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Contemporary problems of energy security of agriculture

In the article the controversial questions of the nature and significance of management system of energy security are examined. The features of energy security classification levels are considered by following levels: nano-level, micro-level, meso-level, macro-level and mega-level. The authors of the article defined the place and role of agriculture in the structure of energy security. The article notes that the energy security of agriculture is associated with ensuring the progressive development of productive forces and improving the efficiency of production in the agricultural sector of the economy, as well as the creation of the necessary housing and social conditions in rural areas. The authors identified the main consumers of electric energy in rural areas: houses of workers and employees in settlements, farms; objects of social infrastructure; industrial consumers of farms; enterprises of agro-industrial complex, grain receiving points, enterprises for processing of agricultural products; other consumers. According to the authors, the electric load of rural areas is constantly changing, following the features of the structure of agricultural production and employment of the rural population, which are not constant, associated with both seasonality and employment during the day. In the article the factors influencing the energy security of agriculture are highlighted: socio-political factors; technogenic and natural factors; management and legal factors.

Keywords: agriculture, energy, energy security, levels of energy security, rural population.

In modern conditions, the energy security of agriculture is becoming one of the conditions for the sustainability of the socio-economic system and environmental parameters which determine the quality of life of the population and are an essential indicator of the effectiveness of public administration.

Features of energy security of agricultural consumers are associated with a large length of electrical networks, with a relatively low power of electrical installations and seasonal nature of the load. Also, the short-term use of installed capacity in agriculture causes significant losses of electricity and increases the cost of its transmission. In addition, there is a problem to ensure the reliability of power supply to these consumers due to the large deterioration of electrical networks. All of this, in turn, leads to a decrease in the efficiency of agricultural production.

For a very long period in the socio-economic development of the state and society, the issues of the nature and importance of the energy security management system cannot have a proper scientific justification. Therefore, the reasons for the growing interest of the scientific community in the issue of energy security vary considerably from country to country. For some, this is determined by a deep deficit of their own energy resources [1], as a result of which the economies of these countries become significantly dependent on the energy situation. For others, with their excess fuel resources [2, 3], the economy becomes dependent on energy as an industry. This situation can determine their successes and failures due to its large share in the economy.

Energy security, colloquially, is often portrayed as reduced dependence on imported energy, most significantly oil [4] (Böhringer & Keller, 2011).

Yergin's classic definition states that the cultural and political aspects are as an asset which safeguards energy security. The objective of energy security is «[...] *to assure adequate, reliable supplies of energy at reasonable prices and in ways that do not jeopardize major national values and objectives»* [5].

Studies of energy security have been conducted only in recent years in connection with the emergence of threats to both economic and energy security of the country and its regions. Prior to this, a fairly detailed analysis of the reliability of energy systems was carried out on the basis of their consideration as purely technical systems. Accordingly, the formed methods of studying such components reliability of systems of power as stability, reliability, maintainability, survivability, etc., the theory of reliability of energy systems was developed [6].

The concept of energy security has a significant difference between modern and «classical» discourse. In the 70-80-ies of the last century, energy security meant the stability of the supply of cheap oil under the threat of embargo and price manipulation of exporters [7]. The current importance of energy security issues

has become much broader than just oil and includes a wide range of issues. Moreover, energy security is closely linked to other energy issues, such as ensuring equal access to energy, while mitigating the effects of climate change [8]. Thus, modern society faces the task of classifying energy security features.

Energy security is a state of security of the country (region), its citizens, society, the state serving their economy from the threat of shortage in providing energy needs with economically available fuel and energy resources of acceptable quality in normal conditions and under emergency circumstances, as well as from the threat of instability of fuel and energy supply [9].

According to Cherp, A., & Jewell, J. [10], energy security issues became the focus of attention in the 2000s due to the increased needs of Asian countries, disruption of gas supplies to Europe, as well as the need for countries to pursue a policy of decarbonisation of energy systems due to climate change.

The views of scientists indicate that the world community has faced fundamentally new problems that require a change of traditional approaches to the issue of economic security of the country, since the concept of «energy security» is currently interpreted by the scientific community more extensively and economists, lawyers, environmentalists, sociologists and even political scientists with state managers have joined its research, along with engineers and power engineers.

In the law on national security of the Republic of Kazakhstan [11], energy security is one of the components of economic security and is understood as «*...the state of protection of fuel and energy, oil and gas and nuclear energy complexes of the economy from real and potential threats, in which the state is able to ensure energy independence and sustainable development to meet the needs of society and the state in energy resources*».

Russian economist Maltseva P.N. [12] proposes to classify energy security by levels. Ranging from the nano-level – energy security of the individual to the micro-level – enterprise, meso-level – region or industry, macro-level – country-wide, as well as mega-level — energy security of the world as a whole.

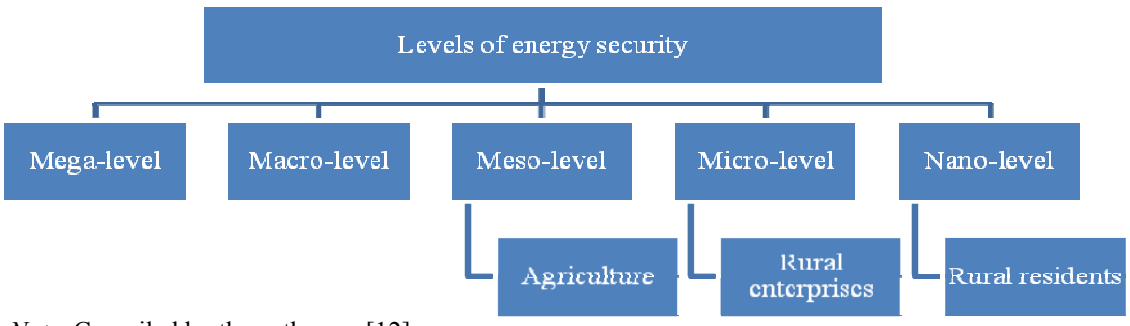
Energy security at the mega-level is a state of protection of the planet Earth from global threats of exhaustion and shortage of fuel and energy resources. In order to maintain this state, the world community pursues the main strategic goal, which is to preserve and save irreplaceable energy sources for future generations with rational current energy consumption, taking into account the interchange ability of energy resources.

International energy security can also be formed at the local (regional) international level in order to successfully address the internal problems of energy and fuel supply at the present time and taking into account the prospects for development.

At the macro-level, energy security involves ensuring the sustainable functioning of the fuel and energy complex, supplying it with the products of the national economy and achieving stability of export supplies without compromising the economy in fuel and energy resources.

The problems of energy security at the meso-level are related to the uneven geographical distribution of fuel and energy resources in conjunction with the socio-economic, geographical, natural and climatic specifics of the territorial entities, which create difficulties in the timely and full provision of the economy and population with energy resources.

Based on the proposed level of energy security, the place and role of agriculture can be determined (Fig.).



Note. Compiled by the author on [12].

Figure. Levels of energy security

As evidenced by the content of the figure, the nano-level is characterized by the need to achieve a state of full and timely provision of energy resources to rural residents. The micro-level involves the management of energy security of rural enterprises and farms in order to create a state of protection from threats to reliable fuel and energy supply, which ensures the stability of its functioning, financial and commercial success and social development. It should be noted that the achievement of full and timely provision of fuel and energy resources and regional energy security at the level of agricultural sectors (at the meso-level) is impossible without taking into account the energy needs of individual citizens living in rural areas and enterprises operating in rural areas.

It is obvious that it is a difficult task to formulate a fully universal and not too abstract definition of the energy security of agriculture, and this is explained by the fact that its main components can vary depending on the characteristics of the country and sectors of the economy. The question has a wide range depending on the purposes of further research.

Thus, the energy security of agriculture is an integral part of economic security, as well as the entire national security system of the country, ensuring the safety of fuel and energy facilities from internal and external threats. The main task of the state in ensuring the energy security of agriculture is to maintain the economy of the village at a level that would provide normal living conditions for the rural population, in particular, its employment, opportunities for further economic growth, maintenance of all fuel and energy facilities necessary for the economic development of rural areas.

Energy security of agriculture is associated with ensuring the progressive development of productive forces and increasing the efficiency of production in the agricultural sector of the economy, as well as the creation of the necessary housing and social conditions in rural areas.

Electrical networks in rural areas usually feed a large number of diverse consumers of electrical energy, which is understood as a receiver or a group of receivers of electrical energy unified by a technological process and located in a certain territory. The receiver of electric energy (electrical receiver), in turn, is a device, unit or mechanism designed to convert electrical energy into energy of another kind.

In rural areas, the following consumers of electricity are:

– houses of workers and employees in settlements, farms;

– hospitals, schools, clubs, shops, bakeries, laundries and other businesses serving the public;

– production consumers of farms (livestock farms, grain cleaning stations, greenhouses, storage of agricultural products, mills, garages, boilers, etc.);

– enterprises of the agro-industrial complex, grain receiving points, enterprises for processing of agricultural products (dairy plants, canneries, meat processing plants, etc.);

– other consumers, including industrial enterprises.

The electric load is constantly changing, following the peculiarities of the structure of agricultural production and employment of the rural population, which are not constant, associated with both seasonality and employment during the day. Some consumers turn on, others turn off. This is a characteristic feature of agriculture, which is not like the work of industrial production. These changes are usually random but they are subject to probabilistic laws, which can be established with great accuracy in the presence of a large number of experimental data used in their determination. Therefore, in order to identify trends and forecast the development of rural electricity, it is necessary to assess the threats to energy security, as their knowledge will allow to take timely measures to prevent the most real problems.

According to Voropai N.I. [13], at the national level of energy security, internal threats can also be divided into several groups: economic, socio-political, technological, natural and managerial-legal threats.

Meanwhile, Arginbaeva G.M. and Amirbekuly E. [14] as the main factors of energy security are relevant to most countries in the world, highlights the diversification of supplies, security of transit, the availability of the necessary reserves, quality and timeliness of information, security of infrastructure, stable functioning of international markets, improving energy efficiency, ensuring a steady flow of investment, scientific and technological progress, the protection of the environment.

Analysis and assessment of energy security levels can be carried out using the method of indicative analysis, which allows to solve the problems of functioning of large socio-technical and economic systems, which include the energy system. These systems are characterized by a variety of properties, parameters, complexity of internal and external relations, uncertainty of States and conditions of development [15].

As we can see, the existing discussions affect three defining aspects of energy security: as a functional property of energy systems; as a state of protection of energy interests from internal and external threats; as confidence in ensuring the protection of these interests.

In the conditions of power supply of agriculture, it is necessary to consider its features which are connected with the big dispersion of consumers of the electric power. The housing stock in rural areas is a small subsidiary farm, which is home to the rural population, occupying a large area. The electricity consumption of such households is small. However, the presence of large agricultural complexes as a whole, changes the picture of power supply, as the power of these complexes can reach hundreds or thousands of kilowatts.

The configuration of electric network schemes depends on a number of factors: the number of consumers, their location and categoricity in terms of reliability of power supply to consumers, the number and location of power system substations. The variety of these factors can lead to a large number of variants of schemes for the construction and configuration of networks with different technical and economic indicators.

The vast majority of agricultural consumers receive electricity from a centralized source – state power systems (National companies). Under these conditions, the basis of the rural power supply system — electrical networks. These include those for which more than 50 % of the design load is transferred and distributed among agricultural production consumers, as well as non-production and household consumers in rural areas.

Thus, threats to the energy security of agriculture are short-term or long-term events that can destabilize the operation of the energy complex limit or disrupt energy supply, which lead to accidents and other negative consequences. Therefore, to ensure the energy security of agriculture, the following factors should be taken into account:

– socio-political;

– man-made and natural;

– management and legal.

A group of socio-political factors, it would seem, with the relative political stability of Kazakhstan should be the least significant in this list of impacts on energy security. Meanwhile, regional and national (possibly ethnic) conflicts accompanied by force actions at the facilities of the fuel and energy complex (sabotage, terrorist acts), as well as extremist actions of social movements, expressed in the picketing or blockade of energy buildings, are now increasingly becoming a reality of our days, and therefore, are crucial for the energy security of agriculture.

In all branches of power engineering, including nuclear, coal, oil, gas industries, there is a probability of accidents, first of all for the technical reasons with the subsequent negative consequences on ecology, health of the population and process of fuel and power supply.

A special group of factors affecting the achievement of energy security is management and legal factors. Management here is understood in a broad sense – not only technological, but also economic management, as well as state and legal regulation of activities in the energy sector. What is most interesting, the imperfection of management, the inefficiency of public policy entail the implementation of the threat of economic, social and political nature.

The presented review of factors demonstrated possible events and various consequences in the event of such events, and management factors have a huge impact on all other factors of energy security. In this regard, the energy security management system of agriculture should be aimed at reducing the susceptibility of the economy or fuel and energy complex to threats, or mitigating the consequences of their implementation, contributing to the preservation or increase of energy security, reducing the risk of its weakening.

Thus, the generalization of theoretical issues of energy security of agriculture leads us to the following conclusions.

First, the energy security of agriculture is an integral part of economic security, as well as the entire system of national security. Therefore, it is associated with ensuring the progressive development of productive forces and increasing the efficiency of production in the agricultural sector of the economy, as well as the creation of the necessary housing and social conditions in rural areas.

Secondly, the electrical load of agriculture is not constant associated with both seasonality and employment of the rural population during the day. Short-term use of installed capacity in agriculture causes significant losses of electricity. This, in turn, threatens energy security, increasing the cost of its transmission.

Third, analyzing the factors of evaluation of the level of energy security highlights the different factors (socio-political, natural and technological, managerial law) by which possible risks and consequences for energy security of agriculture can be identified.

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Т.К. Болысов, Л. Тылл

Ауыл шаруашылығының энергетикалық қауіпсіздігін қамтудың қазіргі мәселелері

Мақалада энергетикалық қауіпсіздікті басқару жүйесінің мәні мен маңызының пікірталас сұрақтары зерттелген. Энергетикалық қауіпсіздіктің жіктелу белгілері қарастырылған: нанодеңгей, микродеңгей, мезодеңгей, макродеңгей, мегадеңгей. Авторлар энергетикалық қауіпсіздік құрылымындағы ауыл шаруашылығының орны мен рөлін анықтаған. Мақалада ауыл шаруашылығының энергетикалық қауіпсіздігі өндірістік күштердің үдемелі дамуын қамтамасыз етумен және экономиканың аграрлық секторындағы өндіріс тиімділігін арттырумен, сонымен қатар ауылдағы қажетті тұрғын үй-тұрмыстық және әлеуметтік өмір сүру жағдайларын жасаумен байланыстылығы көрсетілген. Ауылдық аумақтардағы электр энергиясының негізгі тұтынушылары анықталған: елді мекендердегі жұмысшылар мен қызметшілердің тұрғын үйлері, фермерлік шаруашылықтар; әлеуметтік инфрақұрылым нысандары; шаруашылықтардың өндірістік тұтынушылары; агроөнеркәсіптік кешен кәсіпорындары, астық қабылдау бөлімдері, ауыл шаруашылығы өнімдерін қайта өңдеу кәсіпорындары; өзге де тұтынушылар. Авторлардың пікірінше, ауылдық аумақтардың электр жүктемесі ауыл шаруашылығы өндірісінің өзіндік құрылымы мен ауыл халқының маусымдық және тәулік бойы жұмыспен қамтылуына байланысты тұрақты емес сипатта болатын жұмыспен қамтылу ерекшеліктеріне сәйкес үздіксіз өзгереді. Мақалада ауыл шаруашылығының энергетикалық қауіпсіздігіне әсер ететін факторлар айқындалған, яғни әлеуметтік-саяси; техногендік, табиғи, сондай-ақ басқару-құқықтық факторлар.

Кілт сөздер: ауыл шаруашылығы, энергетика, энергетикалық қауіпсіздік, энергетикалық қауіпсіздік деңгейлері, ауыл халқы.

Т.К. Болысов, Л. Тылл

Современные проблемы обеспечения энергетической безопасности сельского хозяйства

В статье исследованы дискуссионные вопросы сущности и значения системы управления энергетической безопасностью. Рассмотрены признаки классификации энергетической безопасности по уровням: наноуровень, микроуровень, мезоуровень, макроуровень, мегауровень. Авторами статьи определены место и роль сельского хозяйства в структуре энергетической безопасности. В статье отмечено, что энергетическая безопасность сельского хозяйства связана с обеспечением поступательного развития производительных сил и повышением эффективности производства в аграрном секторе экономики, а также созданием необходимых жилищно-бытовых и социальных условий жизни на селе. Кроме того, определены основные потребители электрической энергии в сельских территориях: жилые дома рабочих и служащих в населенных пунктах, фермерские хозяйства; объекты социальной инфраструктуры; производственные потребители хозяйств; предприятия агропромышленного комплекса, хлебоприемные пункты, предприятия по переработке сельскохозяйственной продукции; прочие потребители. По мнению авторов, электрическая нагрузка сельских территорий непрерывно изменяется, следуя особенностям самой структуры сельскохозяйственного производства и занятости сельского населения, носящих непостоянный характер, связанный как с сезонностью, так и с занятостью в течение суток. В статье определены факторы, влияющие на энергетическую безопасность сельского хозяйства, а именно социально-политические, техногенные и природные и управленческо-правовые факторы.

Ключевые слова: сельское хозяйство, энергетика, энергетическая безопасность, уровни энергетической безопасности, сельское население.

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