

UTDC: 658:338.45:620.0

Jumakhanov Sh.Z.
Associate professor of the Department of Geography and
Environmental Protection, Doctor of Geography (DSc)
Abdullayev A.A.
Gifted 3rd student in the direction of geography
Namangan State University
Namangan. Uzbekistan

THE SECTORAL AND REGIONAL COMPOSITION OF UZBEKISTAN'S FUEL AND ENERGY COMPLEX

Abstract: This article provides a scientific analysis of the unique characteristics of Uzbekistan's fuel and energy complex. It highlights the strategic importance of the fuel and energy complex in the national economy, detailing the development status of its key sectors, including oil, gas, coal extraction, and electricity production. Additionally, modern measures aimed at enhancing energy efficiency and utilizing renewable energy sources are proposed.

Keywords: sectoral composition, fuel, electric power, oil, gas, coal, consumption, lignite, coke, forecast.

Жумаханов Ш.З.
Доцент кафедры географии и охраны окружающей среды, доктор
географических наук (DSc)
Абдуллаев А.А.
Одаренный студент второго курса в направлении географии
Наманганский государственный университет
Наманган. Узбекистан

ОТРАСЛЕВАЯ И ТЕРРИТОРИАЛЬНАЯ СТРУКТУРА ТОПЛИВНО- ЭНЕРГЕТИЧЕСКОГО КОМПЛЕКСА УЗБЕКИСТАНА

Аннотация: В данной статье проведен научный анализ особенностей топливно-энергетического комплекса Узбекистана. Рассмотрена стратегическая значимость ТЭК в экономике страны, состояние развития его основных отраслей – добычи нефти, газа, угля и производства электроэнергии. Кроме того, предложены современные меры по использованию возобновляемых источников энергии и повышению энергоэффективности.

Ключевые слова: Отраслевая структура, топливо, электроэнергетика, нефть, газ, уголь, потребление, лигнит, кокс, прогноз.

Introduction: The fuel and energy complex (FEM) is one of the sectors of strategic importance in the economic development and industrial potential of the Republic of Uzbekistan. FEM plays an important role not only in meeting the domestic needs of the country, but also in strengthening foreign trade and international economic relations. The rich reserves of natural resources in the republic, including fuel sources such as oil, gas and coal, create favorable conditions for the sustainable development of this complex.

The network and territorial structure of the fuel and energy complex is a decisive factor in ensuring the stability of the national economy. The territorial location of industrial sectors within the complex and their economic indicators directly affect the economic potential of the country's regions. The regions of Uzbekistan have various reserves of natural resources, and their effective use is important for the development of the local economy.

In particular, the consumption of energy (electricity, gas, coal and oil products) in the territory of the country has been increasing in recent years, as a result, the demand for energy resources has increased. In particular, special attention is being paid to ensuring the sustainable development of the fuel and energy complex in Uzbekistan, using renewable energy sources on a large scale, reducing energy consumption in industrial sectors, and increasing technologies based on alternative energy. A number of decrees and decisions have been adopted by the President of the Republic of Uzbekistan regarding the development of the network. In particular, the Resolution of August 23, 2024 "On measures to improve the state control system in the fuel and energy sector" to prevent conflicts of interest, save energy, use it rationally, and increase energy efficiency in the process of implementing state control in the energy sector, also serves to ensure effective state control in this area [9].

Methods: The purpose of this article is to clarify the network structure of the fuel and energy complex and analyze its current state. To achieve this goal, the following tasks have been defined:

- research of the current state of the main sectors within the fuel and energy complex - oil, gas, coal production and electricity production sectors.

- analysis of geographical factors of development of fuel and energy complex.

- development of scientifically based proposals for measures and strategic plans aimed at developing the network and territorial structure of the complex.

Results: The fuel - energy complex is considered an interbranch industrial complex, in which the fuel and electric power industries are closely connected. This complex is of great importance in the economy of any country or region [7; p. 41]. This network has an impact on the development of the country's or region's economy, its potential, the location of industries and the creation of a region. In addition, the processes from the needs of the population to the production sectors are directly and indirectly based on the fuel and electricity industry. Also, the fuel and energy complex includes the fuel industry, which is engaged in the extraction, processing and transformation of primary fuel and energy resources, as well as the production, distribution, transformation of electricity (decrease or increase of alternating current) and its delivery to consumers (transmission over a certain distance). includes the electric power industry, which provides and forms the fuel-energy balance (Table 1).

Table 1

Network composition of the fuel and energy complex

Complex type	types of cross-sectoral industries	Industry type sectors	Sections of networks
Fuel - energy	Fuel industry	Extraction	Coal, gas, oil, oil shale, peat, uranium
		Transportation	Pipeline, road, rail and water transport
		Recycling and modification	Oil and gas processing and underground gas generators
	Electric power industry	Electricity generation	TPP, TPC, HPP, NPP and alternative energy sources (QES, SHES, QES, GeoTES and others)

		Delivery to consumers	Main lines, power grids and electrical cables
		Distribution and transformation	Electrical substations, electrical equipment and devices

Comment: This table was revised by the authors based on information from [3; p. 39].

Today, Uzbekistan widely uses fuel and energy resources. In particular, 3 branches of the fuel industry (coal industry, oil and oil refining industry and gas and gas processing industry) and electric power industry have been formed in the country. These industries are classified according to the type of specialization as follows [5; 47- b]:

- electric power industry - electric power generation, transmission, distribution, steam transfer and air conditioning;
- coal industry - coal and lignite¹ mining;
- oil and oil refining industry - extraction of raw oil and natural gas, production of coke² and oil refining products;
- gas and gas processing industry - production³ and distribution of gaseous fuel.

Taking into account the mutual compatibility of the types of specialization of the above industrial sectors, in 2000, the fuel industry made up 15.3% of the republic's industrial sectors, and the electric power industry made up 8.5%. Industry shows that it decreased by 1.7% [5; p. 49]. In 2000, the role of the fuel and energy complex in the production of the republic's industrial sectors was much higher, its share was 23.8%. After two years, this figure was 15.9%. It can be seen that the share of the fuel industry and the electric power industry in the weight of industrial sectors has decreased. The main reason for the decrease of these indicators from year to year is the stable development of other industries.

¹ **Lignite** (Latin 'lignum' wood – tree) is a combustible mineral. It is a poorly coalified wood (mainly coniferous trees) that has preserved the structure of tree tissue within brown coal layers.

² **Coke** (German 'Koks', English 'coke') is a carbon-rich solid residue produced during the process of heating natural fuels (such as coal, oil, peat, etc.) or their processed products to 950–1050°C without the presence of air (carbonization).

³ **Gaseous fuel** is natural gas in its natural form, and generator gas and blast furnace gas in its artificial form.

In particular, the increase in the share of ferrous and non-ferrous metallurgy, machine building and metal processing, chemistry and petrochemical, and light industry (development of textile products) in the structure of the gross industrial production of the republic has its influence. However, Uzbekistan can rightfully be called a self-sufficient country based on the extraction of fuel and energy resources, their reserves and the electricity produced. Because the longer the resource reaches, the higher the supply. In particular, in 2022, natural gas reserves will be 1552 billion m³, and extraction will be 44.5 billion m³. The oil reserve found in the country is 100 million tons, and the production is 0.55 million tons. Coal with a reserve of 1.375 million tons will be mined in 2023 at 6.5 million tons, uranium, which is a radioactive metal, used in the creation of nuclear fuel and is expensive, is 111 thousand tons, and the annual production volume is 2.6 thousand tons. In addition, the amount of electricity produced in the country in 2023 will be 78.005 billion kWh, and the total installed capacity of power plants will be 18472.1 MW (Table 2).

Table 2

The current state of Uzbekistan's fuel and energy resources

Total installed capacity at electric power stations (MW)	Electric energy production volume (million kWh)	Type of station	Electric power industry	Fuel – energy complex	Fuel industry	Fuel type	Unit of measurement	Extraction	Reserve volume				
18 472,1	78 005,4	TPP, TPC				Gas	billion m ³	44,5	1 522				
		HPP								Oil	million t	0,55	100
		SPP								Coal	million t	6,5	1 375
		WPP								Uranium	thousand t	2,6	111

Comment: The table was compiled by the authors based on information from the Statistics Agency under the President of the Republic of Uzbekistan [10] and [4; p. 16].

The reserve of Uzbekistan's fuel and energy resources and the forecast⁴ of their extraction, use and how long they will last show that gas can last for 34 years, oil for 181 years, coal for 416 years, and uranium for 42 years. Also,

⁴ This **forecast** was developed by the authors using formulas to determine how long the resource will last and to calculate the amount of natural resources per capita.

according to the amount of natural resources per capita of the total population (36,024,900 people) in 2023, gas is 43.08 m³/capita, oil 2.77 t/capita, coal 38.16 t/capita, and uranium 3.08 t/capita corresponds to the person.

Fuel industry. This industry is related to the production of various fuel products based on the extraction and processing (transformation) of resources such as coal, oil, gas, oil shale, uranium ore and firewood (saksavull in the Kizilkum deserts) (Table 1). In addition, the locomotive branch of the economy is one of the main branches of the striking "three".

Gas and gas processing: natural gas is one of the cheapest sources of fuel energy, it is widely used in the process of industrial production and to meet the needs of the population, and it is also an important raw material for the chemical industry. Natural gas is delivered to consumers through pipelines or in liquefied form. Natural gas production in our republic was launched in the second half of the 1950s in the Bukhara region (Uchqir, Gazli gas fields) and in the early 1980s in the Kashkadarya region (Mubarak and Shortan gas fields). Later, a number of large gas fields were opened in the Republic of Karakalpakstan, and they are being put into operation step by step. Several large gas processing enterprises operate under the names of the above mines. For example, in Kashkadarya region - Mubarak gas processing plant, Shortan gas-chemical complex, "Uzbekistan GTL" plant, in Bukhara region - Kandim and Gasli gas processing plants, and in the Republic of Karakalpakstan - Ustyurt gas-chemical complex [5; p. 55]. The volume of extraction of this resource - gas condensate - is decreasing year by year (left side of Table 3). In particular, the volume of mining in 2023 has decreased by 2.8 times compared to 2000. However, in terms of gas extraction, the republic will take 17th place in the world in 2022 and 21st place in terms of reserves [4; p. 16]. In particular, 155 promising fields of natural gas have been discovered, which are located in the territory of 5 oil and gas rich regions of Uzbekistan. The largest gas fields are located in South-Western Hisar (Dehkanabad and Boysun districts), Bukhara-Khiva (mainly in the western and

southern parts of the region) and Ustyurt (Orolqum regions of the Republic of Karakalpakstan).

Oil and oil processing: This fuel is called "Black Gold" and is a valuable raw material of the chemical industry, which has an important place in the national economy. As a result of oil refining, many different fuels and chemical products are produced and delivered to consumers. In Uzbekistan, oil is extracted mainly by drilling from among the layers belonging to the Cretaceous period [6; p. 83]. Oil production in our country started in 1876. In particular, in the Southern Fergana hills of the Fergana valley (Kamishboshi village, Fergana district, Fergana region) in the early 80s of the 21st century, businessman D. P. Petrov drilled 2 oil wells up to 25 m deep, and at that time up to 160 kg of oil was obtained from each well per day [2; p. 47].

Initially, the main part of oil was extracted in Fergana and Andijan regions, later oil fields were developed in Surkhandarya, Bukhara, Kashkadarya regions of the Republic of Karakalpakstan and Namangan regions, and now oil is extracted in these regions. It should be noted that the volume of oil extracted in Uzbekistan is decreasing (Table 3). In particular, the volume of extracted oil in 2023 has decreased by 5.3 times compared to 2000. The reason for this is that new oil fields are not being put into operation and the reserves of the old fields that are being used in practice have decreased.

Table 3

In Uzbekistan, oil and gas condensate extraction (left (million tons)) and the dynamics of the production of certain oil products (right (thousand tons))

a)	Feul t.	2000	2010	2023	b)	Oil products	2000	2010	2023
	Oil	4170,0	2017,9	778,3		Gasoline	1709,4	1413,8	1336,0
Gas Condensate	3366,0	2019,5	1199,4	Diesel	1972,0	1127,9	1188,7		
				Aviation kerosene	394,0	339,0	287,4		
Total	7536,0	4037,4	1977,7	Fuel oil	1709,0	287,2	164,1		

Comment: The table was compiled by the authors based on the information from the State Committee on Statistics of the Republic of Uzbekistan [10].

Also, oil refineries in Uzbekistan were built in 1906 in Altiariq district of Fergana region, in 1959 in Fergana city, in 1997 in Karavulbazar district of Bukhara region, in Jarkurgan city of Surkhandarya region and Chinoz city of Tashkent region. [5; p. 56]. The above enterprises mainly produce various fuel products (Table 3). Also, the Bukhara Oil Refinery in the city of Karavulbazar has been a leader in the production of oil products since its launch.

Coal industry: Coal - kaustobiolytic (from Greek - "kausto" - burning, "bio" - life, "litho" - stone) belongs to organic rocks, and the industry of this fuel consists in its extraction and delivery to the consumer. Coal is mainly used in electric power, chemical, ferrous metallurgy industries and for the needs of the population [3; p. 52]. Depending on the carbon content of it, it is divided into several types. For example, Angren lignite mine in Tashkent region (1940) and Shargun coal mine in Surkhandarya region (1950) were formed in Uzbekistan.

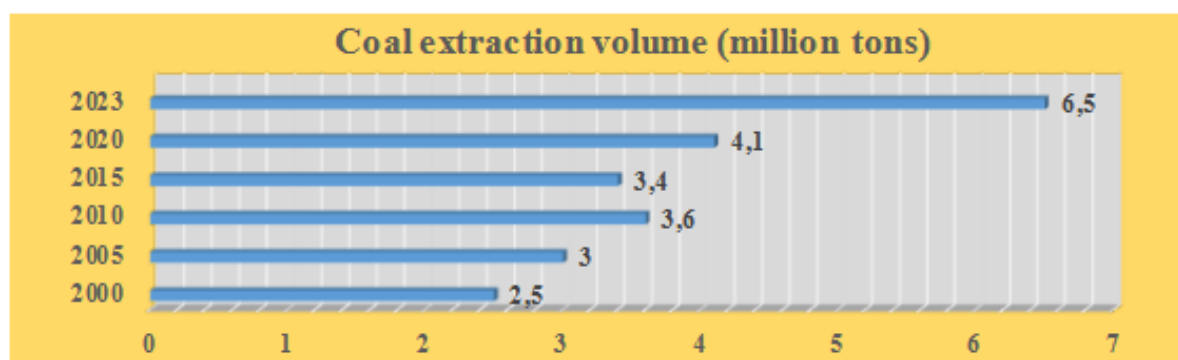


Figure 1. Dynamics of coal extraction in Uzbekistan

Comment: This figure was created by the authors based on information from the State Committee on Statistics of the Republic of Uzbekistan [10].

In 2023, 6,519.6 thousand tons of coal were mined in Uzbekistan, which shows a 2.6 times increase compared to 2000 (Figure 1). Lignite is the main part of the coal mined in the republic. This fuel is mainly mined in the open pit, and the Angren lignite mine in the Tashkent region is the main source of this process. It should be noted that coal gas is turned into gas generators under the Angren lignite mine. In it, coal beds are heated with coke or special reagents, and high-pressure air and water vapor are passed over the coal surface. As a result of this environmentally friendly process, several types of fuels (gas, shale, bitumen and

liquid fuels) are obtained with a low heat level. Such a process is mainly carried out in lignite with high moisture content or coal with low heat. This mine produces 1.0 million kroner per day at Yerostigaz, a subsidiary of Australia's "Linc Energy" company. m³ of gas is produced and transferred to Angren GRES [6; p. 82].

Electric power industry. This network is one of the main branches of the industry, which covers the processes of electricity generation, its delivery to consumers (transmission over a certain distance), transformation (decrease or increase of alternating current), distribution and its use in all areas [1; p. 163]. Positive indicators of electricity production are observed in Uzbekistan (Figure 2).

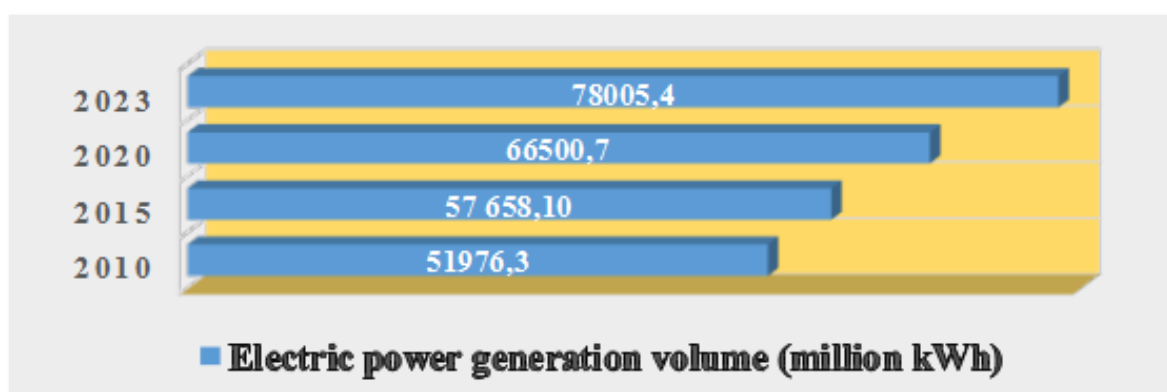


Figure 2. Indicator of electric power production in Uzbekistan

Comment: This figure was created by the authors based on information from the State Committee on Statistics of the Republic of Uzbekistan [10].

In particular, in 2023, 78.005 billion kilowatts of electricity was produced in Uzbekistan, which is 1.5 times more than in 2010. Also, the total installed capacity of Uzbekistan's power plants is 18,472.1 (MW), of which 84.5% are IES and IEM, 12.8% are hydroelectric power plants, and 2.7% are renewable energy sources (QTE/M) (figure-3).

The main sources of generation before independence included the three largest power plants in the republic with a capacity of over 1000 MW – Sirdaryo TPP, Tashkent TPP, and Navoi TPP; the power plant with a capacity of 500-1000 MW – Takhiatash TPP; two power plants with a capacity of 100-500 MW –

Angren GRES and Fergana TPC; and two power plants with a capacity of 10-100 MW – Mubarek TPC and Tashkent TPC. After independence, power plants constructed include the Talimarjan TPP with a capacity of over 1000 MW and the To'raqo'rg'on TPP with a capacity of 500-1000 MW. In the last decade, power plants established include the AKVA Power Sirdaryo TPP with a capacity of over 1000 MW, and six power plants with a capacity of 100-500 MW – AKSA Bukhara, AKSA Tashkent-240 MW, Jengiz Tashkent, AKSA Tashkent-230 MW, Jengiz Sirdaryo, and Odash Khorezm TPP (Table 4).

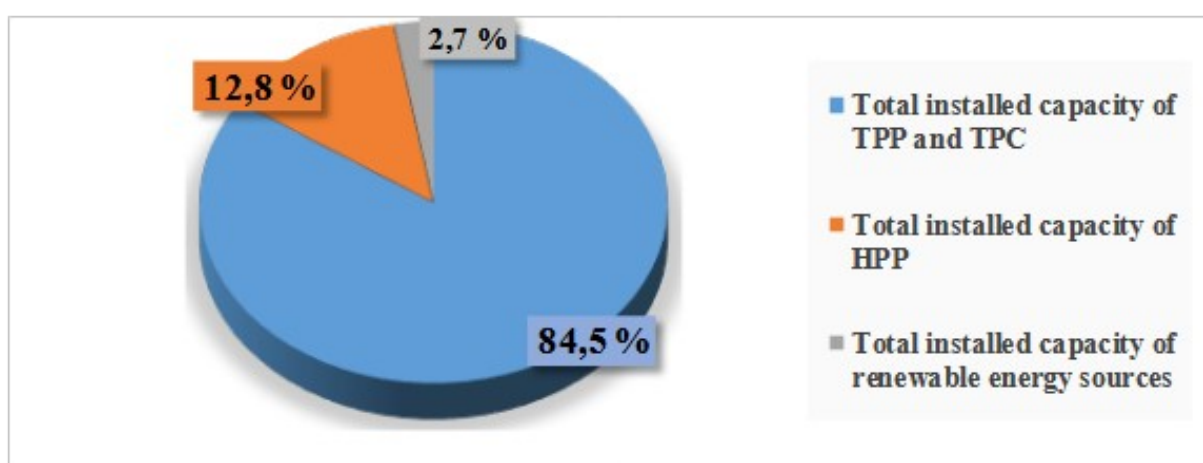


Figure 3. Composition of total installed capacity in power plants of Uzbekistan (%).

Comment: This figure was created by the authors based on information from the State Committee on Statistics of the Republic of Uzbekistan [10].

Table 4

Classification of thermal power plants generating electric power in Uzbekistan

№	Station name	Grouping (MW)	Year of commissioning	Number of energy blocks	Type of fuel	Capacity (MW)
1	Sirdaryo	Above 1000	1972	10	Gas	3 215
2	Tashkent		1963	13	Gas	2 230
3	Navoi		1961	10	Gas	2 068
4	Talimarjan		2004	3	Gas	1 700
5	AKVA Power Sirdaryo		2023	3		1500
6	Takhiatash	From 500 to 1000	1961	4	Gas	980
7	To'raqo'rg'on		2019	2	Gas	900
8	Angren GRES		1963	5	Coal	393
9	Fergana TPC		1956	8	Gas	329

10	AKSA Bukhara	From 100 to 500	2022	30		270
11	AKSA Tashkent-240 MW		2022	5		240
12	Jengiz Tashkent		2022	4		240
13	AKSA Tashkent-230 MW		2022	30		230
14	Jengiz Sirdaryo		2022	26		220
15	Odash Khorezm		2022	12		174
16	Mubarek TPC	From 10 to 100	1985	2	Gas	60
17	Tashkent TPC		1939	2	Gas	57
Total number of energy blocks and capacity at power plants				169		14 806

Comment: The table was compiled by the authors based on the data from [8; 211-b.] and [11].

At the same time, 55 large, small and micro hydropower plants are operating in the rivers, canals and streams of our country. The total capacity of these hydroelectric plants is 2225.4 MW. Chirchik River, Dargom Canal of Zarafshan River and other rivers and canals are distinguished by the largest number of hydroelectric power plants in the republic. In addition, more than 36% of hydroelectric power stations in our country are located in Tashkent region (Table 5).

Table 5

Classification of hydroelectric power plants generating electric power in the water basins of Uzbekistan

№	Water basins	Number of HPPs	Number of generators	Capacity (MW)	Area
1	Chirchiq r.	20 HPPs	51	1289,4	Tashkent
2	To'palondaryo r.	3 HPPs	8	250,6	Surkhandarya
3	Amudaryo r.	1 HPP	6	150	Khorezm
4	Qoradaryo r.	2 HPPs	6	190	Andijan
5	Sirdaryo r.	1 HPP	4	128,24	Sirdarya
6	Oqsuv r.	1 HPP	2	45	Qashkadarya
7	Zarafshon r. (Darg'om c.)	10 HPPs (3 micro)	23	63,52	Samarkand
8	Ohangaron r.	1 HPP	4	26,5	Namangan
9	Ohangaron r.	2 HPPs	4	32,4	Tashkent
10	Shahrixonsoy c.	3 HPPs	5	26,15	Andijan
11	Big Fargena c.	2 HPPs	4	12	Namangan
12	So'x r.	1 HPP	2	5	Fergana
13	South Fargena c.	1 HPP	1	2,2	Andijon
14	Yertoshsoy s.	1 HPP	2	2,032	Tashkent
15	Chortoq s.	1 HPP (micro)	3	0,825	Namangan
16	Right Bank c.	1 HPP (micro)	2	0,65	Andijan

17	New canal c.	1 HPP (micro)	1	0,26	Namangan
18	Isfara collector	1 HPP (micro)	1	0,23	Surkhandarya
19	Ispaysoy s.	1 HPP (micro)	2	0,2	Tashkent
20	Zominsuv s.	1 HPP (micro)	2	0,2	Jizzakh
Total		55	133	2225,4	Uzbekistan

Comment: The table was compiled by the authors based on the data from [8; 211-b.] and [11].

Renewable energy sources accounted for 1.59% of the total electricity production in the country in 2023, with solar power plants producing 1237.3 million kWh and wind power plants producing 7.2 million kWh [10]. Additionally, according to the decree PQ-436 of the President of the Republic of Uzbekistan dated December 2, 2022, "On measures to increase the efficiency of reforms aimed at transitioning to a green economy in the Republic of Uzbekistan by 2030," it is planned to increase the production capacity of renewable energy sources to 15 GW and to raise their share in total electricity production to more than 30% [12].

Conclusion. For the sustainable development of the fuel and energy complex, it is advisable to consider the approaches available in world practice. In this regard, it is necessary to diversify the sectoral structure of Uzbekistan's fuel and energy complex. It is also important to enhance the sustainable development of social sectors, rational use of fuel resources, maintain ecological balance, transition to alternative energy sources, and conserve traditional energy sources for future generations. The results of this research will help develop scientifically-based proposals to increase the importance of the fuel and energy complex in Uzbekistan's economy and ensure its sustainable development.

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