

Energy as an inseparable factor of productive forces and production

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ORIGINAL ARTICLE

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Abstract. Energy is an inseparable attribute of productive components. The article considers the need to identify energy production as a fundamental and independent factor. The law of conservation of energy formed an effective demand for the development of the process of searching and using alternative energy sources. However, there is an issue of limited resources of energy. Recent years there is an increasing interest in the study of energy as an economic category. There are many scientific problems of green energy, renewable energy resources, sources, human intellectual energy, etc. The research highlights the role and importance of energy in the industrial development of the Republic of Tajikistan, the correlative relationships between GDP production and electricity consumption per capita, the process of development and placement of productive by regions of the country. The research justifies a number of proposals on the efficient use of energy and formation of energy clusters in the country.

Keywords: factors of social production; energy as an economic category; energy carriers; energy system; industrial and technological revolution

JEL codes: Q43, Q42, O14, R11, O33

DOI: 10.52957/2782-1927-2025-7-2-4-9

For citation: Avror B. Mirsaidov (2026). Energy as an inseparable factor of productive forces and production. *Journal of regional and international competitiveness*, 7(2), 4.

Introduction

The transition of the Republic of Tajikistan to an industrial-agrarian type of economy and accelerated industrialisation of the country ensures the importance and role of energy industries. It provides the spatial development of productive forces and form industrial spaces in all regions of the country. Energy has a stimulating effect on the development of productive forces. Therefore, the development of socio-economic systems, branches and sectors of the economy, and social spheres of society, are closely related to the use of energy.

Energy is the basis of all industrial revolutions, since when describing it with characteristics of new generations of machines, information about energy sources that are crucial in a particular technological order is necessarily given. The global socio-technological revolution faces the modern problems of humanity – the search for new energy sources. Energy is a component of the productive forces. It activates and animates every instrument of labour for industrial and infrastructural purposes. However, energy as an economic category and an independent factor of social production does not have a prominent place in researches.

Energy has a fundamental position in the system of economic relations. Its role and importance in the development of social production, investments, trajectories, technological trends, solving social and environmental problems, the formation and development of international relations, state regulation of the economy, and so on is increasing. In the economic literature, there is a study of the scientific problems of energy within the framework of the theory of factors of production and industrial revolutions. For example, Klaus Schwab [15], exploring the influence of artificial intelligence, robotics, and the Internet of Things on socio-economic relations. He also notes the function of energy, its impact on society, economy, and public administration. V.F. Baynev believes that energy is a key production resource, ensuring the progress of technology and the Earth's civilization as a whole. Natural energy, attracted by the power of human intelligence into production processes, through the mediation of machines replaces complex human functions [3, p. 26]. Beschinsky A.A. and Kogan Yu.M. [5] back in the 80s of the XX century raised the economic problems of electrification, the role of energy in the system of factors of production. They justified the development of

electrification and its role in shaping the fuel, energy, and the national economic balance. Bezgodov A.V. and Smirnov V.T. consider the energy as demanded natural resource [4]. Golovanov L.A. studies the issues of energy as an independent factor of production. The author considered the relationship between labour and energy, contributing to intensive economic growth, from the perspective of energy efficiency [6, p. 151]. According to B.V. Naumenko, energy ensures the satisfaction of basic human needs and it is one of the fundamental factors of production used in almost all sectors of the economy, as well as the parallel increase in its consumption with the level of socio-economic development of the country [11]. According to Pankratieva S.G., Rezak E.V., Chervyakova M.V. [12], the one of the most promising areas of energy in the world is renewable energy as an alternative to traditional types of energy. The advantages of this type of energy are inexhaustibility of energy resources, ecological purity, and the absence of a fuel component in the cost of energy produced [12, p. 2-8]. Therefore, energy is the main factor of production and economic categories, reflecting the totality of relations related to the search and development of energy conversion tools. It is increasingly relevant problem of economic theory.

The purpose of this research is to theoretically substantiate energy as an independent factor of production and the attributive properties of the components of productive forces, generating rental income, and identify the main aspects of its role in the rational allocation and development of productive forces, specialisation of production.

Methods

Substantiation of energy as an independent factor of social production and as an economic category required the use of a number of methodological approaches. They are as follows: dialectical, considering economic phenomena and factors of production in constant motion under the influence of kinetic and potential forces, deductive-inductive, determining the logic of reasoning and the stages of accumulation of knowledge, and a systemic-structural approach, to identify the role of energy in social production, in the branches of the national economy, in the development and placement of productive forces.

Results

According to the classical economics, the following classification is known: a set of factors of production: capital, labour, land, and entrepreneurial abilities [10, p. 37]. Energy is not allocated to a separate position, category, or factor. According to philosophical literature, energy is a property of matter, which consists in the movement and interaction of its constituent parts [2]. The Law of Conservation of Energy states that energy does not disappear or reappear, it is only transferred from one energy to another through various physical and chemical processes (or otherwise various forms of energy transfer) [2]. Therefore, energy passes from one type to another, from one energy to another. The principles of this law provide the development of the process of searching and using alternative energy sources. This interpretation shows the fundamental importance of energy in all spheres of society.

The energy component and the attributive properties of matter and production resources have specific physical properties that differ from the tangible matter. Therefore, it involves into all of the above factors of production. For instance, the physical capital functions through energy and determines its usefulness and significance. The land acts as an economic category precisely in the process of using its aboveground and underground energy, minerals (coal, oil, gas, etc.). Energy is acquired by irradiating the sun (solar energy is captured or radiated). Employment and entrepreneurial activity are also associated with the expenditure of human energy (mental, intellectual, and physical one). Therefore, energy is crucial in all factors as it is integrated with production resources. However, it is understudied and an urgent issue of economic theory. There are a few researches on the issue of energy as an economic category. Nevertheless, the scientific interest to this particular issue is increasing in terms of modern conditions of 'green energy', renewable energy, human intellectual energy, etc. In connection with the fundamental or substantial positions of energy in factors of production system, it is necessary to consider it as an important independent factor of production. Indeed, it is very important in the context of the technical and technological evolution of social production and the development of the productive forces of society.

In the historical process of the development of social production, the main role was played by the evolution of machinery and production technologies. As a result, there was an easing of labour, the phenomenon of the law of economy of social labour, an increase in labour productivity, and patterns of the placement and development of productive forces. The steam engines were the reason for the first industrial revolution and the development of the technical and technological base of production. The transformed nature energy contributed to the mechanisation of production, i.e., it caused the substitution of human physical energy into the energy of steam engines. As a result, the managerial and creative functions of man, the functions of controlling machines, have become more active. Energy electricity, or industrial electricity, became the cause or basis of the second industrial revolution. The computing processor and electronic computing machines became the basis of the third industrial revolution. Due to the use of electric drives, it is possible to automate production.

Industry 4.0 determines the profound changes in the industry associated with the introduction of digital and information technologies. It determines the transition from traditional production methods to information and innovative production methods. Moreover, the fourth industrial revolution implements digital technologies, automation, and the transition to more sustainable energy sources and provides energy conservation and the search for alternative energy sources. Nowadays, information technologies with electrical devices are being massively applied. Indeed, electricity is used as power base and also as an information carrier. Therefore, the development of information electricity is intensified. The fourth industrial revolution and the intellectual economy form an intelligent electricity circulating inside microprocessors to intellectualise the technosphere, production activities, and artificial intelligence systems. The fourth Industrial Revolution defines the trajectory of modern industrial and innovative development of economic sectors. The modern stage of development of social production is determined by the emergence and use of a new generation of machines to perform intellectual and creative human functions. These means of labour are machines aimed at converting specific types of natural energy. They replace the muscular and intellectual abilities of humans in the social production process.

Therefore, the energy drives the system of factors of production and the machines, increases the labour productivity, etc. According to an ontological or substantive approach, in the process of social production, machines transform specific type of natural energy. Energy in the factor system is the leading factor of production. On the one hand, energy combined with a variety of natural resources and ways to use them generates one type of natural rent – energy rent. An increase in the volume of demand for energy resources generates energy rent flows. For instance, Tajikistan's huge hydropower resources (about 527 bn kW per year) is three times higher in the CIS countries. It provides opportunities to assess rents from energy production, the use of advantageous mountain river locations, and the supply of clean drinking water on the global market. In addition, the flows of solar energy and light, the power of the water, the magnetic field of the mountainous territories (93%) of the republic are sources of energy rent. Energy and hydropower resources in Tajikistan are the exclusive state monopoly property. Therefore, energy rent is an economic form of energy resources ownership. In these conditions, the monopoly rents are occurred. They are a source of replenishment of the country's budget and, accordingly, resources for the protection of nature and energy resources, the maintenance of ecosystems, and ecological balances. The source of income from energy is different. It depends on the type of extracted energy or the method of its production and marketing. Indeed, it is possible to allocate the following types of income: from the production and supply of electricity, from thermal energy, from the processing of waste into energy, and income from solar and wind energy use. As a result, energy owner acquires a profit as a factor income.

Therefore, energy as a factor of production for the separation of energy as an independent sector of the economy. The energy system was formed as a result of historical development, technological breakthroughs, and the need for centralising management of energy production, transmission, and distribution. This process is determined by the demand for energy in the economy. An energy system is a set of integrated facilities and elements that promotes a continuous mode of operation regarding the production, conversion, transmission, distribution, and consumption of electrical and thermal energy within a specific integrated management

system. The energy system is a key element of the productive forces. It ensures the production, transmission, and distribution of energy, necessary conditions for the development of productive forces through the effective functioning and development of production processes.

Moreover, the energy system is a catalyst for technological change. It is a result of electrification, technological processes, automation, and development of production through the implementation of the information function of energy. It increases the level of social labour productivity and reduces the cost of material resources. Therefore, in the National Development Strategy of the Republic of Tajikistan for the period up to 2030, the one of the fundamental priorities for development in the real sector of the economy is ensuring the transition of the country's hydropower industry to the budget-forming industry of the country. Its decisive role is in reducing poverty, contributing into development, ensuring Tajikistan's transition from regional and global the leader in potential reserves of hydropower, effective developing and using the country's energy potential, and promoting the interests of national energy in foreign markets both through appropriate energy diplomacy and through the use of market mechanisms¹.

The country's energy system has a fundamental impact on the formation of regional specialisation. It is a form of manifestation of the regularity of the location and development of productive forces. The concentration of production is in the regions of the country. It depends on their natural, socio-economic, and institutional conditions and potentials, demographic and other characteristics. In this aspect, the energy sector determines the trajectories of structural shifts in the economy of territories, the location of economic enterprises and the technological capabilities of the region's economy. The main mechanisms that influence the allocation of productive forces and the regional specialization of production are shown in Figure 1.

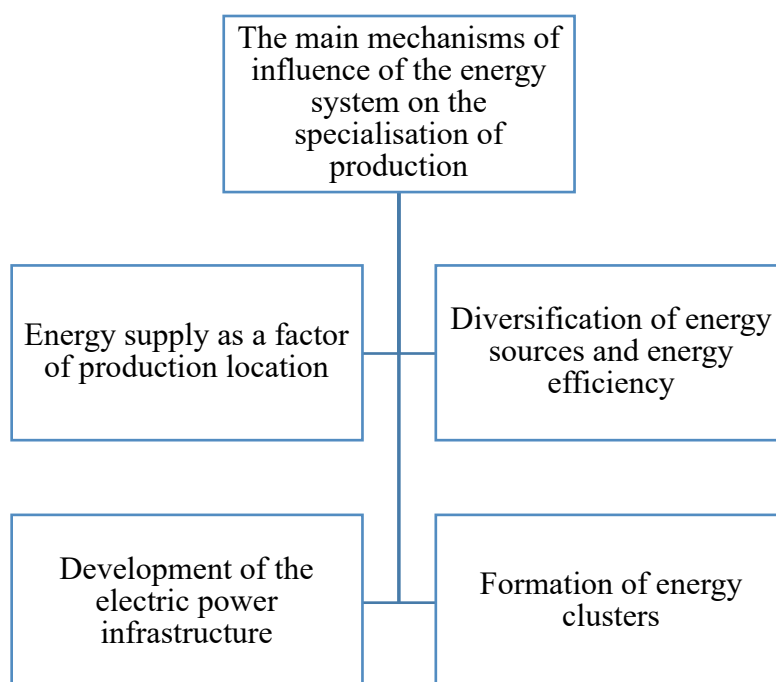


Figure 1. The main mechanisms of the energy system's influence on the allocation of productive forces and regional specialisation [8; 9]

The energy system influences the formation of structural proportions of social reproduction, the participation of economic sectors in the formation of gross domestic product, etc. As the level of energy supply increases, the participation of individual sectors of the economy, especially sectors of the real economy, in the production of gross domestic and regional product is changing. In 2018-2024, the share of mining enterprises related to electricity consumption in the formation of GDP increased from 3.5% to 4.6%. During the period under study, it increased by 1.2 percentage points.

¹ Republic of Tajikistan. (2016). *National Development Strategy of the Republic of Tajikistan for the period up to 2030*. Source: <https://egov.tj/site/farhang-tjk/documents/details/1008?lang=en&ysclid=mrdkjues11587214634> (accessed on 04.03.2026)

Conclusion

Therefore, energy as a factor of production has a significant impact on the pace of social reproduction and is a source of rent. However, it depends on the conditions of its use, production technologies, and energy market conditions. Currently, the many theories of economic growth, with the exception of certain models of supply-side economics and resource economics exist. In the context of the growing global energy crisis, the importance of renewable energy resources is increasing. In Tajikistan, hydroelectric power is the largest source of renewable energy. The hydroelectric power plants produce more than 96% of the country's electricity. They almost have no greenhouse gas emissions, have flexibility in management, etc. It allows the energy system to quickly respond to changes in electricity consumption to ensure stability in the network and correspond stability in production processes.

In terms of the development of innovative and digital economy parameters in the economy of the republic and its regions, the electric power industry is a strategic resource and a determining factor. The process of rational allocation and development of productive forces depends on the nature of the placement of electric power sets. In the republic, special attention is paid to ensuring energy efficiency and energy sustainability. The energy sustainability of the country and its regions involves the diversification of energy sources, increases energy efficiency and the use of renewable technologies, contributes to the efficient placement and development of productive forces, guarantees the long-term competitiveness of the country's economy, regions, and economic sectors. Ensuring energy efficiency and energy savings is a major factor in reducing transformation and transaction costs to increasing product competitiveness. Moreover, it is necessary to form energy clusters as a stimulating factor for the efficient placement of production, and energy sustainability of the country's regions. This institution or mechanism for the development of productive forces and the effective placement of production across the country's territories contributes to the integrated development of the country's regions, accelerates the transition from the sectoral principle to the program-target principle, ensuring integrated development, etc. In this aspect, the development of energy-saving technologies as an element of energy sustainability forms the incentive systems for the emergence of new growth points based on the innovative clusters, digitalisation of energy infrastructure. As a result of technological modernisation of industries and sectors of the economy, it causes a qualitative structural shift in the economy of the regions. The development of the electric power system and the parameters of energy sustainability ensures spatial development of the industrial space of the country's regions.

FUNDING

The work was done on a personal initiative.

CONFLICT OF INTEREST

The author declares no conflict of interest.

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Received 09.04.2026

Revised 01.05.2026

Accepted 11.06.2026