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## RESEARCH OF ENERGY RESOURCES IN UKRAINE

*We carried out the study on characteristics of electricity consumption, electric power generation and electricity needs in countries of the world. We conducted an analysis of the efficient use of energy resources in the world. We identified problems of efficient use of energy resources in Ukraine. Based on the conducted research, we presented the forecast of electric power production, dynamics and structure of electric energy consumption by types of industry in Ukraine. We described measures to stabilize and develop the effective use of fuel and energy resources.*

**Key words:** *energy efficiency, fuel and energy resources, structure of consumption, electric energy*

**Introduction.** The energy balance of the state is a system of indicators, which reflects the full quantitative conformity of production, receipt and use (including costs and losses on their transportation, conversion, storage and surplus) of all energy carriers (energy sources) in the economy as a whole or in its separate components (region, industry, enterprise) at a certain interval of time to establish conformity of the state of energy supply with the needs of the national economy in energy resources, to identify and to correct imbalances and weaknesses in the energy supply, in particular, in ensuring the efficient use of energy resources.

In the form of compilation, the energy balance is defined as a consolidated statistical report on production (extraction) and receipt of species (sources) of energy, cost and use, which shows the origin and uses of all energy sources used in the country for a year (or perhaps a different time period).

Determining the mechanism for forming the energy balance requires the coordination of actions of central and local executive authorities, related to the provision of energy security and the creation of an information base for the analysis, optimization and forecasting of the stable functioning of the economy taking into account branch features.

The formation of the energy balance of the state will make it possible to establish the conformity of the energy supply to the needs of the national economy in energy resources and increase the efficiency of the use of all types of fuel and energy.

The problem of efficient use of energy resources for Ukraine is extremely relevant today. We were able to apply the European practice of planning, forecasting energy development and implementation of energy efficiency policy. The Cabinet of Ministers of Ukraine introduced the National Energy Efficiency Action Plan for the period until 2020 [1].

One of the measures to implement the National Action Plan on Energy Efficiency is the creation of legislative conditions for the implementation of the priority tasks of the state policy in the field of energy efficiency, in particular through the introduction of systems: management, monitoring, standardization, marking, energy audit, the mechanism of "white certificates" [1].

As for the monitoring of energy consumption, in particular electricity, then the processing of information on monthly consumption of electric and heat according to the data of the State Statistics Service of Ukraine is not provided by the State Statistical Survey. There are only our annual use of electricity and heat. Therefore, full monitoring of energy efficiency and implementation of energy management systems is possible only at the level of individual enterprises.

**The aim of the study.** The purpose of the study is to conduct a structural analysis of the generation of electric energy, electricity consumption and electricity needs of the countries of the world and in Ukraine, identifying problems and measures for stabilization and development of efficient use of energy resources.

**Analysis of recent research and publications.** Among the works that include the analysis of consumption, the development of the energy resources market in Ukraine, the reasons for its imbalance, the role of energy resources in the overall development of Ukrainian economies and scientific development in the issues of energy resources, it should be noted scientific works of such domestic and foreign scientists as B. Korobko, D. Zerkalova, G. Semenova, T. Markova, V. Haiduk, A. Dmitrievsky, V. Tolbatov, V. Ostalsky, V. Samokhvalov, V. Kudlai, M. Yudevich, O. Ivanova, A. O. Beshti, I. Hoffman, V. Korsun and many others. But during the reform and transformation of the Ukrainian energy system, which is constantly being updated, which is constantly updated in accordance with the EU directives, we need to pay attention to the dynamic changes in the energy policy of Ukraine, to the appropriate changes that resulted in the choice and direction of our research.

**Main results of the study.** The monitoring of the statistical indicators of the state's energy balance must be ensured by the bodies of legislative and executive power and is the process of systematic long-term observation, which aims to solve such problems:

- determination of ways of optimization and forecasting of the state energy balance;
- Optimization of the structure of primary energy consumption with measures to reduce losses and and specific energy consumption and dependence on their imports, an increase in the share of non-traditional and renewable energy sources, including "green energy", in the structure of the energy balance of the state;
- - increase of efficiency of use of all kinds of fuel and energy in the spheres of vital activity of the state;
- definition of the mechanism for coordination of work and control over implementation of the realization of the National Energy Efficiency Action Plan of Ukraine, Energy Strategy of Ukraine for the period up to 2035 "Safety, Energy Efficiency, Competitiveness";
- ensuring a well-defined definition and conducting an assessment of perspective ways of economic development and priority measures to ensure the protection of national interests in the sphere of energy supply of the state;
- creation of information and analytical information base for forecasting trends and regularities of changes in the level of energy efficiency, ensuring energy security of the state.

We will analyze the current and prospective levels of extraction and use of the main fuel and energy resources, primarily in terms of ensuring energy independence and we will formulate the main requirements for ensuring energy independence in order to take them into account in the further development of strategies for the progress of the fuel and energy complex in general and the fuel and energy balance of the country.

The economic development of the countries of the world implies an increase in the demand for fuel and energy resources. At the same time, according to the International Energy Agency (IEA), there is a general increase in electricity demand (Fig.1).

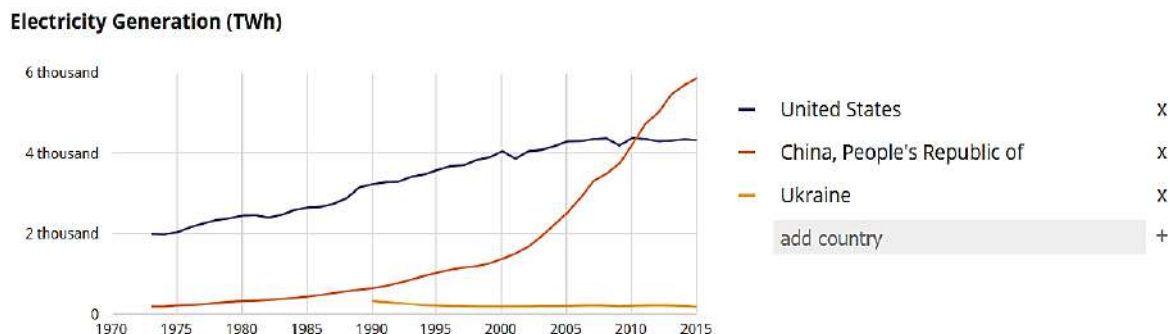


Figure 1 – Analysis of demand for electricity over the years, TWh

The share of electricity produced by each country in 2016 is given in Table. 1

Table 1 - Electricity production in countries of the world

Country	Value, billion kWh	Country	Value, billion kWh
China	5,84 thousand	Italy	281,56
United States	4,30 thousand	Spain	277,79
Russian Federation	1,07 thousand	Turkey	261,78
Japan	1,04 thousand	Poland	164,34
Canada	670,74	Ukraine	162,11
Germany	640,97	Sweden	161,93
Brazil	581,65	Kazakhstan	106,47
France	563,49	Israel	64,23
Korea	549,23	Austria	61,76
United Kingdom	336,36	Belarus	34,08

The International Energy Agency opposed the plan of state statistical observations Ukraine presents report "Monthly electricity statistics," its data ensures the timely and consistent receipt of electricity and trade data for all OECD member countries (Organization for Economic Cooperation and Development). Efforts to promote access to electricity have a positive impact in all regions, and its pace of growth has accelerated. However, progress in access to electricity is uneven, Figure 2 shows that the monthly production of world electricity [2].

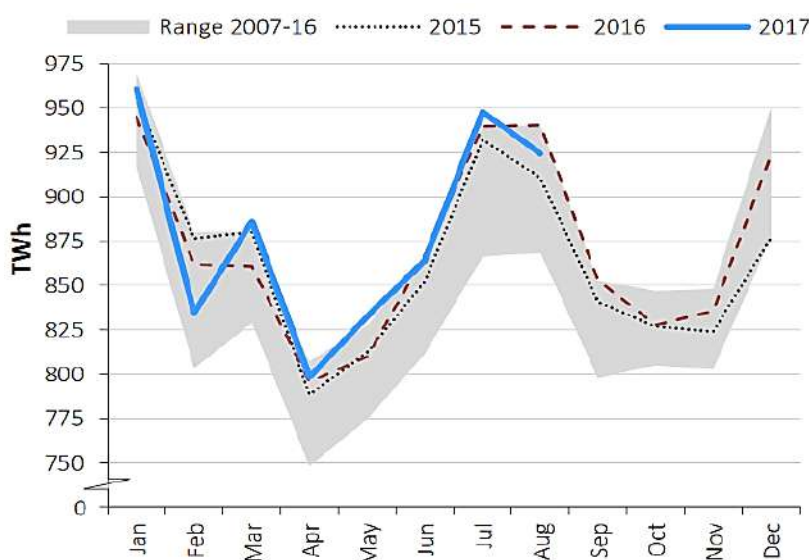


Figure 2 – The structure of the monthly production of world electricity

Energy efficiency has been recognized as a major priority for energy strategies at the international level. Increasing energy efficiency, developing and implementing the latest technologies, changing the structure of electricity production should take place in parallel. In such circumstances, only a radical improvement in energy efficiency will reduce energy consumption, conservation of resources, reducing emissions of carbon dioxide (CO<sub>2</sub>), reducing implementation cost RES (renewable energy sources) and slower growth in electricity prices for industry and population.

In the main IEA scenario, global energy consumption by 2040 will increase by one third mainly due to India, China, Africa, the Middle East and Southeast Asia. All global energy consumption growth will be in the set of countries outside the OECD, as overall energy consumption by the OECD countries will be reduced if compared with the peak value of 2007 by increasing energy efficiency,

demographic and structural and economic trends. The leaders in reducing energy consumption for the period up to 2040 will be the EU (15%), Japan (-12%) and the USA (-3%).

For example, in China, the country's energy industry is developing at a very high pace in a regulated market of electricity in comparison with other countries; every 90 to more than 111 GW of power are generated depending on the pace of economic development of the country (for 2016 11.7 GW were introduced).

Today, the most effective energy reform conducted in the UK, Germany, Norway, Sweden, Finland by creating an effective competitive electricity market. The competitive electricity market is successfully operating in selected US states, Japan and a number of other countries.

Despite the significant differences in the industrial-organizational structure of the power industry of different countries, in the principles of organization of the functioning of the electricity market, the methods of regulating the activities of energy companies and pricing, actually in all developed countries, at the state level, in one form or another, the control over the implementation and regulation of certain types of activity of energy companies is exercised.

Pricing policy is one of the main indicators of the success of the liberalization of the energy market as for producers of goods and services, and for residential electricity consumers, since it depends on the competitiveness of the country's products and payment capacity of the population. At the same time during the formation of prices important factors are the increase in fuel costs, as well as costs for the implementation of environmental protection obligations of countries at the international (regional) level.

For example, in order to prevent possible abuses in the conditions of competition in electricity markets, PJM (USA) and Nord Pool (Scandinavian Electricity Exchange) groups of companies set up market monitoring departments, they monitor and analyze the market in order to prevent possible manipulation of market power. In particular, the Danish Trunk Network Operator (OMM, Energinet.dk) publishes monthly market surveys, which, based on a general analysis, determine the steps taken to prevent unauthorized pricing in the electricity market [3].

As for Ukraine, for the last five years, renewable energy sources have begun to gain momentum, and it is expected that such a change will accelerate. Renewable energy sources (in particular hydroelectric power stations and geothermal sources) have become sources of more than a third of new compounds over the last five years, while decentralized renewable energy sources compose for 6% of access to new electricity. Electricity demand is determined by three main factors: population growth, economic development and technological progress. The population is an important determinant of the volume and structure of energy consumption..

Expected electricity production forecast in Ukraine for [4] is shown in Fig.3.

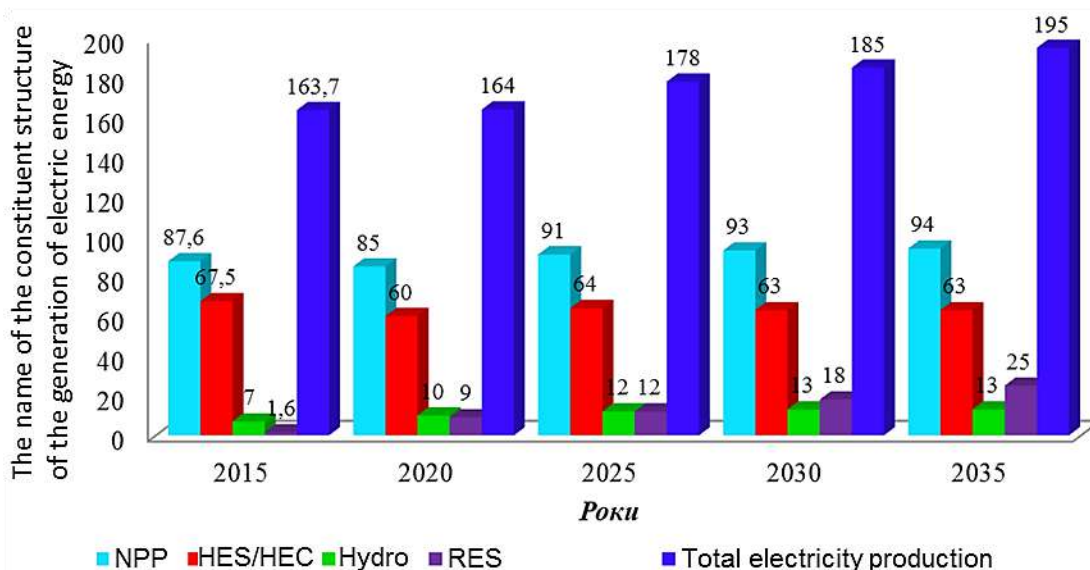


Figure 3 – Forecast of electricity generation in Ukraine up to 2035, billion kWh

Ukraine uses various sources of energy for its own needs, such as oil, natural gas, coal, atomic and hydro energy, wind and sun energy, etc.

Availability of all these resources in Ukraine, creation of a competitive market environment and conditions for systematic development of the resource base for nuclear power, modernization of generating capacities and replacement of the raw material base with alternative fuels, further exploration and extraction of hydrocarbons, including non-traditional resources, as well as more efficient use of potential in the field of renewable energy will contribute to the gradual strengthening of Ukraine's position in rational energy production and economical use of energy. Primary energy production is depicted in Fig.4.

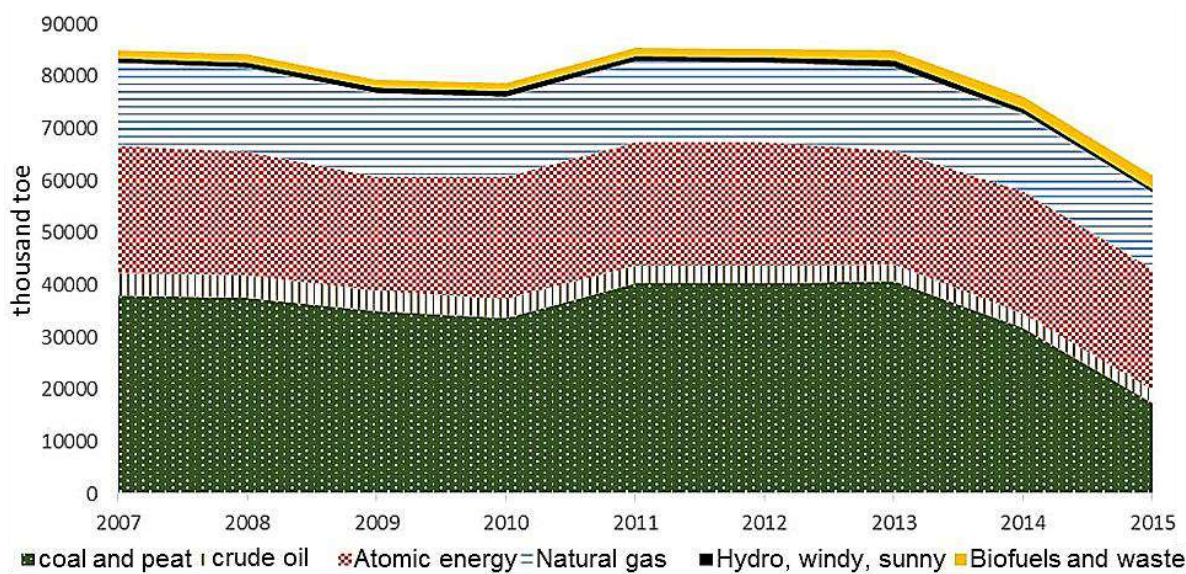


Figure 4 – Dynamics of primary energy production in Ukraine from 2007-2015, thousand toe

The energy system of Ukraine in the model is divided into seven main sectors: the energy supply sector; production of electricity and heat; industry; agriculture; domestic consumers; service sector; transport sector. The industrial sector is actually represented only by the manufacturing industry, since the energy production and power industry is included in the model to the energy sector in accordance with the structural energy balance scheme, and their consumption of fuel for their own needs and losses during transportation are not included in the calculation of final consumption.

Industry sectors are divided into two categories according to the level of energy intensity of production. Energy-intensive industries are represented in the context of the technologies of production of the main types of their products, i.e their energy demand is the production of units of the industry (steel, aluminum, ammonia, cement, lime, paper, glass, etc.). The categories of energy-intensive industries include metallurgy, chemical industry, production of non-metallic mineral products, pulp and paper industry, dynamics and structure of their electricity consumption in the figure. 5. For other industries, the structure of energy flows is standard and consists of four types of conditional technologies that meet the needs of technological heat, machine drive, electrochemical process and other processes. The success of a particular company depends on how well built the functioning of these processes and their relationships. Process optimization through the process approach is one of the main means to increase the efficiency of the organization, including engineering and metallurgical enterprises, which are the most energy-intensive [5].

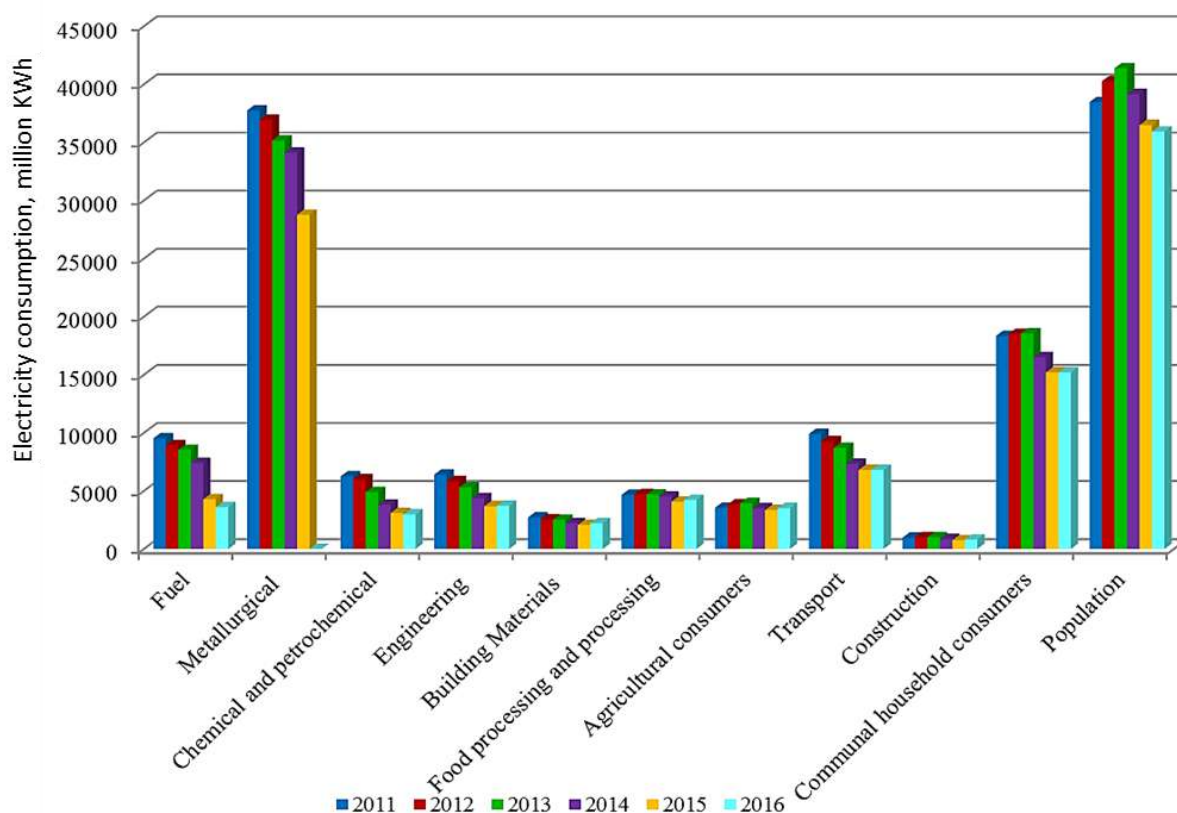


Figure 5 – Dynamics and structure of electric energy consumption by type of industry in Ukraine, million KWh

\* according to the Ministry of Energy and Coal and SE "EnergoMarket"

The main consumers of electricity were enterprises of such types of economic activity as processing industry (42.4%), from it the metallurgical production made 22.3%; supply of electricity, gas, steam and air-conditioned air (17.2%), transport, warehousing, postal and courier activities (7.4%).

Changes in the electricity consumption of individual industries depend on volumes of production and rational or inefficient use of energy on industrial objects, such as in the food industry, most of the processes are aimed at optimizing the overall energy performance of the process for specific conditions of work [6].

Enterprises and organizations of all types of economic activity in 2016 used 114.8 million tons of conditional fuel of primary and secondary types (taking into account the volumes of sales to the population), and by 4.6% more than in the previous year.

Electricity production by power plants of the UES of Ukraine in 2016 amounted to 162.11 billion kWh (2% less than in 2015). The total volume of electricity supplied by all sources of energy supply in 2016 amounted to 147.8 billion kWh, heat energy - 99.0 million Gcal. In the structure of sources of electricity supply by types of generating units, the most important were thermal power plants (TPPs), the share of which accounted for 47%, nuclear power plants (NPPs) - 23%, thermal power plants (CHP) - 18%; in the structure of the sources of heat supply, the largest share fell on the heating plant (boiler-houses) - 83% and CHP - 11%.

In 2016, compared to the previous year, the volume of electricity consumption, excluding own consumption by power generating units, increased by a total of 0.5%. The increase in electricity consumption was observed in 14 regions, including the largest in Kyiv, Tcherkasy, Mykolaiv, Volyn, Odesa and Zakarpattia areas. A significant part of the electricity (62%) was used by enterprises in Donetsk, Dnipropetrovsk, Zaporozhye, Kharkiv, Poltava regions and Kyiv.

Ensuring sustainable development of the fuel and energy complex is especially important at the stage of the country's entry into the world economic space, because the state of the FEC depends to a

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large extent on the degree of economic and political independence of the country, the pace of the country's exit from the crisis and its national security. Inefficient domestic consumption of fuel and energy resources increases the level of dependence on exporting countries and deepens the problem of energy security of the country by the level of import dependence of more than 51% with the unsatisfied energy saving potential in Ukraine to 48% of the volume of consumer fuel and energy resources.

Stabilization and development of electric power industry, and with it and the economy, can be based only on the latest scientific and technical achievements. In the electric power industry, the main problems are the inefficient use of energy resources, wear and tear and the inefficiency of most of the generating assets and energy supply networks. Most of the facilities in the industry are obsolete, have a high degree of wear, use of resource and energy intensive technologies of yesterday. Significant existing energy saving potential in the industry is not enough.

Today the urgent problem is the reconstruction, modernization and updating of obsolete and physically worked out equipment. Ukraine's industrial sector still lags behind in using modern industrial technologies. This leads to an overestimation of fuel consumption per unit of industrial production and correspondingly an increase in the unit cost of production, therefore the priority task is the modernization of production processes. The measures needed to achieve this aim include: engaging energy service companies, energy labeling, indicating standard information on energy consumption and other resources in the production of energy-intensive industries, the introduction of energy audit schemes and energy management in industry, the introduction of standards for industrial devices, implementation of specialized information campaigns to raise awareness of industrial manufacturers and realize the potential of energy efficiency in industry of Ukraine.

The introduction of European energy standards in national legislation [7] will contribute to a significant increase in energy security of the country, and uploads to the European market will reduce the opacity of domestic energy markets.

**Conclusions.** It should be noted that the energy balance of the state is the basis for assessing the efficiency of the use of energy resources, as well as an information base for analysis and forecasting of a stable functioning of the economy, further improvement of legislation, assessment of the results of execution of decisions in the field of production and use of energy resources.

One of the main reasons for the unsatisfactory energy situation is the absence of a state mechanism to control the production, supply, consumption and payment of energy resources.

The solution of this problem requires the development and implementation of the State Program on the state system of monthly monitoring of production (extraction), supply, transportation, consumption, export and import indicators. In addition, we need effective use of fuel and energy resources as the main indicators of energy balance on the basis of a modern, constantly operating information and communication system, which successfully operating in countries with developed market economies and countries in Eastern Europe and the Baltic States.

The energy balance of the state is supposed to be formed from the energy balances of the regions, balances by types of economic activity, balances by type of fuel and energy, which ultimately will characterize production. In addition, it includes the use of primary energy and the costs of its transformation, transportation and final consumption.

Implementation of modern energy-efficient technologies is one of the most important strategic tasks of the country's metallurgical complex, which will allow to increase the competitiveness of its products on the foreign market.

The development and implementation of this policy will allow Ukraine to ensure a high level of energy security and energy independence, significantly improve the competitiveness of the national economy and take a worthy place among the developed countries of the world.

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### **Н.А. Мєдвєдєва, М.А. Левицький, В.Ю. Сухенко ДОСЛІДЖЕННЯ ЕНЕРГЕТИЧНИХ РЕСУРСІВ В УКРАЇНІ**

*У статті надано характеристики електроспоживання, виробництва електричної енергії та потреб в електроенергії країн світу. Проведено аналіз ефективного використання енергетичних ресурсів у світі. Визначено проблеми щодо ефективного використання енергетичних ресурсів в Україні. Представлено прогноз виробництва електроенергії, динаміку й структуру споживання електричної енергії за видами промисловості в Україні. Надано характеристику заходів щодо стабілізації та розвитку ефективного використання паливно-енергетичних ресурсів.*

**Ключові слова:** енергоефективність, паливно-енергетичні ресурси, структура споживання, електрична енергія.

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#### **ИССЛЕДОВАНИЕ ЭНЕРГЕТИЧЕСКИХ РЕСУРСОВ В УКРАИНЕ**

*В статье охарактеризованы электропотребление, производство электроэнергии и потребности в электроэнергии стран мира. Проведен анализ эффективного использования энергетических ресурсов в мире. Определены проблемы по эффективному использованию энергетических ресурсов в Украине. Представлен прогноз производства электроэнергии, динамика и структура потребления электрической энергии по видам промышленности в Украине. Охарактеризованы меры стабилизации и развития эффективного использования топливно-энергетических ресурсов.*

**Ключевые слова:** энергоэффективность, топливно-энергетические ресурсы, структура потребления, электрическая энергия

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