat, fuel and electric energy for production; in design, technical and operational documentation; energy passport of the enterprise; load schedules; instructions of the energy conservation inspection; reports on energy audits; documents on energy-saving measures and long-term development plans of the enterprise.

Given the interchangeability of various energy resources, it is necessary to pay attention to the formation of the energy balance, in which the cash flows are shown (table 1). The purpose of creating an energy balance is to determine the indicators of energy intensity of products, the amount of losses, the energy dependence of the enterprise, the potential for emissions and the balance of

payments of subagents. The cost of fuel and resources is determined taking into account transport costs, travel losses and the cost of storage at the enterprise, provided that these areas are used for other needs. The second part of the balance allows to estimate energy and resource intensity of production, the cost of maintenance of buildings and grounds, assess the component of normative losses of energy are transferred to component of production costs [14].

The development of the enterprise as a process of transition to a more perfect state is impossible without reducing energy consumption, using the energy potential of emissions and improving the environmental situation by reducing the man-made load. The state of the energy system of an agricultural enterprise is directly related to its financial condition. The main reasons for imperfect energy consumption can be called obsolescence and low load of equipment, high energy intensity of production. Given the significant share of energy saving potential, it can be argued that the development of the enterprise is impossible without the introduction of energy-efficient solutions. Analysis of the implementation of energy saving measures can be evaluated by determining the efficiency of the use of fuel and energy resources.

Special attention should be given to energy-saving measures that involve the use of energy-saving potential, the energy potential of the enterprise through the introduction of low-cost and organizational solutions [15].

Table 1 – Energy Finance balance of an agricultural enterprise

THE COST OF ENERGY RESOURCES RECEIVED BY THE ENTERPRISE, UAH.	THE COST OF ENERGY RESOURCES WAS TRANSFERRED TO PRODUCTS, UAH.
1. The cost of fuel and resources: coal; gas; mineral oils; water; electric energy; masut; firewood; peat fuel briquettes, etc.	1. The cost of fuel, energy and resources are transferred to the cost of production
2. Cost of energy resources supplied from outside: electrical energy; heat energy.	2. the Cost of fuel, energy and resources spent on utilities and are not transferred to the cost of production
3. Cost of fuel waste disposal: utilization of slags and ash; payment for gas emissions; payment for waste water.	3. The cost of regulatory losses that are transferred to the cost of production.
4. Debt of subagents	4. Payments by subagents
5. The debt for the previously received energy	5. Cost of the enterprise's energy saving potential
TOTAL: UAH.	TOTAL: UAH.

Special attention should be given to energy-saving measures that involve the use of energy-saving potential, the energy potential of the enterprise through the introduction of low-cost and organizational solutions [15]. The main energy reserves of an agricultural enterprise are:

- reducing energy consumption by improving enterprise management, reducing the energy intensity of raw material processing, improving the quality of fuel and raw materials, improving and optimizing the technological process;
- replacing traditional energy sources with alternative or cheaper local fuels;
- using the potential of thermal emissions, flue gases, waste water, solid waste; generating energy using heat pumps, solar collectors, biogas plants;
- increase of the fuel and energy efficiency coefficient; replacement and modernization of equipment, thermal insulation of equipment, buildings and networks, replacement of lighting devices with energy-saving ones, automation and mechanization of labor, advanced training of production workers.

A separate organizational direction of energy saving is the creation of an energy management service at the enterprise. According to [16]: energy management is a management system based on standard measurements and checks that ensure the operation of an object that consumes only the amount of energy that is absolutely necessary for production. The chief energy Manager appointed by the company's management forms the structure of the energy management service, which performs such duties:

- monitoring and accounting of energy consumption;
- assistance in conducting an energy survey of an enterprise; implementation of energy saving measures;
- monitoring compliance with the company's energy efficiency policy;
- formation of incentive and motivational bases for employees of the enterprise in the issue of reducing resource consumption;
- training of the company's personnel in energy saving measures;
- monitoring of modern achievements of science and technology and new legislation in the field of energy saving.

The company's dependence on monopolistic energy suppliers leads to an increase in the risks of production activities. The enterprise is obliged to receive energy at the prices and quality imposed on it by a monopolistic supplier. Reducing energy consumption, diversifying energy supply sources, and reserving energy resources reduces the risks associated with energy supply. The introduction of energy-saving technologies will reduce the volume and probability of losses in production, the value of the effect obtained from reducing the risk of losses can be calculated according to equation 1 [7]:

$$E = \sum_{i=1}^n (m_{0i} - m_{1i}) \times \theta \times P_i + \sum_{i=1}^n (H_{1i} - H_{0i}) \times (1 + (O_{1i} - O_{0i})), \quad (1)$$

where E is the effect of implemented energy saving technologies, UAH;

n is the number of types of energy resources, the volume of which varies from energy saving measures

m_{0i} , m_{1i} are energy intensity of 1 UAH of produced products for the i -th type of energy resource before and after the implementation of the event, one / UAH;

θ is the volume of products produced after the implementation of the event, UAH;

P_i is the unit price of the i -th type of energy resource, UAH;

H_i is the probability of occurrence of risks and energy resources of the enterprise, share;

O_i is the volume of losses from risks and those energy resources of the enterprise, UAH.

The introduction of energy saving measures will allow the company to get a number of positive effects, which have a significant role in the development of the enterprise. Energy saving measures lead to reduction of consumption of energy resources, reduction of fixed costs by enterprise, which ultimately will lead to an increase in profitability, decrease in costs of purchase of energy and environmental payments for polluting emissions.

Taking into account the features of two-part tariffs for heat supply, the enterprise, reducing the consumption of energy resources, can revise the terms of the contract with the heat distribution organization and reduce payments for the conditional constant component of the tariff.

3. Methodological bases for evaluating the effectiveness of investments in energy-saving measures of agricultural enterprises

In the context of the growing cost of energy carriers and the significant energy intensity of modern production, the problem of energy conservation and the choice of priority areas for investment in projects to improve the energy efficiency of enterprises is acute. One of the most important ways to effectively compete and increase the profitability of an enterprise in modern conditions is to reduce the cost of production. The process of energy saving should be evaluated comprehensively, taking into account all the consequences of investment: economic, technical, environmental, organizational, commercial and others. Analysis of the effectiveness of energy-saving measures is performed in order to determine its feasibility or to select the best event. This is due to the fact that energy-saving measures require investment, which is usually quite significant. In addition, the effectiveness of energy-saving measures is evaluated by a number of financial indicators of the enterprise, in particular, the cost price.

The choice of priority energy-saving means for improving the energy efficiency of an enterprise is a complex multiple task that requires effective evaluation criteria.

Due to the fact that a modern industrial enterprise is usually limited in funds, there is a need to model the consequences of investment and a detailed justification of each selection criterion. Modern literature sources allow you to choose the necessary methods for calculating economic efficiency, but do not cover all the evaluation criteria for the analysis. The issue of evaluating economic, organizational, production, technical and environmental criteria in aggregate, as well as alternative comparison of investment in other investment projects, has not been sufficiently studied. This is why the criteria for selecting energy-saving investment projects and improving the methodology for determining the effectiveness of energy-saving measures require further research [15].

The set of criteria for selecting energy-saving measures should be classified as follows: economic, technical, industrial, environmental and organizational. The first step in comparison is the economic criterion. Initial capital expenditures, financial results of the project, and operating expenses for the implementation of this project for a certain period of time (credit and equity contributions, taxes) are the initial data that characterize the investment process [17]. Forecasting of financial results is usually carried out, focusing on the three basic development scenarios: optimistic, realistic and pessimistic.

An optimistic development scenario will be determined by the maximum profit from its implementation, while a pessimistic one will be determined by the minimum. The most uncertain development is a realistic project. By time factor: static, in which cash flows arising in different time periods are classified as equivalent, and dynamic – cash flows for comparison using discounting or accrual. In absolute factors estimated absolute value of the profit obtained from the investment process; in relative factors are characterized by financial results from implementing them in the aggregate cost of the implementation process; time – are to a certain period of time. By the type of generalizing indicator – absolute, relative, and temporary.

Projects are also divided into those that are implemented in conditions of absolute certainty and uncertainty. The economic criterion is to find optimal sources of financing for energy-saving projects. The most common economic criteria include:

- net present value (*NPV*);
- net cost of the terminal (*NTV*);
- return on investment index (*PI*);
- internal rate of return (*IRR*);
- modified internal rate of return (*MIRR*);
- discounted return on investment (*DPP*);
- payback period (*PP*);
- the coefficient of efficiency of investments (*ARR*);
- present value;
- annuity method;
- capitalized income;
- full economic result of the project (*PR_j*) [18].

The summary indicator of the economic efficiency of energy-saving measures E_f at the enterprise, for example, can be defined as:

$$E_f = \left(\frac{\frac{V_0 \times C_0}{S_0}}{\frac{V_1 \times C_1}{S_1} - 1} \right) \times 100\% , \quad (2)$$

where V_0, V_1 are production volumes of the same type of products before and after energy modernization;

C_0, C_1 are unit prices before and after upgrading;

S_0, S_1 are costs of production.

With a constant product price and constant production volumes, the overall indicator of the economic efficiency of energy-saving measures will be determined only as the ratio of production costs before and after modernization.

According to the main criterion for comparing independent and alternative energy – saving projects is *NVP*-net present income, which is determined based on the number of projects, their interdependence and the availability of financial restrictions.

The simple payback period T is determined by the formula:

$$T = \frac{C}{E}, \quad (3)$$

where E is the savings received from the implementation of activities, UAH;

C is the cost of implementing energy-saving measures in UAH.

This method is based on the use of the indicator "e" – the internal rate of efficiency, which corresponds to the percentage of a Bank loan, in which the Bank's loan for energy-saving measures can be repaid over the period of implementation of energy-saving measures. Also, this method does not reflect the entire set of economic, technical, organizational, environmental, and production effects. Changes in profit over the years and the amount of the liquidation value are not taken into account.

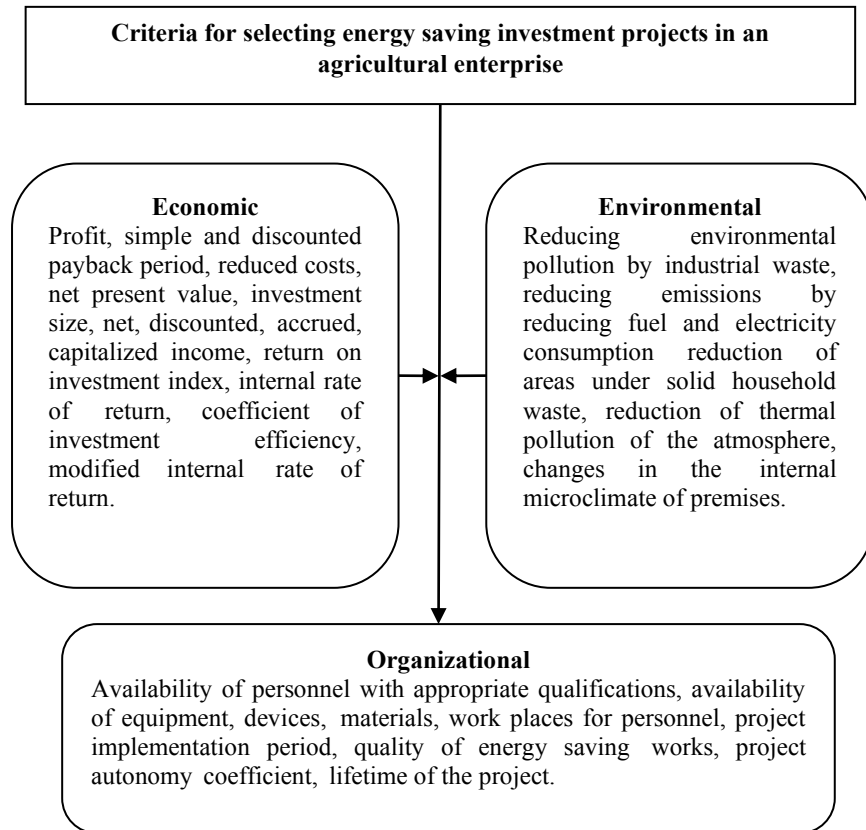


Fig.4 – Selection criteria for energy saving investment projects in agricultural enterprises

In [19], the discounted payback period is proposed as the optimal criterion – the period for which the amount of net profit and depreciation will reach the value of the discounted initial investment. The main advantages of this method, according to the author, are its simplicity and direct characterization of the risks of investing funds. The discounted payback period is determined from the equation:

$$\sum_{t=0}^T \frac{\Delta \Pi_t}{(1+E)^t} = 0, \quad (4)$$

where E is the discount rate;

$\Delta \Pi_t$ is the increase of profit due to implementation of energy saving measures.

To determine the effectiveness of investment funds, the service life of the investment object is compared with the resulting payback period. The shorter the discounted payback period, the lower the risks for the investor and the higher the liquidity of the invested funds. The principle of evaluating the effectiveness of investment on the reduced costs, proposed in [29], is to minimize the reduced costs and use the coefficient of relative efficiency of capital investments, the value of which is unknown:

$$\Pi_t = C_i + E \times K_i \rightarrow \min, \quad (5)$$

The authors [20] and [21] propose a comprehensive approach to the issue of economic evaluation of energy saving measures based on the theory of fuzzy logic. The combination of qualitative and quantitative characteristics of the project with the help of expert statements allows you to cover a wide range of factors that influence the decision to invest in the project. This technique requires a thorough study of expert information and should be used for analysis and comparison of complex multi-variant projects.

In [22], the main criteria for evaluating the economic efficiency and risks of energy saving investments are to use the net current effect of the investment project (NPV) and the modified internal rate of return of the investment project (IRR). It is proposed to evaluate the efficiency of investments in the formation of cash flow as a result of energy-saving measures by evaluating the energy intensity of one hryvnia of products for certain types of energy resources:

$$R = \sum_{j=1}^m (e_{0j} - e_{1j}) \times Q_1 \times P_j, \quad (6)$$

where R is the main results from the implementation of investments, UAH;

m is the number of types of energy resources, the volume of consumption of which changes from the implementation of the event;

e_{0j} , e_{1j} are energy intensity of 1 UAH of produced products for the j -th type of energy resource, respectively, before and after the implementation of the event, NAT units / UAH;

Q_1 is the volume of products produced in value terms after the implementation of the event, UAH;

P_j is unit price of the j -th type of energy resource, UAH.

A comprehensive assessment of the economic efficiency of energy-saving projects is based on comparing the following characteristics of the project: non-discount income, income with growth (capitalization) and discount income, while calculating the corresponding payback periods. This method is based on the recommendations of the "Association of engineers for ventilation, heating, air conditioning and heat supply" [23] and will allow you to simultaneously consider

all possible investment options and choose the most optimal one. The discounted income from the energy-saving project is determined from the dependence (7), and the capitalized (accrued) income is determined from the equation (8) [23]:

$$DD = D \times [1 - (1 + r)^{T_{cl}}] / r, \quad (7)$$

$$ND - D \times [(1 + r)^{T_{cl}} - 1] / r, \quad (8)$$

where ND – capitalized (accrued) income;

DD is the present value;

D is the annual income;

r is the discount rate.

At the same time, net present income (NPV), simple payback period (T_0) and profitability index (PI) are calculated:

$$NPV = DD - K, \quad (9)$$

$$T_0 = K / D, \quad (10)$$

$$PI = DD / K, \quad (11)$$

where K – necessary investment in the project.

Preliminary analysis of investment performance should be carried out by comparing the NPV criteria, a project that will have this criterion larger and more acceptable for implementation. When comparing a set of alternative projects with each other, it is necessary to use the additive NPV property [18]:

$$NPV(A+B) = NPV(A) + NPV(B). \quad (12)$$

Another criterion widely used in the practice of comparing investment projects-the internal rate of return on investment (IRR), does not have such properties [18]:

$$IRR(A+B) \neq IRR(A) + IRR(B). \quad (13)$$

In addition to the criteria for evaluating investment processes, models are used that can be classified as follows: stochastic model; tabular information models; static information models; dynamic information models; network information models; quantum network model; fuzzy models; models based on neural networks. Economic methods for analyzing investment projects include: the method for analyzing the sensitivity of influence, the method for analyzing development scenarios, the Monte Carlo method, the decision tree method, and others.

The method of influence sensitivity analysis is one of the most common in the economic analysis of investments. It consists of a comparative analysis of the impact of various factors on the key indicator. NVP I IRR are most often used as key indicators. After selecting a set of factors of influence and the limits of their

variation, the value of the key indicator is calculated. The final step is to plot the sensitivity graph. The use of investment efficiency analysis methods based on the discounting principle has a number of disadvantages [24]:

- spectral complexity and accuracy of calculations by the specified method;
- artificially underestimating the real effectiveness and value of the project;
- sharp depreciation of future receipts of funds in comparison with the receipts of money in the coming years;
- there is no accounting for the impact of additional income from previous years' profits on the total income of future periods and, as a result, an underestimation of the effectiveness of investment in General.

To overcome these disadvantages of the discounting method, the author suggests using the indicator of the full economic result, which is determined according to the equation [24]:

$$PR_j = \sum_{t=1}^{T_j} \sum_{k=1}^{K_t} \sum_{i=1}^{I_t} [(D_{it} - Z_{it}) - Nl_{it}] \times (1 - p_{tk}) + \sum_{t=1}^{T_j} \sum_{k=1}^{K_t} DP_{kt} + S_t - \sum_{t=1}^{T_j} I_t \quad (14)$$

where PR_j is the full economic result of the j-th period;

D_{it} is the income from the i-th type of project activity in year t;

Z_{it} is the expenses for the i-th type of activity in year t;

Nl_{it} is the tax payments for the i-th type of activity in year t;

DP_{kt} is the income from investing the company's profits in previous years and received by it in the year t;

p_{tk} is the share of the company's profit directed to the K-th type of investment activity in the year t;

K_t is the total number of types of investment activities carried out by the enterprise up to a year t;

S_t is the market value of the company in year t;

I_t is the investment in the project in year t.

This method requires a detailed justification of the possibility of using energy saving measures of enterprises to study the investment efficiency. Using only economic criteria for evaluating investments will not allow you to fully evaluate all the features of energy saving measures. There is a need to study other criteria. A number of limitations and features form the organizational criteria for implementing energy-saving measures. The problem of lack of qualified personnel and the necessary equipment or tools for their work creates organizational restrictions in the choice of energy-saving measures. The daily increasing complexity of the equipment requires specially trained maintenance personnel for high-quality operation. Unskilled use of equipment or materials can negate all advances in energy efficiency.

No less important is the time factor-the period of implementation of the selected energy saving measures. If the implementation of a certain event requires a lot of time and can negatively affect the company, then such negative consequences should be taken into account either in monetary terms, or by expert means. The term of installation and commissioning should be determined by calculation, for example, building a calendar of installation work. Usually events related to the replacement of equipment, installation of energoutilizatoriv or transfer to alternative sources, require a stop of production. Therefore, they must be carried out during periods of the lowest production load, on weekends and repair days.

Similarly, it is necessary to take into account the quality of work carried out with the introduction of energy-saving measures. The quality of installation and commissioning works is directly proportional to the effectiveness of the implementation of measures. Even with the highest quality of equipment and materials, incorrect installation will not lead to the expected result. The quality of work can be characterized by the following criteria: the quality of design work, the quality of installation work, and the quality of commissioning. Errors at any stage lead to reduced performance [7].

There are two ways to assess the quality of work: either with the involvement of third-party specialists who are competent in this area, or during operation, determining the change in energy consumption to a declared level. The first way requires the involvement of specialists who can not always be found, the second way requires a clear separation of energy flows measured from other consumers.

From the point of view of practical use, the best way to control the quality of work is to involve third – party specialists, because after the completion of work on the modernization of production and obtaining negative results, repeated modernization requires a repeated stop of production and new investments. The calculation of the investment payback period should be carried out while determining the life of the project. Comparison of these indicators will allow us to draw additional conclusions about the acceptability of investment. The project lifetime depends on various factors, the main ones being:

- quality of work and equipment;
- availability of qualified personnel for maintenance;
- compliance with installation and operation technology;
- period of physical and moral wear and tear.

Estimation of the life cycle duration of an energy saving measure with equal weight coefficients of estimates is carried out according to the equation [24]:

$$K = \frac{1}{n} \times \sum_{i=1}^n \sum_{j=1}^m \left(\frac{M_{i,j}}{n} \right). \quad (15)$$

The resulting lifetime of the project is compared with the payback period of the project and conclusions are drawn about the attractiveness of such an energy-saving event. There may be a situation when the life of the project calculated by

experts will be significantly less than declared in the technical documentation, and investing in such an event will only make sense if the received income is capitalized, or it will not pay off at all.

The project autonomy coefficient will be defined as the total value of financial and intellectual autonomy. Under financial autonomy, we will understand the ratio of own funds to attracted funds, and under intellectual autonomy – the ratio of the attracted's own intellectual resource (developed by the author):

$$A = A_f + A_r = \frac{Z_v}{Z_z} + \frac{I_v}{I_z}, \quad (16)$$

where A_f and A_r are financial and intellectual autonomy;

Z_v and Z_z are accordingly, its own and attracted funds;

I_v and I_z are accordingly, own and attracted intellectual resources.

Autonomy coefficients allow you to give preference to alternative projects with equal qualities of other characteristics. It is necessary to try to get as Autonomous a project as possible, so that you do not feel either financial or intellectual dependence. The main directions of technical focus on energy saving can be classified as follows:

- elimination of leaks of heat, water, air and energy resources;
- increasing the thermal resistance of the thermal insulation shell of buildings and structures;
- heat recovery from engineering networks and production equipment;
- replacement of technological equipment or its modernization for less energy consumption;
- optimization of modes and methods of operation;
- use of alternative energy sources and secondary sources;
- diversification and optimization of energy supply.

Simultaneously with the implementation of these directions, it is necessary to check the compliance of the proposed measures with regulatory requirements: whether there are violations of state building codes, state standards, sanitary standards, fire regulations, and so on. Elimination of leaks of heat energy, water, air resources is a priority. After a detailed survey of the building, places with damaged thermal insulation, piped pipes of the heat network and water supply system, uninsulated inputs of engineering networks, there are no check valves, equipment that operates at excessive capacity, and other sources of direct loss of heat, electricity and water are determined.

Also, in places of direct losses, there are contaminated translucent fences that do not pass the necessary amount of light, heat exchange equipment whose surfaces are covered with a layer of scale, and others.

The priority set of works is low-cost measures to eliminate direct losses in setting up production, which is based on existing technologies and equipment to a

certain level resource consumption without significant and obvious losses. Elimination of leaks of heat, water, air does not require replacement of equipment, technologies and materials, but only allows you to achieve the maximum possible level of resource savings due to minor repairs at the existing level of physical and moral wear and tear.

Measures related to the utilization of heat from engineering networks and production equipment are characterized by the efficiency of utilization – the ratio of temperatures or enthalpy of the mass carrier (water, air, steam) before and after passing through the heat exchanger.

Replacing equipment with less energy-intensive equipment requires detailed justification. From the point of view of technical criteria, the main indicator that characterizes the advantages of new equipment over existing ones is the specific consumption of heat or electricity per unit of time or per unit of output. The main criterion for implementing such an event is to achieve energy consumption levels in accordance with existing technological standards.

Alternative energy sources must meet the technical characteristics of the primary energy carriers that they replace. Usually, such sources have lower quality parameters than traditional energy carriers, so replacement should occur under the condition of full compensation for heat or electricity.

Technical limitations of alternative sources may be the features of energy-consuming installations installed in production. Hot water from solar collectors is produced unevenly, and its temperature depends on the time of year and cloud conditions, so it can not be used directly for production without heat accumulators. If the implementation of an event requires significant transformations, it is necessary to check the technical feasibility of implementation.

Special attention should be paid to the quality of the equipment and materials offered. Given the trends of recent years, when the market was filled with low-quality fakes of world brands, and a significant difference in cost between the same type of products from different manufacturers, the problem of technical quality becomes significant. Especially the impact of production quality and adaptation to the conditions of use in Ukraine is felt on complex energy-saving equipment: heat pumps, heat reclaimers, refrigeration units, fans, boilers and other equipment. Only highly professional experts can perform a qualitative assessment of the material or equipment when products are declared to be of high quality.

Analysis by production criteria includes a comparison of measures based on the need to make changes in the production process and the degree of processing of raw materials and the final quality of the product. If a highly efficient energy-saving project requires a radical modernization of production, then the capital cost of its implementation must be taken into account and the cost of modernization.

An equally important aspect is the impact of new equipment, technologies or organizational measures on the quality of production products. At the present stage of competition between enterprises, it is unacceptable to allow product

quality to deteriorate. Increasing energy efficiency is usually accompanied by an increase in the processing depth of primary raw materials.

If reducing energy consumption usually leads to a reduction in the environmental burden on the environment, often ill-considered measures lead to a deterioration of the indoor microclimate of premises. Sealed Windows, insulated walls lead to a complete lack of ventilation in the room. Opening in micro-ventilation mode can partially correct the situation if there are normal environmental conditions outside the window. Unregulated intake of dirty and cold outdoor air can negate all the benefits of implemented measures. Non-cleaning of premises leads to an increase in the concentration of carbon dioxide in the room, which causes allergic and cardiovascular diseases, diseases of the pulmonary system and kidneys.

Especially dangerous is the sealing of basements and first floors. This is due to the accumulation of radioactive radon gas in the premises [18].

The issue of energy saving for the development of agricultural enterprises occupies an important place. The link between energy saving and enterprise development is shown in the significant impact of the component of the cost of energy resources on the cost of products.

Energy saving can affect the increase of the enterprise's potential, the improvement of product quality, the ability to counteract negative manifestations of the environment, and the improvement of environmental friendliness of production. For this purpose, there is a need to determine the state of the modern energy market and energy saving in it, to identify trends and dynamics of consumption and production of primary energy carriers and to determine the potential for energy saving.

Only after a detailed analysis of the above set of criteria, a conclusion is made about the acceptability of a certain set of energy-saving measures for a particular enterprise. A significant number of these criteria can only be evaluated by an expert with the assignment of a qualitative characteristic on a certain conditional scale.

The task arises to investigate the features of investment in energy saving measures and develop an intelligent decision support system for finding optimal ways to manage the energy saving potential of agricultural enterprises.

As a conclusion, we can say that the experience of Ukraine on energy saving, in comparison with European countries, is less and not so widespread. Ukraine has only recently embarked on a massive energy saving policy among enterprises. Projects and laws on energy saving have just started to be implemented at the legislative level. Energy saving is one of the factors of agricultural development, because it not only saves fuel and energy resources, but also encourages the population to work on renewable-alternative energy sources, the use of which will not only bring great benefits and profit, but also will not pollute the environment, will carry environmental friendliness and profit.

4. Global experience in managing project risks and approaches in energy-saving projects

The world Energy Council (WEC) annually calculates the energy sustainability index of countries. The index is assigned based on a comparative analysis of the energy situation in a particular country, based on three indicators: "energy security", "energy capacity", "environmental sustainability", taking into account a balanced approach between the relevant indicators.

Energy security refers to effective management, energy supplies from internal and external sources, energy market diversification, reliability of energy infrastructure, and the level of satisfaction of current and future demand for energy resources.

Energy capacity is the level of fuel and energy resources expenditures per unit of GDP, as well as the availability and accessibility of consumers to energy resources.

Environmental sustainability describes the efficiency of using energy resources and the share of renewable energy sources in the total volume.

Business efficiency is based on the balance of income and production costs, which necessarily include the cost of energy consumed – heat, electricity or other. And the lower these costs, the more efficient the business is. The lower the energy consumption, the higher the energy efficiency. Energy saving in any sphere is reduced to rational use of energy, reducing wasteful losses.

To measure energy efficiency, first count how much energy is produced in each country in a given time period. To do this, use the conventional universal unit of measurement of various types of energy toe (ton of oil equivalent), or the amount of energy that is generated from the combustion of one ton of crude oil. The lower the ratio of energy use to GDP, the more efficiently and economically a country uses its energy resources.

The top ten countries on this list are Colombia, Great Britain, Italy, Venezuela, Romania, Portugal, and Spain. These countries have the lowest level of energy use in the world. At the bottom of this list are Ukraine, Russia, Taiwan, Uzbekistan, South Africa, and Kazakhstan. These are the countries that use energy more than others.

Energy efficiency is studied by the independent research and analytical company Energydata, founded in 1991. Analysts of the company conduct a lot of research, one of the most famous is the Statistical Yearbook of world energy. It provides data on the production of gas, oil, electricity and other types of energy and the level of their use in different countries [25].

With an index of 0.246, our country is the last in the world in terms of energy efficiency. In neighboring Poland, this level is 0.095, in Romania there is 0.069, in the Czech Republic there is 0.115. The global average is 0.116. Data on these indicators are presented in table 2.

Table 2 – indicator of the level of energy efficiency of countries at the end of 2019

A country	Indicator	The average rate in the world
Poland	0,095	0,116
Romania	0,069	
Czech	0,115	
Ukraine	0,246	

According to the Oxford Institute for Energy Studies, the level of energy consumption in terms of GDP in Ukraine is 3.8 times higher than the average in Europe [26].

This is mainly due to the low level of investment in the development of energy-efficient technologies. Usually, a Ukrainian household consumes 32% more energy per square meter of living space (with the same duration of the heating season). If Ukraine reached the European average for these categories, the use of gas for the population and heating of premises would be less by 61%, according to analysts of the Oxford Institute for Energy Studies. Thermal modernization of residential buildings, the monetization of subsidies is only the first and obvious action. There may be many more.

Last time, we can see the trend that every year more and more energy consumption based on renewable energy is gaining popularity. In particular, energy consumption from biofuels and waste increased by 2102 thousand tons n. e. to 3049 thousand tons n. e. in 2017. Also, consumption from wind and solar energy increased, as in 2015 it was at the level of 134 thousand tons n. e., and in 2017 it was already 149 thousand tons n. e.

Implementation of the energy saving strategy at the enterprise takes place at the level of production divisions and administrative centers using a number of management methods (economic, organizational, socio-psychological, etc.) for energy saving and energy consumption at the enterprise. Implementation of energy saving occurs through the creation of an appropriate structural division, or a group of employees responsible for energy conservation in the enterprise. Therefore, the introduction of an energy saving strategy in industrial enterprises is appropriate as it is one of the key factors in increasing their profitability.

Depending on the success in each direction, the country is assigned a rating from A to D in alphabetical order, where each letter is assigned a scale from 0 to 10:

A is the highest result corresponds to a scale from 8.01 to 10.00;

B is the average result corresponds to a scale from 5.01 to 8.00;

C is below average, corresponds to a scale from 2.51 to 5.00;

D is the lowest, unsatisfactory result corresponds to a scale from 0 to 2.5.

Behind this ranking, the following countries have the best result in 2018: Switzerland, Sweden, Norway, Great Britain, Austria, Denmark, Canada, France, Finland, the Netherlands and the United States (table 3).

Table 3 – Countries' energy saving Policies

A country	Results in the field of energy saving
1	2
USA	<p>An example is the financial program "Energy Efficient business", which is successfully operating in the state of Connecticut (USA). Under its terms, business owners who decide to improve the energy efficiency of their own enterprise can expect a significant discount from energy supply companies, as well as an interest-free loan for the introduction of new technologies. In General, energy conservation issues in the United States are resolved on a strict, mandatory basis. The user of energy resources is deprived of the right to choose or not to choose the path of energy-efficient management. The consumer has two options for legitimate behavior: either they comply with the requirements of Federal and local state authorities for energy conservation, or they pay fines for failure to comply with these requirements. Back in 1992, the Federal energy policy Act of 1992 was adopted, which defined the main areas of energy conservation in the United States of America.</p>
Denmark	<p>The country has invested heavily in efficient energy solutions and renewable energy sources. At the same time, tax breaks have made it more attractive for businesses to focus on alternative and optimally efficient energy solutions. For example, the Danish energy Agency enters into a three-year contract with energy-intensive industrial enterprises. For its part, the Agency provides a discount on the payment of energy tax (applies to electric energy for heavy industrial processes and for space heating). On the other hand, industrial enterprises are obliged to implement a certified energy management system, i.e. an energy management system, in accordance with the agreement, as well as implement energy efficiency projects that have a payback period of less than four years. If industrial enterprises do not comply with the terms of the agreement, it is canceled, and the company is obliged to repay the tax discount for the duration of the agreement. Industrial enterprises also receive financial support for the purchase of energy efficient equipment.</p>

Continuation of the table 3

1	2
Finland	<p>The Finnish government is developing additional incentives for enterprises to improve their energy efficiency: subsidies for the purchase of new technologies, tax incentives. All Finnish enterprises are included in the waste recycling system. The focus on energy efficiency and environmental friendliness has allowed Finland to become one of the leaders in the production and export of clean technologies and breakthrough innovative solutions. The expansion of energy audit recommendations for municipalities and enterprises is positive on a national scale. In addition, voluntary agreements on energy efficiency in trade and industry are expanding across individual sectors of the economy and companies. A number of programs have been introduced that provide financial support for energy efficiency.</p> <p>There is even a merger of municipalities to implement the plans, since smaller municipalities have fewer opportunities in the field of human resources and in financial terms, and with the merger there is enough own funding for the implementation of rather expensive energy efficiency projects.</p>
Norway	<p>Norway has liberalized the electricity market, which has declared the main principle of energy efficiency – high electricity prices, which reflect its real cost, can make investments in the energy efficiency sector profitable, while low prices make the implementation of most programs in this area impossible. Thus, the refusal at the state level to lower the price of electricity better encourages owners to implement energy efficiency in enterprises. Otherwise, businesses are not able to compete in the market, which eventually leads to their bankruptcy. Norway's energy efficiency policy is strict, but, as practice shows, effective.</p>
Sweden	<p>Sweden has a clear system of control over the use of energy resources. This can be seen in mandatory declarations for enterprises with the use of energy resources, energy certificates of buildings, in the labeling of goods and even in the labeling of food. In addition, officials actively use economic incentives to promote the use of alternative energy sources. There is an exemption for a period of five years from the energy tax, the provision of state subsidies for the reconstruction of old buildings (replacement of boilers, insulation, etc.), simplified obtaining permits for the construction of wind farms.</p>

Continuation of the table 3

1	2
Germany	<p>German legislation and regulations state that banks and large corporations Finance the implementation of energy saving, not the state. Over the past decades, the country has tested the use of a Contracting tool (energy service contracts) as an element of public - private partnership. It assumes that in conditions when the owners of the enterprise are financially unable or do not have sufficient information to implement an energy-efficient policy at the enterprise, the solution of this task is assumed by the contractor, who conducts energy audits of structural divisions of the enterprise, assesses the efficiency of the production process at the enterprise in accordance with established standards. Further, based on the received data, the contractor makes the appropriate decision and ensures the implementation of the planned action plan in the direction of energy efficiency and assumes the project financing</p>
Netherlands	<p>In the Netherlands, a regulatory energy tax was introduced in 1996 to provide financial incentives to save energy and reduce carbon dioxide emissions. Regarding depreciation policy, in the Netherlands there is a free depreciation scheme for environmental investments (the Vamil list). It provides entrepreneurs with financial advantages, since it allows accelerated depreciation of certain equipment included in the environmental list for tax purposes (Vamil list), which reduces the company's tax payments and its deductions from profits in the first years after the investment and improves the company's position in terms of receiving money. The energy investment benefits Scheme (EIA) offers tax incentives for investments in energy-saving technologies and technologies for generating energy from renewable sources. If a particular equipment is included in the Vamil list, up to 52% of investment expenses can be deducted from profit taxation.</p>

World experience shows that effective measures in the direction of energy efficiency can reduce the growth of national demand for fuel and energy resources, which will reduce the import of fuel and energy resources and, consequently, remove the energy problems of countries with economies in transition. At the same time, a well-developed energy strategy of the country and effective projects of international cooperation in the field of energy efficiency will contribute to improving energy efficiency, economic development, environmental and national security of the country.

Taking into account the world experience, the International energy Agency identifies the following mechanisms of energy efficiency policy at the state level: pricing; regulatory and controlling; financial and fiscal incentives; information mechanisms; technological, commercial and financial development [27]. This classification is objective for evaluating the energy efficiency of industrial enterprises in Ukraine, subject to appropriate adaptation of mechanisms.

Having conducted the analysis, we will try to identify the following specific mechanisms of energy efficiency policy for industrial enterprises in Ukraine:

- prices that encourage industrial enterprises to search for new ways and methods to increase the level of efficiency of the use of fuel and energy resources;
- regulatory, including national and international standards, certification, as well as compliance with mandatory and recommendatory legislation;
- controlling bodies that provide for monitoring compliance with legislation and the company's obligations in the direction of energy efficiency, and in exceptional situations – the imposition of penalties;
- information that combines sources of information about ways and methods to improve energy efficiency in industrial enterprises;
- motivational programs that provide financial and fiscal incentives, soft loans, technical assistance, and so on.

Compare specific mechanisms (pricing, regulatory, regulatory, informational and motivational) managing energy efficiency in industrial enterprises on the basis of the analysis of best practices in industrialized countries such as: USA, Denmark, Finland, Norway, Sweden, Germany, the Netherlands and the experience of Ukraine, which are presented in table 4.

Table 4 – Systematization of energy efficiency policy elements for industrial enterprises

A country	Elements of an energy efficiency policy				
	Price	Regulatory	Supervisory	Informational	Motivational
1. USA		+	+	+	+
2. Denmark				+	+
3. Finland				+	+
4. Norway	+	+	+		+
5. Sweden		+			+
6. Germany				+	+
7. Netherlands					+
8. Ukraine		+	+		

The energy policy of the EU and the leading countries of the world in the direction of energy efficiency is proving to be effective and should therefore be adopted by domestic specialists. Implementation of energy efficiency programs in Ukraine requires changes in the algorithm of work in the organizational, financial, legal and information spheres.

A study of world experience in energy efficiency policy has found that an effective energy saving policy is based on three main principles: encouraging energy savings, forcing energy efficiency, and providing educational programs in the direction of efficiency. The main element of the mechanism for implementing energy efficiency in domestic enterprises is the transition to public-private partnership, which will provide the necessary financial resources and provide the necessary dynamics to the process.

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**ENERGY-EFFICIENT CHANGES MOTIVATIONAL MECHANISMS
FORMATION METHODOLOGICAL ASPECTS AT THE ENTERPRISE**

Improving energy efficiency can quickly reduce the cost and resource intensity of production by maximizing the use of available energy sources and related material assets. This, in turn, will reduce not only costs, but also the volume of energy consumption. The transition to an energy-efficient economy requires optimization of the energy consumption system, but not every employee is interested in the activities carried out by enterprises for this purpose.

Existing motivational mechanisms do not sufficiently contribute to improving the energy efficiency of enterprises in Ukraine, and in general to the consumer attitude to energy resources, not only in everyday life, but also in the workplace. Any changes are often perceived negatively, especially those that require the development of new mental rules and skills. Energy-efficient measures cannot immediately become popular. It is necessary to form an appropriate attitude to them among the staff.

Motivating the staff of each business entity in Ukraine to implement energy-efficient changes is a significant reserve for saving material resources, optimizing costs and increasing the level of production efficiency.

Therefore, carrying out relevant research to develop scientific and methodological foundations for effective motivational mechanisms formation for the introduction of energy-efficient changes in Ukrainian enterprises is relevant in the development of an energy-efficient economy.

Theoretical and practical aspects of employee's motivation at enterprises of various types of economic activity in Ukraine to introduction of energy-efficient measures were considered in scientific paper by many scientists: Vasyuta V. B. [1], Grabar O. I. [2], Danilkova A. Yu. [3], Zalashchuk L. V. [4], Klimchuk M. M. [5], Kotelnikova Yu. M. [7], Sotnik I. M. [8], Kasyanova D. Yu. [10], Nakonechnaya L. Yu. [11], Temchenko G. V. [13] and others.

However, the methodological aspects of motivation the mechanism for energy-efficient changes for enterprises operating in the mining and processing industry, construction, and transport have not been sufficiently developed yet.

The lack of an effective energy efficiency management system, the introduction of changes in this process leads to significant energy costs for production and low investment attractiveness of energy-intensive enterprises.

The main reasons for low energy efficiency at enterprises are:

- significant physical and moral deterioration of fixed assets and, as a result, high accident rate of equipment;
- low level of control and regulation of energy consumption;
- increased losses in production processes and high consumption of primary fuel and energy resources;
- lack of qualified specialists in the field of energy management;
- low level of staff motivation to energy saving, etc. [10].

Adapting to a new vision of motivating employees problem and the business itself in energy-efficient changes may be of interest to those who want to optimize their processes of energy consumption, constantly improve economic efficiency, reduce the risks of accidents and emergencies through failures in energy supply, and encourage staff to implement energy-efficient projects.

For any business entity, a problematic approach to rationalizing the use of energy resources should be implemented through the main goal of the enterprise's operation to obtain profit, economic benefits from the optimal use of all resources, and energy cannot be an exception.

Economically feasible, design achievable and actually existing levels of energy efficiency are closely related to the process of energy saving at the enterprise, which necessitates a more detailed consideration of the impact of factors of energy saving and energy efficiency at the enterprise, which determines the specifics and determines energy saving features [11].

To get the maximum effect from the implementation of energy-efficient changes program at the enterprise, it must represent the optimal set of energy-saving measures for it.

Two models are important to ensure the development of highly effective motivation of personnel in a particular enterprise:

- 1) model of employees mutual interests coordination at the enterprise;
- 2) model of motivation and stimulation labor organizational and economic mechanism [13].

The concept of the motivation model mechanism that stimulates the effectiveness of labor activity is to recognize the management of energy-efficient changes as the key to effective business activity (Fig. 1).

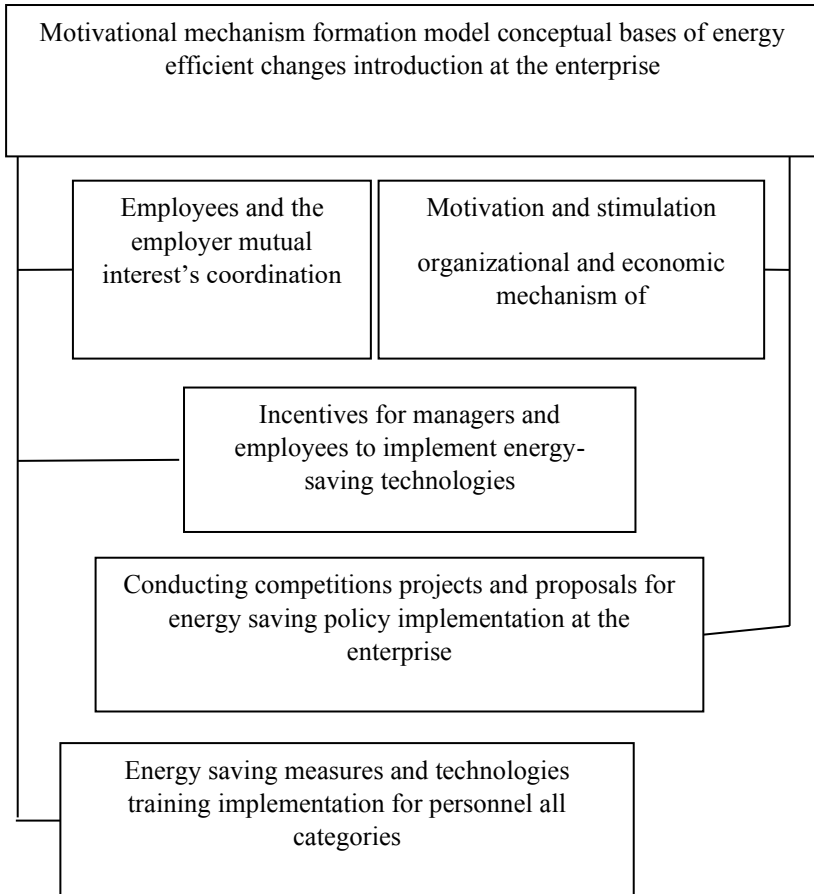


Fig. 1 – Company's personnel ensuring effective motivation model formation regarding implementation

The motives of employees that encourage them to work more effectively are different, but to a certain extent are divided into economic and socio-psychological in different proportions. Motivational monitoring can help to identify the key motivations of staff in structural units not only to implement energy-efficient changes, but also to consciously or unconsciously resist them.

The importance of this problem actualizes the development of economic and managerial incentives mechanism based on dependence of reward entities formation from the results of energy efficiency, profit fair distribution between energy saving project participants [5].

The scientific and methodological level of motivation for energy saving includes the following postulates: axiological, ontological, epistemological [2].

This model can serve as a methodological tool for finding the optimal organization of production and labor that meets the interests of all social partners (community, employer, employees), which ultimately leads to an economic effect in the form of increased profitability, increased productivity, increased competitiveness and investment attractiveness.

Today, as well as the last decade, at the enterprises of Ukraine, except for those that have foreign partners, to assess the performance of employees mainly use the accounting of labor results and analysis of factors that affect them. The experience of Western companies display that the evaluation of results is necessary, but it is not a sufficient condition and criterion for making informed personnel decisions. No less important is the definition of business and personal qualities that are manifested in the process of work. To do this, it is proposed to use the methods of expert assessments, methods of assessment "360 degrees", CRI, integrated assessment and others, in which, in accordance with the accepted criteria, the quality characteristics of employees and their ability to achieve maximum performance, as well as the level of competence are determined. This makes it possible to use an individual approach in the selection of personnel. Based on processing the collected information about the quality characteristics and performance indicators of each employee and structural unit, managers have the opportunity to form a unique and at the same time effective motivational mechanism for a particular company and even for an individual employee.

The conditions for improving the energy efficiency of the enterprise is the availability of personnel with established energy efficiency competence in order to enable the company's staff has energy efficiency competence, the company's management must develop and maintain a staff development plan and related processes [7].

Another component of effective motivational mechanism formation should be that each employee himself should be informed about the features of the company's activities, output, energy expenditure, as well as possible options for evaluating the results of their activities.

The new economic conditions for entrepreneurial activity are closely related to the rapid changes in the external environment of enterprises, should contribute to the formation of professional competencies of personnel, which are associated with the use of resources and property of the enterprise, recognition of the need to take care of the environment and territory, protect their own interests and the interests of society.

Energy-efficient competence formation depends on the understanding of its needs and motivational attitudes. Material incentives and non-material motivation system of employees should be based on comprehensive monitoring of employee behavior, that is, on motivational monitoring [7].

Taking into account these aspects, the motivational model, which provides employees with the following competencies for their development and improvement, is schematically shown in Fig. 2.

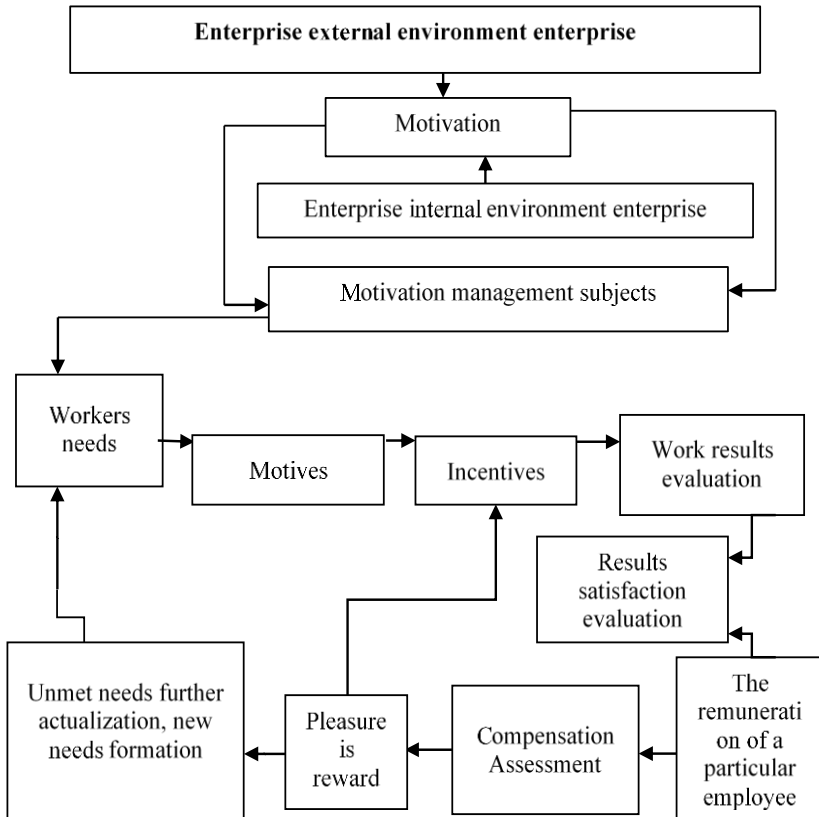


Fig. 2 – Employee motivation mechanism model for implementing energy-efficient changes

The motivation system for implementing energy efficient changes at the enterprise level in relation to an individual employee should be based on certain requirements:

- provision of equal opportunities in relation to employment and promotion by the criterion of performance evaluation results;
- coordination of the level of remuneration with its results and recognition of personal contribution to the overall result;
- job security for employees who participate in the implementation of specific projects of energy-efficient changes;
- creating appropriate conditions to protect the health, safety and welfare of all employees;
- providing opportunities for the growth of professional skills, the implementation of the abilities of employees, providing training programs, professional development;
- maintaining an atmosphere of trust in the team, interest in the implementation of a common goal, the possibility of two-way communication between managers and subordinates.

The main non-material means of maintaining the activity of staff to ensure energy-efficient changes is the creation of favorable working conditions, persuasion, the power of example, moral encouragement. The latter are determined by the fact that incentives for energy-efficient shifts form an active environmental-oriented life position, and then an environmentally favorable climate in the collective and society as a whole. At the same time, it is important to provide a correct and justified system of moral incentives, taking into account the traditions and historical experience of the country [8].

Basic rules of motivation to ensure energy-efficient changes, compliance with which will increase the effectiveness of motivational activities:

- use of regular rewards and recognition of success and effort;
- encouragement not only for effective actions, but also for achievement of intermediate results;
- application of the principle of trust (creating a sense of freedom of action of managers, the ability to control the situation).

The following conditions must be met:

- correct understanding of the content and form of tasks on resource saving and energy-efficient changes in the company's work, its relations with other entities;
- the adequacy of the tasks of the employee's qualification;
- recognition by the employee of the importance of his contribution to the process of resource saving and energy efficiency growth, achieving the interests of society;
- support for the initiative and evaluation of results [8].

Along with external motivation, it is necessary to influence the internal motivation of employees, because its absence will inhibit any energy-efficient changes in the enterprise.

The corresponding system of motivation employees should be considered as a factor of increasing the efficiency of management, oriented not only

economically but also environmentally, and at the same time as a system of complex impact on the staff on the basis of increasing the internal motivation of employees, which increases the activity of their activities in the direction of resource-saving actions.

Therefore, when improving the system of staff motivation, it is advisable to take into account the following principles:

- the complexity of the motivational model, which involves the simultaneous use of moral and material, collective and individual incentives;
- differentiation of motivation tools for implementing energy-efficient changes depending on the age, mentality and social status of employees using an individual approach to stimulating different groups of staff;
- flexibility of motivation tools and efficiency of decision-making on incentives, which is manifested in the constant revision of incentive systems under the influence of changes in society and the workforce.

Motivation of energy saving is a structural element of the process of energy efficiency management of a modern enterprise and consists in building a system of incentives for employees to economical and rational use of fuel and energy resources [3].

It should be noted that the current legislation of Ukraine enables to encourage employees to save fuel and energy resources. Material stimulation of labor collectives and individual employees of enterprises for effective use of fuel and energy resources and water is carried out in accordance with the order of the State Committee of Ukraine on energy saving and the Ministry of economy of Ukraine dated 21.06.2000 No. 47/127 "on approval of the Regulations on material stimulation of collectives and individual employees of enterprises, organizations and institutions for saving fuel and energy resources in public production" by awarding. The purpose of the regulation is to strengthen the creative and business activity of employees and managers of enterprises, organizations and institutions of their material interest in reducing the energy intensity of production by rationalizing the use of fuel and energy resources [12].

According to this Provision, material incentives for efficient use of energy resources are provided by awarding employees within the established share of the cost of saved energy resources. The head of the enterprise is granted the right to reduce the size of the award or to deprive it completely for failure to perform tasks to reduce the energy intensity of products, the use of secondary energy resources, for overspending of certain types of fuel or electricity. The basis for material incentives for labor collectives and individual employees of enterprises is the calculation of the cost of saved fuel and energy resources and water, based on the actual specific costs of fuel and energy resources. The calculation is made according the accounting of the consumed fuel and energy resources and water with the use of auxiliary information and data, operational accounting departments and is documented in the economic service of the company, signed by the chief

electrician, chief accountant, chief economist, state inspector for energy conservation and approved by the Director of the company. Accounting for the use of heat energy is necessary for the analysis and management of energy consumption processes. Effectively adjusted energy accounting allows you to quickly and efficiently analyze its consumption, make the right decisions about measures that will improve the efficiency of energy use. Usually, the amount of the premium Fund is determined as a percentage of the amount of savings of a particular type of energy resources [12]. At the same time, bonus systems must necessarily be cost-effective, purposefully stimulate positive energy-efficient changes with appropriate psychological perception of all aspects of the incentive system by employees.

As mechanisms of incentives for efficient use of energy resources can be distinguished: communication between job performance (qualitative and quantitative) based on energy savings at a certain stage of the production process and labour reward.

One of the means of monitoring the effectiveness of energy-efficient changes implementation at the enterprise can be an energy audit. Achieving noticeable energy savings and adequate perception of energy-efficient changes by employees at the enterprise is possible if the energy management system is implemented.

Energy management is the process of managing all aspects of the company's energy saving activities. The main goal of energy management is to provide the most effective ways to implement the energy-saving strategy of the enterprise at certain stages of its development [4].

The main tool for implementing the mechanism of energy-efficient changes can be attributed to both financial and incentive motivation.

To financial aspects of motivation of employees of the enterprise to energy saving it is possible to carry:

- premiums proportional to the cost of annual stored energy;
- bonuses;
- providing social packages;
- valuable gifts, vacation packages.

The incentive aspects include:

- provision of additional vacation days;
- reduction of the working day with the preservation of wages;
- awarding certificates, commendations, commemorative signs, the use of honor boards and the like.

In addition to motivational tools, the company should also implement a system of penalties, which is based on fines, reduction of bonuses, reduction of additional days off and other areas that do not contradict labor legislation and agreed by the company's management with trade Union committees. However, it

should be noted that the abuse of negative incentives can lead to the fact that they cease to operate.

It should be noted that according to article 147 of the labor Code for violation of labor discipline, only two penalties can be applied to employees – reprimand or dismissal, and it is forbidden to collect fines from wages, but this does not stop many Ukrainian employers. They create a system of remuneration with a constant and variable part, and it is the latter that is the subject of punitive manipulation. Changes in the market economy, legislation, political environment, business models and goals of the company require employees to take a fresh look at the problem, creative, creative approach to decision-making, internal freedom to expand horizons and go beyond the already known methods of work. The system of penalties is based on fear and avoidance, but the fear of punishment is not a guarantee of avoiding mistakes, it rather blocks normal mental activity and leads to a drop in performance [9].

The structural diagram of the process of implementing the motivational mechanism of energy-efficient changes in the enterprise is shown in Fig. 3.

Implementation of the motivational mechanism without monitoring its support at all structural levels of the enterprise can lead to the gradual extinction of insufficiently motivated organizational decisions and insufficient organizational, technical, and production support for implemented energy-saving measures.

For effective implementation of the proposed solutions by all employees involved in the process of the enterprise, there is a need to implement a set of actions aimed at monitoring the existing situation.

As a rule, when applying any motivational theory, quite an important area of consideration the question of correct choice and definition of the guidelines from the standpoint of motivation of energy saving, the implementation of which will contribute to the achievement of the staff assigned to the enterprise goals, defining ways to achieve them, that is the Foundation and implementation of the appropriate set of motivational programs and activities as reactions to the challenges of modernity [1].

The monitoring tools include heat, electric energy, water, waste water meters, temperature, pressure, flow, humidity sensors, and others. Information from the sensors is sent to the computers of the relevant services, where it is processed and stored.

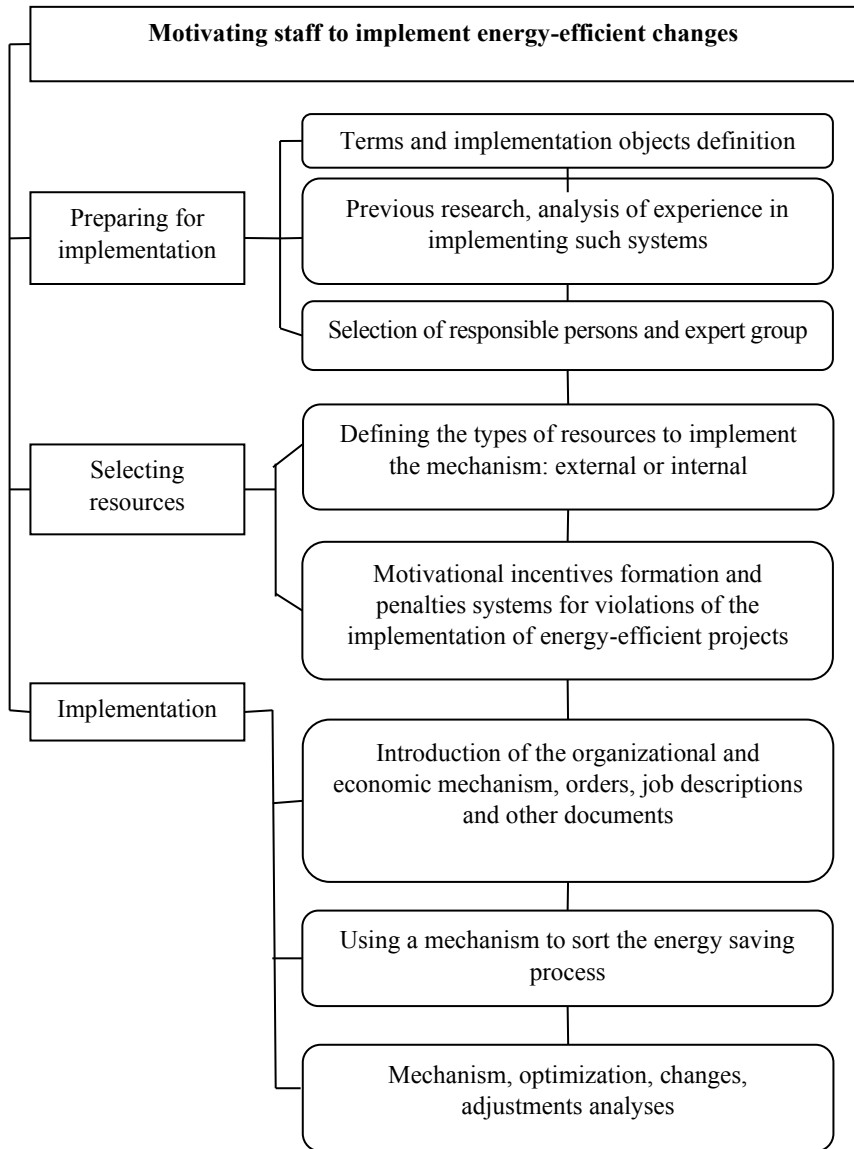


Fig. 3 – Energy-efficient changes motivational mechanism formation process at the enterprise structural diagram

These proposals provide for changes to the current Regulations on material incentives for the collective and individual employees of enterprises in order to motivate staff to save energy for saving fuel and energy resources.

The purpose of this Provision is to strengthen the creative and business activity of employees and managers of the enterprise, their material interest in reducing the energy intensity of production by rationalizing the use of fuel and energy resources. The funds used by the enterprise for material incentives for saving resources are credited to the gross costs. From the point of view of ensuring economic efficiency, the total amount of funds that can be used to award employees should not exceed 30% of the cost of saved energy resources. The total amount of saved energy resources at the enterprise or in a particular production unit is determined by the cumulative total over a period of time, the results of which are set variable part of the remuneration. Usually such periods do not exceed 3 or 6 months, which is associated with a negative impact on the motivation of employees to save energy due to the increase in the time between the result and the receipt of material remuneration [12].

It is important to determine the factors that affect the energy efficiency of an industrial enterprise as elements of the environment of its formation (table. 1).

At the stage of adaptation of the enterprise to the new motivational mechanism, certain subsystems require attention and implementation (Fig. 4), allowing to start implementation measures to improve energy efficiency and carry out corrective actions. According to the provided energy efficiency management algorithm, the company will be able to implement the energy saving program and apply it to each service separately.

Energy efficiency management leads to the need for timely identification of problems in the course of work and control of its functioning.

Based on the above, we can offer the following directions for developing a model of motivational mechanism for energy-efficient changes in the enterprise (Fig. 5). As a result of proposed mechanism formation, the company can expect to increase energy efficiency and reduce the cost of production, which in turn can contribute to improving competitiveness and increasing performance.

Competent business management cannot be organized until all levels of the company's management are aware and understand the needs, motivations and incentives of their own employees. Without a well-coordinated team, the labor collective also becomes impossible to carry out economic activities, therefore, the interest of employees is a key condition for the growth of the company's profits [5].

Mechanism formation for motivating staff to save energy is advisable to start with the definition of specific goals and check the technical and economic feasibility of achieving them.

Economics Energy Efficiency: Problems of Nowadays and of the Future

Table 1 – Industrial enterprises energy efficiency factors

Responsibility center	Influence factor
Human resources	Personnel qualification level in the field of energy saving
	Cooperation level with other companies in the field of experience exchange, participation in energy saving events
	Personal incentive system availability for saving energy resources (ER) by personnel
Energy audit	Energy audit system availability
Production	Energy-saving technologies and equipment application
	Degree of secondary use of HER degree
	Production technology efficiency level
	ER accounting system modernization
	Focus on energy-efficient production
	ER costs regulation
Energy service	Infrastructure availability for servicing the supply system at the enterprise ER
Enterprise interaction with the external environment	System availability monitoring legal acts regulating ER
	Participation in energy saving programs
	State fiscal policy focused on energy saving
	Financial motivation availability for enterprises to improve energy efficiency
	Tariff policy of the state in the sphere of ER
	Tariff policy of the ER supplier
Company financial state	Investment potential in energy efficiency
	Financial condition of the company

The proposed motivational mechanism for energy-efficient changes involves the analysis of the structure of energy consumption of the enterprise and the search for the most promising areas of energy saving with the involvement of personnel. The presence of a system of motivation in the enterprise is not yet a guarantee of motivation of the staff to certain actions. It will really stimulate employees only if there is a motivational environment formed on the basis of the attitude of the staff to motivational measures.

So, the motivation of energy saving is a structural element of the process in energy efficiency management at a modern enterprise and consists in building a system of incentives for employees to economical and rational use of fuel and energy resources.

The main tool for implementing the mechanism is motivation based on financial and incentive aspects.

It is proposed to amend the current Regulations on material incentives for the collective and individual employees of enterprises in order to motivate staff to energy saving for saving fuel and energy resources.

Appropriate is the combination of non-material remuneration in the form of social approval and monetary bonuses, which act as a reinforcement in the process of motivating staff; motivation by career and change of functional responsibilities. For those interested in employees professional and career growth, it is appropriate to provide a system of promotion for achievements in the field of energy conservation.

Energy efficiency management leads to the need for timely identification of problems in the course of work and control of its functioning.

As mechanisms of workers stimulation at the enterprise for efficient use of energy resources can be distinguished: communication between job performance (qualitative and quantitative) based on energy savings at a certain stage of the production process and labor remuneration; consolidation of human resources in the enterprise.

As a result of formation of the proposed mechanism, the company can be expected to improve the efficiency and reduce the cost of production, which in turn can improve competitiveness and increase efficiency of economic activities.

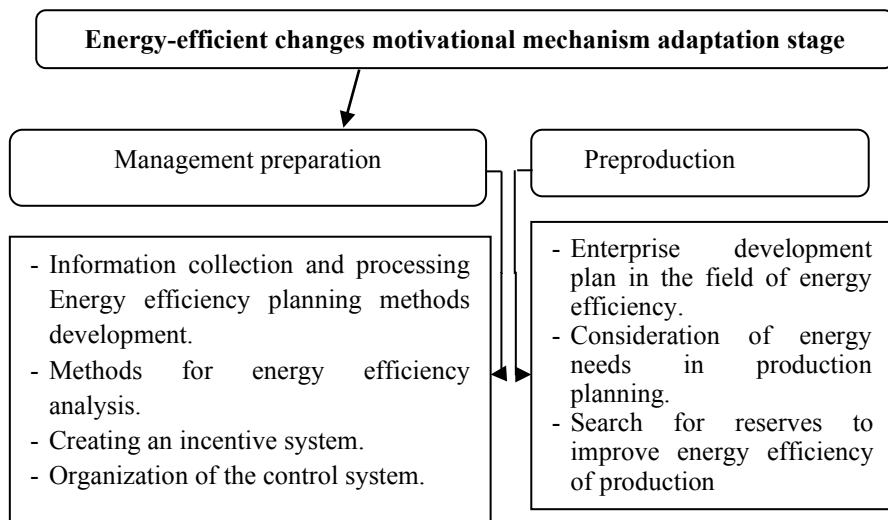


Fig. 4 – Motivation management adaptation directions algorithm for implementing energy-efficient changes in the enterprise

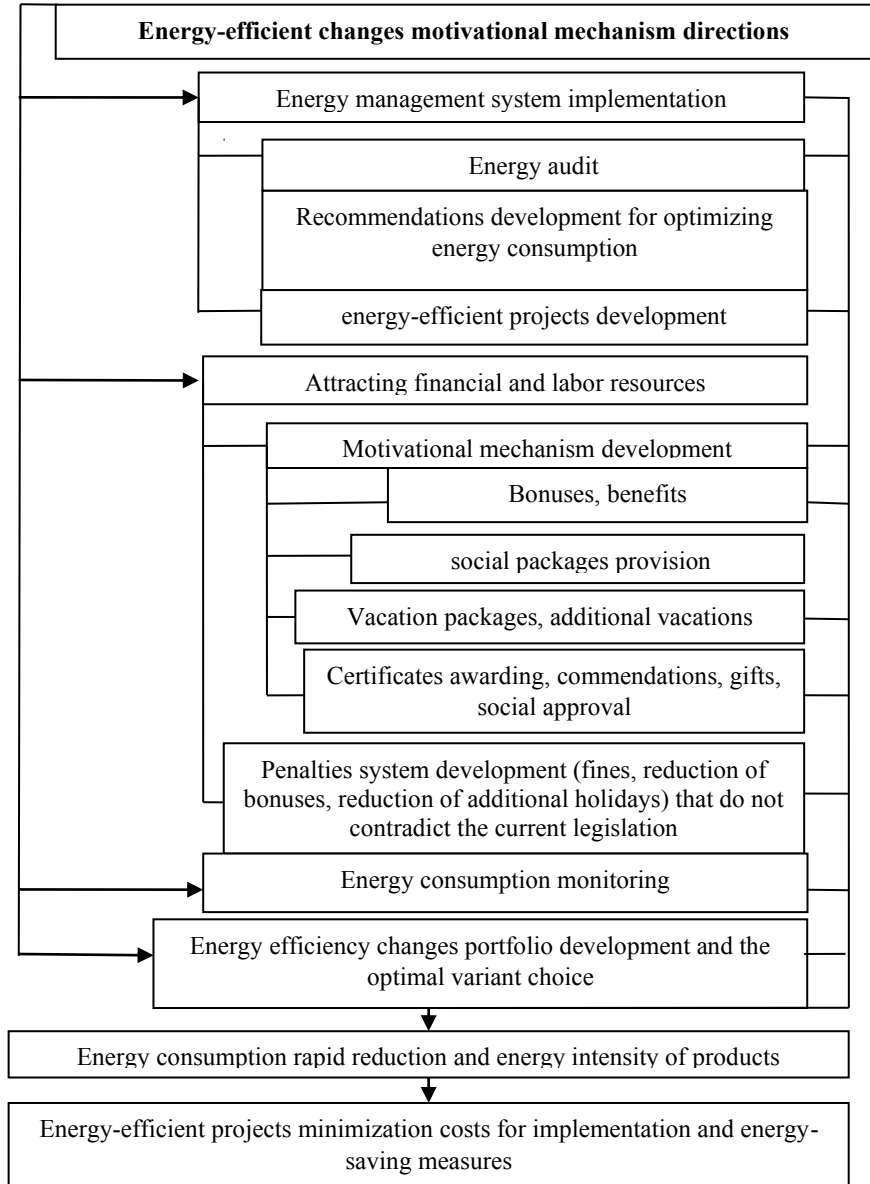


Fig. 5 – Measures to form a motivational mechanism for energy-efficient changes in the enterprise

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CONCLUSIONS

The analysis made it possible to evaluate the efficiency of implementation of the energy conservation program and its main components, namely the readiness of the personnel of the enterprise to interact with the management in order to achieve the set goal, measures for the technological and technological equipment of the production process.

The energy policy of the EU and the leading countries of the world in the direction of energy efficiency is proving to be effective and should therefore be adopted by domestic specialists. Implementation of energy efficiency programs in Ukraine requires changes in the algorithm of work in the organizational, financial, legal and information spheres.

A study of world experience in energy efficiency policy has found that an effective energy saving policy is based on three main principles: encouraging energy savings, forcing energy efficiency, and providing educational programs in the direction of efficiency. The main element of the mechanism for implementing energy efficiency in domestic enterprises is the transition to public-private partnership, which will provide the necessary financial resources and provide the necessary dynamics to the process.

The analysis of obstacles on the way to efficient energy use in Ukraine has made it possible to determine that the main obstacle is the lack of motivation of all economic entities of the state, control of enterprises and households for energy efficient activities, explaining to citizens the issues of stimulating energy conservation, energy audit and energy management. Therefore, it is advisable to consider the identified threats when developing national and regional development strategies for the future.

The proposed motivational mechanism for energy-efficient changes involves the analysis of the structure of energy consumption of the enterprise and the search for the most promising areas of energy saving with the involvement of personnel. The presence of a system of motivation in the enterprise is not yet a guarantee of motivation of the staff to certain actions. It will really stimulate employees only if there is a motivational environment formed on the basis of the attitude of the staff to motivational measures. So, the motivation of energy saving is a structural element of the process in energy efficiency management at a modern enterprise and consists in building a system of incentives for employees to economical and rational use of fuel and energy resources. The main tool for implementing the mechanism is motivation based on financial and incentive aspects. Energy efficiency management leads to the need for timely identification of problems in the course of work and control of its functioning.

As mechanisms of workers stimulation at the enterprise for efficient use of energy resources can be distinguished: communication between job performance based on energy savings at a certain stage of the production process and labor remuneration.

Economics Energy Efficiency: Problems of Nowadays and of the Future

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