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Rational resource in the context of forming a model of using fuel and energy resources expenditure

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Abstract. The article defines the general provisions of formation and substantiates the main components of the overall energy balance, presents the algorithm for its calculation according to the indicators of the current forms of state statistical reporting on energy. It is proposed to monitor the energy balance of the state to eliminate unresolved problems of the fuel and energy complex of Ukraine. The formation of provision model and use of fuel and energy resources of the economy of Ukraine is detailed. It is determined that an important direction of state development is the introduction of energy-saving technologies and increases its own production of fuel and energy resources. Therefore, the basis for building a theoretical and analytical model of supply and use of fuel and energy resources is the relationship between different components of the economy: forms of ownership, centralization and decentralization, innovation and investment, environmental orientation and economic efficiency and more. The relationship between the economic development of the state and its environmental security is proved.

1. Introduction

The problem of interaction between man and nature has always existed, but it became especially acute in the late twentieth century. The study of the relationship between economic development and environmental security has become especially relevant today, as the priorities of economic development of independent Ukraine are: high quality of life, its spiritual prosperity, meeting reasonable human needs, environmentally healthy and environmentally safe lifestyle of present and future generations.

Providing the state with fuel and energy resources, including oil and gas, is a necessary condition for the normal functioning and development of the domestic economy. Therefore, effective management of enterprises that are part of the structure of the fuel and energy sector is an important task for Ukraine.

Energy efficiency and energy saving are challenges for most countries. For Ukraine, this is not only a task, but also a priority of the state's energy policy. This is due to the depletion of non-renewable fuel and energy resources, the lack of real alternatives to their replacement, the presence of risks in their production and transportation. Recently, these factors are becoming increasingly important due to the general instability in the regions of production of fuel and energy resources (FER), tensions in the



fuel and resource markets and unfavorable forecasts for further deterioration of the environmental situation. Therefore, our state, as well developed countries of the world, continues to search for new and alternative sources of energy supply and develop measures for their implementation.

2. Critical literature review

Rational use of energy resources, their impact on the environmental security of the country necessitates more detailed study among scientists. This question is relatively new, so it is interesting, in particular: US scientists [1] in their work studied the impact of natural resources, energy consumption and population growth on environmental quality and concluded that the consumption of natural resources and renewable energy improves environmental quality in the long run. They also suggested establishing a policy that controls the overuse of natural resources, promotes a sustainable lifestyle and sets an environmental budget to ensure the country's sustainable development.

Burlov V at. al. [2] substantiated the mathematical model of energy sector management in the region, which was based on three main system-forming indicators of social, economic and ecological systems. Chinese scientists [3] proposed a model model CN-EES, which is able to predict energy needs by different scenarios of economic development, reflecting the uncertainties generated by the long-term (2021-2050) planning period. It is argued that this model will allow China to deal effectively with energy supply, environmental protection and climate change. According to the Paris Agreement, scientists [4] in their study tried to assess the environmental impact and prove that energy resources should be used very efficiently by combining two models - the integrated GCAM model with the air quality model (TM5-FASST). Cosmi C. at. al. [5] proposed the use of the R-MARKAL model to study the possibility of using renewable sources for production of electricity and heat. Incekara C & Ogulata S. prove that energy resources and energy policy are the main factors determining the country's position in a globalized world [6].

The main goal of optimal energy distribution is to reduce energy production costs, create minimal impact on the ecosystem and use uninterrupted, environmentally friendly energy sources under the light of the UN FCCC and the Kyoto Protocol. Ukrainian scientists [7] proposed models for providing the Ukrainian economy with energy resources, in particular for electricity and natural gas. It was also established that Ukraine's economy is characterized by a shortage of energy resources, which is covered by imports, obsolete and physically worn-out means of production, imperfection of economic and financial mechanisms, which determines the low level of use of fuel and energy resources. In recent years, the security of energy supply has become one of the most pressing policy issues for Central and Eastern Europe [8]. At the same time, many scientists [9, 10] pay attention to the relationship between security of energy policy and environmental security and sustainable development [11, 12]. In the article have built predictive trend models of energy security of the enterprise according to selected scenarios [13].

The optimal distribution of the state's fuel and energy resources has a positive effect on the state's security factors. The formation of the pricing policy of the fuel and energy sector depends on the number of consumers of this type of energy. The model for obtaining the maximum profit of an enterprise depending on the price and the number of consumers is presented in [14]. A balanced state policy in the field of the fuel and energy sector leads to the growth of the state's economy. This growth can be estimated by the change in the GDP indicator. Forecasting this indicator based on the current economic indicators of the state's activity is considered by the authors in the article [15].

However, further research is needed on the issue of rational resource use in the context of forming a model for the use of fuel and Ukraine's energy resources.

3. Methodology and results

The difficult environmental situation in the regions of Ukraine, largely due to harmful emissions from traditional energy companies, requires the widespread implementation of energy saving measures. There is a certain relationship between the consistent implementation of energy efficiency policies (implementation of energy saving measures) in all areas of the national economy and environmental

protection (positive impact on the environment). Efficient energy consumption in both the economy and the population will reduce the overall use of energy resources, which, in turn, will reduce environmental pollution, in particular, to reduce emissions of anthropogenic gases from industrial energy production processes.

The introduction of energy efficient technologies, equipment, appliances and household energy devices will also contribute to the improvement of the ecological state of the environment; the use of non-traditional renewable energy sources, alternative fuels that will save or replace energy resources, technologies of production, production and use of which are environmentally unacceptable. Therefore, when planning and implementing energy saving policy and improving the energy efficiency of production in Ukraine, it is necessary to combine these issues with environmental issues into a single state policy of economic development.

Energy saving measures should have a positive impact on the environment and, conversely, when estimating the cost of reducing harmful emissions it is necessary to take into account the economic benefits of the enterprise from energy saving, ie the payback of these costs. Today, the issues of forming a model for providing and using energy resources of the national economy of Ukraine remain without due attention. Currently, they are at the initial stage of developing conceptual frameworks, which requires the settlement of practical and theoretical provisions in the existing regulatory environment. Special attention should be paid to the development of dialectical unity of the models system, forms, methods, levers, incentives, tools that allow to coordinate the formation of goals, objectives, principles, functions and interaction of institutions in the process of ensuring the necessary energy security of the national economy.

The need to develop theoretical and methodological foundations for the formation of a model for the provision and use of fuel and energy resources in the context of a safe environment of the national economy based on market incentives and finding means to manage market relations in the fuel and energy sector.

In the context of the world economy globalization, physically and morally outdated technologies, broken inter-economic ties did not allow domestic enterprises to enter the world market with competitive products. Lack of external and domestic markets and lack of financial resources for restructuring led to their bankruptcy. Under such circumstances, domestic enterprises have not been able to use effectively the significant resource potential for economic development. Instead, Ukrainian enterprises for the production of primary material and energy resources began to increase exports of their products. The lack of significant incentives for the development of integrated production of consumer goods has led to the construction of a commodity-oriented economic system, which is clearly traced in the structure of extractive sales and processing industries (Fig. 1).

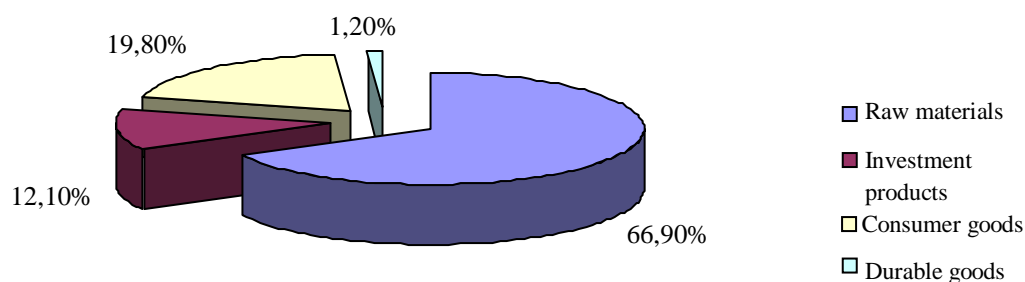


Figure 1. The structure of the of the mining and processing industry sold products volume in the selling prices of enterprises in 2019

Source: built by the authors based on [16]

According to the above structure of production, raw materials predominate - 66.9%. In fact, Ukraine is becoming a raw material appendage of developing countries, because the domestic commodity market is dominated by imported products.

Given the significant increase in the purchase price of imported natural gas and the unstable political situation, rising world oil prices, there is a need to reduce energy imports from the Russian Federation.

Influenced by the reduction of foreign exchange earnings from exports of agro-industrial complex and metallurgy, the projected negative balance of payments due to WTO accession, reducing energy dependence on oil and gas imports is a major strategic factor in Ukraine's economic development in the near future.

Despite this trend, the use of energy resources, along with other natural resources, has not been the subject of due attention by the government and businesses in a deteriorating environmental situation. This situation is due to the lack of economic incentives on the part of the state for the rational use of resources for deeper processing of resources by economic entities. Given the excess demand for raw materials in the foreign market at low cost due to the gap between domestic and world prices and, relatively, higher fuel and energy costs relative to the world level in the processing industry in-depth processing of raw materials is economically unprofitable.

Under modern conditions, excessive anthropogenic pressure on the environment, its pollution due to technological progress and irrational depleting use of nature become significant factors that cause deterioration of the environment, hinder the sustainable development of the country [17, 18]. Factors that determine the complex environmental situation include: violation of the nature laws in the substantiation of consumption patterns and production and development of territories; sectoral approach to nature management planning, lack of a systematic approach and integrated management of natural resources, insufficient environmental justification of resource use; destruction in the process of territory development and economic activity of biogeocenotic cover and functional integrity of natural ecosystems; ecologically unreasonable (deformed) structure of the industrial sector of the economy, insufficient capacity and efficiency of dust and gas treatment plants and facilities for the treatment of industrial and municipal return water; non-compliance with environmental requirements and basic principles of sustainable nature management in all spheres of production activity [19, 20].

During the pre-crisis period, economic growth in Ukraine took place through an accelerated increase in physical consumption and production of material and energy resources. The stimulus factor in this process was the high profitability of export operations due to the devaluation of the national currency and the gap in prices in domestic and foreign markets, foreign market conditions and the difference in labor costs inside and outside the country. Reducing the physical use of fuel and energy resources has a significant impact on the resource security of the national economy, but to a lesser extent stimulates the stability of its operation, as it does not provide for in-depth processing and reduction of imports of consumer products. The decrease in the cost of energy does not create an economic basis for the restructuring of the economy, and the increase - to reduce exports of raw materials and semi-finished products, ie to change the cost nature of the resource use model [21]. To restore the economic development of our country will be crucial to form an effective model of natural resources. in particular, fuel and energy resources with the implementation of innovative technologies.

Large-scale conflict over the formation of a reasonable market price of imported natural gas and changing oil prices on the international market under the influence of military coups in the countries of North Africa, increasing technological dangers of nuclear power in terms of seismic activity and unstable rocks actualize the optimization model using an existing resource potential of Ukraine in particular fuel -energy resources by saving them and increasing their own production and the depth of their processing.

As it turned out, in the pre-crisis period, high growth rates were achieved only by some countries (USA, Japan, Korea, etc.) in the process of the information economic system functioning, focusing on the principles of sustainable development and innovation. There was no development of industrial production of the 4th and 5th modes in Ukraine either. A significant reserve for increasing the share of

own resources in consumption is the introduction of technologies for the use of brown coal in industry and heat. These types of primary fuel and energy resources are partially consumed by the population, used as raw materials and for conversion into other types of energy and fuel (Table 1 - 2).

Table 1. The structure of primary demand for energy resources in 2018

Types of fuel and energy resources	Structure of primary demand for energy resources, %					
	Total		Own resources		Import resources	
	plan.	fact.	plan.	Fact.	plan.	fact.
Coal	29.6	28.2	92.1	90.8	7.9	9.2
Oil	13	10.0	15.9	25.7	84.1	74.3
Natural gas	38.5	42.0	30.8	35.6	69.2	64.4
Nuclear energy	16.4		100	100	x	x
Renewable energy	2.4	19.8	100	100	x	x
Total	100	100	66.1	x	40.2	33.9

Source: built by the author based on [16]

Table 2. The structure of primary demand for energy resources in 2018

Types of fuel and energy resources	The structure of primary demand for energy resources in 2018, %					
	Total		Own resources		Import resources	
	2019 (plan.)	2018 (fact.)	2019 (plan.)	2018 (fact.)	2019(plan.)	2018 (fact.)
Coal	27.1	38.2	89.0	85.3	11.0	14.7
Oil	10.2	5.7	36.8	38.3	63.2	61.7
Natural gas	31.5	28.8	38.2	41.8	61.8	58.2
Nuclear energy and others	17.8	27.3	100.0	100.0	0.0	0.0
Renewable energy	13.4				0.0	0.0
Total	100	100	100.0	100.0	100.0	100.0

Source: built by the author based on [16]

During 2018-2019, there is an overfulfillment of the own resources consumption share of energy resources, which indicates an increase in energy independence of the economy from imports of energy resources. At the same time, during 2016 - 2019 there is a transformation of the fuel usage model and energy resources by increasing the share of own resources in the structure of consumption and reducing the demand for traditional types of energy resources, except coal. This situation is due to the reduction of coking coal production and growing demand for it (Table 3). Among other reasons, the reduction in oil and natural gas consumption in recent years is also due to the reorientation of the population and enterprises to the consumption of alternative energy sources: wind, electricity, secondary fuels, etc.

Table 3. Volumes of own coal production in Ukraine in 2016 - 2019 (thousand tons)

Years	Energy coal	Coking coal	Total
2016	51048.9	24182.1	75231.0
2017	56969.3	25022.1	81991.4
2018	61122.5	24823.5	85946.0
2019	59973.0	23724.5	83697.5

Source: built by the author based on [16]

The only way to improve the efficiency of the fuel and energy resources *внвуд* at this stage of economic development is to increase own production, which requires significant investment in exploration and development of new mineral deposits and technological re-equipment of exploited to ensure full use of their resource potential.

Stimulating investment in the development of oil and gas fields is possible by creating institutional preconditions for increasing the entrepreneurial remuneration of oil and gas industry enterprises from the production and supply of fuel and energy resources. This trend is typical for subsidiaries of Naftogaz, which supply gas: a slight increase in tariffs for all types of consumers allowed to partially provide the investment component in financing the implementation of the investment plan. Own funds predominate among the sources of financing the fixed capital of the oil and gas industry enterprises, so it is necessary to stimulate their growth.

The effectiveness of the fuel and energy resources domestic model is to restore its impact on economic growth in Ukraine, which is undoubtedly an internal source of economic stabilization. Achieving this goal is associated with saving fuel and energy resources and stimulating, on the part of the state, increasing the development of capital investment in the introduction of energy-saving technologies [22]. However, the implementation of such a policy in previous years has not ensured the restructuring of the economy, although it has reduced natural gas consumption by utilities, the public sector and industry.

According to the analysis of literature sources, none of the models of energy systems of developed countries can be implemented in Ukraine, as well as a mosaic of their individual elements. The model of formation and use of fuel and energy resources should be built for each country taking into account the structural features of the economic system, development trends, the available natural potential, taking into account world experience. To analyze economic relations, regarding the provision and use of fuel and energy resources in Ukraine, it is necessary to use the model presented in Fig. 2, built on the basis of fuel and energy balances [23]. This model is a set of theoretical and applied provisions, patterns, dependencies, principles and directions of development, which will justify the optimal combination of different elements of the energy system. Today, the model of formation and use of fuel and energy resources is mixed in terms of the ownership forms ratio and interaction of market mechanisms and state regulation. State regulation differs significantly from the private and public sectors. Regarding the first - market mechanisms of regulation are used: taxation, licensing, state supervision and control over compliance with current legislation in the process of economic activity, etc. The activities of state-owned companies are determined by the socio-economic policy of the state through the regulation of pricing, profit distribution, subsidies and financing of individual enterprises, the provision of state guarantees for obligations, soft loans, etc. For objective reasons, the operating conditions for business entities differ significantly. Ownership of infrastructure facilities leads to the monopolization of certain services and activities in the fuel and energy sector, which creates the dictation of technical, technological and economic conditions of operation of other entities in the industry. This situation is observed in the relationship between private gas companies and gas transmission companies, which can raise the pressure in the pipeline, which does not meet the technological parameters of the gas pumping unit of another production company and will require significant costs for the purchase and installation of a new unit. The activities of licensees for the development of oil or gas fields become more complicated if, for example, the collection, treatment and transportation pipelines are owned or used by other entities, and so on. Issues of safe environment and nature management are being leveled.

Given the high energy dependence of the domestic economy, the main directions of the national model development of fuel and energy resources should be the introduction of measures to save traditional and secondary energy resources and increase the share of consumption of own production. The implementation of energy efficiency projects is initiated by businesses or NGOs with the assistance of local authorities to legalize innovative products. Support and information and consulting support allow to simplify and develop the use of energy-saving technologies for the processing of secondary energy resources. A positive aspect of stimulating the implementation of these measures

was the possibility of involving international organizations in the financing of projects within the projects of sustainable development of local communities. All this will not only lead to the economical use of the state's own energy resources, but also improve the environmental situation in the regions.

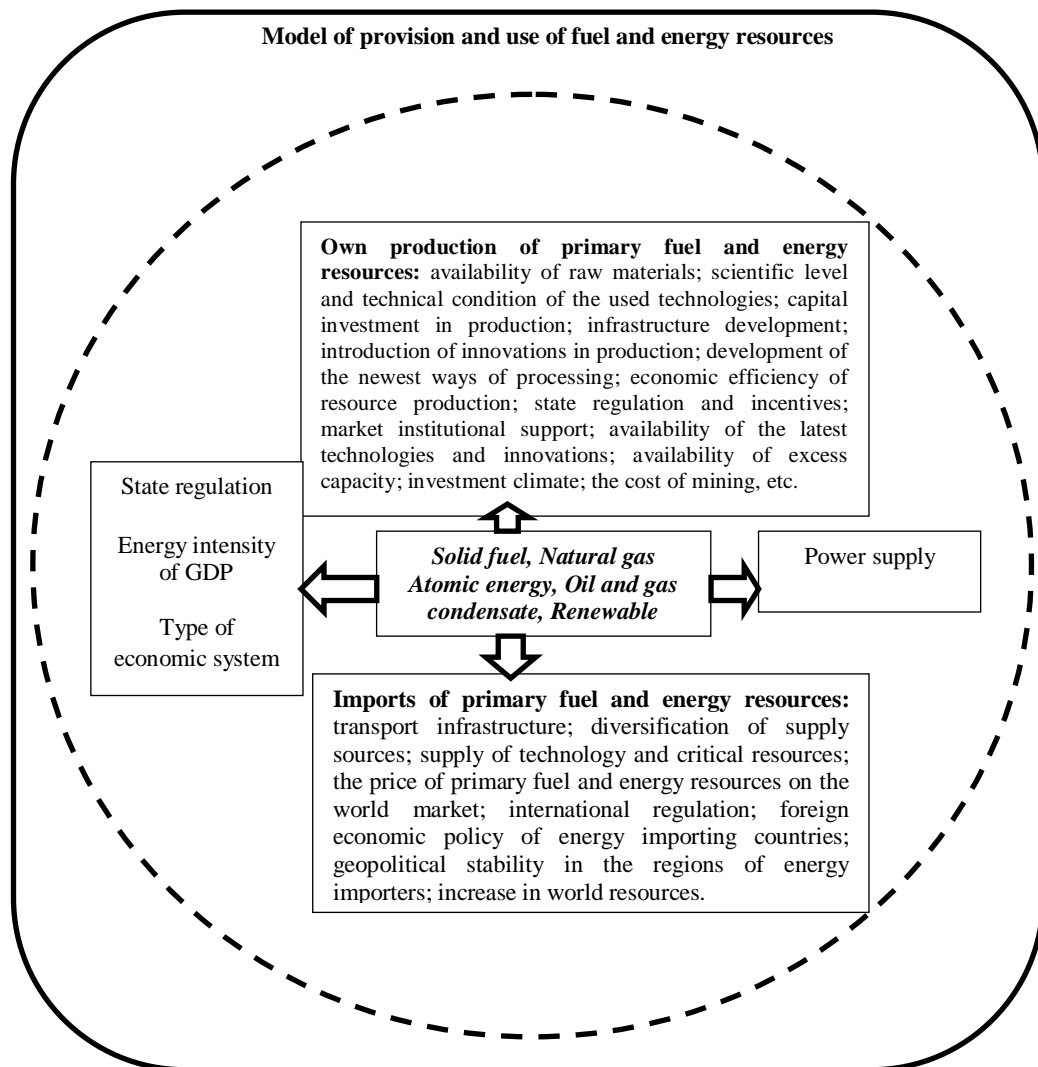


Figure 2. Model of provision and use of fuel and energy resources

Source: authors' own development

The most important tools for the formation and implementation of Ukraine's energy policy in the context of energy efficiency include the General Energy Balance (GEB), which is a system of quantitative indicators of production, supply (production), conversion and final consumption in its territory over time. The formed general energy balance serves as an information base of initial data for calculations of various derivative indicators of estimation of efficiency of use of fuel and energy resources and the tool of their streams movement control at all stages, from extraction (production), delivery to processes of conversion and final consumption. The methodology of forming the general energy balance as a whole, or individual balances by types of energy resources, territorial affiliation, or by types of economic activity, should be consistent with the recommendations of international news agencies and organizations on energy statistics, take into account the state system of statistical accounting their subordination. The issue of developing scientific bases for the formation and

optimization of the balance of fuel and energy resources is relatively new and relevant in the period of transformational changes in the state.

The formation of the energy balance of the state requires the coordination of actions of central and local executive bodies related to energy security and the creation of an information base for the analysis and forecasting of stable functioning of the economy. That is why the energy balance should be built on the basis of existing sectoral balances with its further optimization and transition to the regional principle of formation, taking into account sectoral characteristics. This will allow to establish the state of energy supply to the needs of the national economy in energy resources and increase the efficiency of all fuels and energy [24, 25]. According to the methodological provisions, the general energy balances include fuels and energy extracted or produced from natural sources, or in the process of transformation, as well as those received for import or withdrawn for export, and also the amount of the difference between the balances at the beginning and end of the current year (see formula 1).

In the overall energy balance, its sections are balanced as follows: the energy levels of the "Gross Consumption" section in the sum with the energy levels of the "Transformation Sector" section with their signs are equal to the algebraic sum of energy levels of the "Energy Sector" and "Final Consumption" sections and separate items: "Losses during transportation and distribution", "Consumption for non-energy purposes" and "Statistical discrepancy":

$$\sum_{j=n}^n (\sum_{i=1}^n P_{ext}^i + \sum_{i=1}^n P_{imp}^i - \sum_{i=1}^n P_{exp}^i \pm \sum_{i=1}^n P_{c.r.}^i) - \sum_{k=1}^n \sum_{i=1}^n P_{f.con.}^i + \sum_{k=1}^n \sum_{i=1}^n P_{f.aft.}^i = \sum_{k=1}^n \sum_{i=1}^n P_{e.c.s.}^i + \sum_{i=1}^n P_l^i + \sum_{i=1}^n P_{n.e.}^i + \sum_{s=1}^n \sum_{i=1}^n P_{e.c.}^i \pm \sum_{i=1}^n P_{en.l.}^i \quad (1)$$

P_{ext}^i - the level of energy resources extracted or produced by the country;

P_{imp}^i - the level of imported energy resources;

P_{exp}^i - the level of exported energy resources;

$P_{c.r.}^i$ - the level of change in energy reserves at the end of the current year;

i and j – respectively the index of energy resources types and the index of the section articles

$P_{f.con.}^i = P_{f.aft.}^i$ – respectively, the volume of fuel or energy for conversion and the volume of fuel and energy after conversion;

k – index of enterprises-sources of fuel and energy conversion into other types.

$P_{e.c.s.}^i$ – levels of energy consumption in this section.

P_l^i $P_{n.e.}^i$ - respectively, the levels of energy losses and levels of certain fuels consumption for non-energy purposes.

$P_{e.c.}^i$ - the level of energy resources for a particular type of economic activity;

s – type of economic activity index.

$P_{en.l.}^i$ - energy levels

There are no alternatives to the rational use of nature, so it is necessary to develop and implement such an economic mechanism for environmental protection, which would provide integrated management of natural resources, their inexhaustible use and protection from depletion and pollution. In our opinion, monitoring the energy balance of energy resources and building a model of their provision and use could become one of the components of the environmental and economic mechanism aimed at the vector of economic growth of the state.

4. Conclusions

Thus, this study shows that today Ukraine's energy system is two-sector. It consists of public and private sectors, which led to differences in government regulation of these structures. Ukraine is forced to restrict non-residents' access to the oil and gas transportation system in order to curb the

growth of energy costs for the population. At present, this approach has proven ineffective due to the financial inability of public sector enterprises to ensure easy reproduction and efficient use of production capacity, leading to instability in the energy system and lack of economic development. An important area of state development is the introduction of energy-saving technologies, increasing its own production of fuel and energy resources and their rational use of nature. A safe environment, efficient use of natural potential, its preservation for future generations, should be on the agenda when making informed decisions about governing the state. The first of such steps could be the construction of a theoretical and analytical model of provision and use of fuel and energy resources, which is based on the following relations: 1) forms of ownership and forms of management based on them; 2) self-regulatory market mechanisms and state regulation; 3) centralism and decentralization in governance; 4) competition and monopoly; 5) liberalization and social orientation; 6) innovation-investment, ecological orientation and economic efficiency; 7) strategic reserves, the volume of production of own energy resources and imports. These relations are characterized by close interactions and connections and are determined by the trends of transformation processes in the national economy. It can also be argued that it is advisable to monitor the energy balance of the state, which is a process of systematic long-term monitoring and aimed at solving problems to identify ways to optimize the energy balance of the state by solving the optimization problem by "Solution Search", namely: forecast energy balance and its constant updating taking into account changes and main challenges in energy and in the country as a whole; development of priority directions of energy balance optimization policy; ensuring openness and transparency of the internal energy market; realization of energy efficiency and energy saving potential; justification for the development of renewable energy sources; stimulating innovation and synergy of energy and economic development, etc.

In our opinion, solving such tasks will help strengthen the environmental security of the state, have a positive impact on the formation of macroeconomic indicators and create conditions for ensuring a decent life for its citizens.

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