V International Scientific and Technical Conference Actual Issues of Power Supply Systems

Innovative Electric Power Sector: The Case of Uzbekistan

AIPCP25-CF-ICAIPSS2025-00408 | Article

Innovative Electric Power Sector: The Case of Uzbekistan

Ravshan Xusainov [a)], Alisher Tursunov, Kamola Ibragimova, Nigina Sayfutdinova, Gulnora Saidova

Tashkent State Technical University named after Islam Karimov, Tashkent, Uzbekistan

[a)] *Corresponding author: ravschan.husainov@yandex.ru*

Abstract. In the context of growing energy demand and climate challenges, this article presents a comprehensive analysis of Uzbekistan's transition to an innovative electric power model. It examines structural reforms in the sector, the dynamic development of renewable energy sources, the adoption of advanced technologies such as energy storage systems, and the development of market mechanisms. Data obtained from official sources and international organizations indicate significant achievements of targeted state policies: the share of renewable energy in electricity generation has reached 23%, billions of cubic meters of natural gas have been saved, and emissions have been reduced by millions of tons. The article also identifies key challenges facing the sector and provides recommendations for its further sustainable development.

INTRODUCTION

Modern electric power engineering is a strategically important sector of the global economy and is on the threshold of fundamental transformations. Around the world, the need for sustainable development is driving an urgent reassessment of traditional models of electricity generation and distribution. Growing global energy demand, the limited availability of fossil fuels, and worsening climate challenges are creating new threats to national energy security[1].

In the context of global trends, the study of pathways for modernizing the electric power industry of the Republic of Uzbekistan has become particularly relevant. The country possesses significant potential for renewable energy sources and, since 2019, has been implementing large-scale structural reforms in its fuel and energy sector aimed at ensuring energy security and achieving carbon neutrality. These transformations are taking place against the backdrop of rapidly growing domestic electricity demand, driven by demographic factors and the active development of industry. [2].

The relevance of the present research topic is determined by a combination of factors, among which the following are of particular importance:

Energy security: The growing gap between electricity production and consumption in Uzbekistan, especially during the autumn–winter period, creates a risk of energy shortages. The country's historical dependence on natural gas, which accounts for 75% of electricity generation, necessitates the diversification of energy sources and the introduction of innovative energy-supply methods.

Environmental necessity: As a party to the Paris Climate Agreement, Uzbekistan has committed to reducing greenhouse gas emissions by 35% by 2030 compared to the baseline scenario. These targets cannot be achieved without a fundamental transformation of the electric power sector and the widespread adoption of renewable energy technologies.

Economic benefits: International experts believe that the cost of electricity generation from renewable sources in Uzbekistan is already comparable to traditional gas-based generation. This opens up opportunities to reduce subsidies for the energy sector and redirect budgetary funds to other socio-economic programs.

Technological progress: Rapid advancements in solar and wind energy technologies, energy storage systems, and smart grids provide a foundation for modernizing the country's energy infrastructure. Uzbekistan has the opportunity to adopt the experience of technological leaders and avoid investments in outdated technologies.

The problem is actively studied in academic circles. Research covers both general issues of the energy transition and specific aspects of the development of Uzbekistan's electric power sector. Local scholars, such as M. Abdullaeva and her colleagues, examine the climate-related aspects of the transition to "green" energy in their works. The Ministry of Energy of Uzbekistan has provided materials that systematize the strategic framework of the reforms. International financial institutions (the World Bank, the International Finance Corporation) emphasize in their reports the role of private capital and market liberalization. Nevertheless, a comprehensive analysis of the innovative development of Uzbekistan's electric power sector, taking into account recent achievements and identified challenges, requires further in-depth study.

The aim of the research is a comprehensive analysis of the main directions, achievements, and prospects for the development of the innovative electric power sector in Uzbekistan.

To achieve this aim, the following tasks need to be addressed: Study of reforms in the institutional and legal framework of Uzbekistan's electric power industry, analysis of the current state and development potential of renewable energy sources in the country, assessment of the role of international cooperation and private investments in modernizing the energy sector, identification of key technological innovations being implemented in Uzbekistan's electric power sector, determination of existing challenges and proposal of solutions for the further sustainable development of the industry.

The object of the study is the electric power sector of the Republic of Uzbekistan in the process of transformation and modernization. The subject of the study comprises the organizational, economic, and technical aspects of the innovative development of the country's electric power industry.

The theoretical and methodological basis of the research includes a systems approach, methods of comparative, statistical, and structural-functional analysis, as well as the generalization of obtained data to form comprehensive conclusions and practical recommendations.

The scientific novelty of the study lies in a comprehensive analysis of the transformation process of Uzbekistan's electric power sector, taking into account up-to-date data on implemented projects and achieved results, as well as in the proposal of practical recommendations to address the identified challenges in the development of the industry.

The practical significance of the study lies in the fact that its results and conclusions can be used by government authorities in the development and adjustment of plans for the electric power sector, by commercial organizations in shaping investment strategies, and by the scientific community for further research in this field.

The aim of the research is to analyze the key directions, achievements, and prospects for the development of Uzbekistan's innovative electric power sector. To achieve this aim, the following tasks were set: study the institutional and legal reforms in the sector; assess the current state and potential of renewable energy sources; analyze the role of international cooperation and private investments; identify technological innovations; determine existing challenges and propose ways to address them.

Literature Review. Issues of energy development in Uzbekistan are widely covered in official documents, reports of international organizations, and scientific publications. Works such as the study by M. Abdullaeva emphasize the impact of climate risks on Uzbekistan's energy transition, including rising temperatures, water shortages, and increasing droughts. Documents from the Ministry of Energy of Uzbekistan systematically present the strategic framework of reforms — the "Concept for Ensuring Electricity Supply in the Republic of Uzbekistan for 2020–2030" and digitalization plans.

International financial institutions (the World Bank, the International Finance Corporation) in their reports highlight the role of private capital, public-private partnerships (PPP), and market liberalization in energy decarbonization. Current scientific discussions indicate that, despite well-designed strategies, practical implementation faces challenges related to the integration of intermittent renewable energy sources into the power grid, as well as the need for substantial investments and modernization of outdated infrastructure.

RESEARCH METHODOLOGY

The methodological basis of this study is a systems approach, which allows the electric power industry of Uzbekistan to be considered as a complex and dynamic system. The following methods were applied in this research:

Comparative analysis of official documents, data from the Ministry of Energy of the Republic of Uzbekistan, and international organizations to identify trends and inconsistencies.

Statistical analysis of electricity generation indicators.

Structural-functional analysis to study institutional reforms in the sector (e.g., the reform of the joint-stock company "Uzbekneftegaz" and the establishment of new companies).

Synthesis: The obtained data were used to formulate comprehensive conclusions and practical recommendations.

MAIN PART

1. Institutional and Legal Reforms in Uzbekistan's Electric Power Sector. The fundamental transformation of Uzbekistan's electric power sector began with profound institutional reforms. The establishment of the Ministry of Energy of the Republic of Uzbekistan in 2019 marked the beginning of systemic changes across the entire fuel and energy complex. The newly established ministry was granted the authority to coordinate the activities of all sector participants and to develop a unified state energy policy.

A key factor in these structural transformations was the phased complete reorganization of the joint-stock company "Uzbekenergo." As a result, three specialized joint-stock companies were created: "Thermal Power Plants" (responsible for the operation of thermal power stations), "National Electric Networks of Uzbekistan" (responsible for transmission networks and dispatching), and "Regional Electric Networks" (responsible for distribution networks and interaction with end consumers). This division enabled the implementation of modern corporate governance methods and improved operational efficiency in each area.

During the sectoral reforms, comprehensive legislation was adopted aimed at the development of innovative energy. The Law on Renewable Energy Sources, passed in 2019, established the legal framework for promoting renewable energy development, including guaranteed grid connection and special tariffs. Also in 2019, the Law on Public-Private Partnership was enacted, creating a legal platform for attracting private investments into capital-intensive energy projects.

The Electricity Supply Concept of the Republic of Uzbekistan for 2020–2030, approved by presidential decree, defines the strategic directions for the sector's development. The document provides for an increase in the installed capacity of power plants from 12.9 to 29.3 gigawatts and a growth in electricity generation from 63.6 to 120.8 billion kilowatt-hours by 2030. Particular attention in the concept is given to diversifying energy sources and increasing the share of renewables.

2. Development of Renewable Energy: Current Status and Achievements. Uzbekistan possesses unique opportunities for the development of solar energy, as evidenced by an average annual global horizontal irradiance (GHI) of 4.52 kWh/m² per day, surpassing the levels of some Southern European countries. The potential for wind energy is estimated at 520 GW, with the most favorable conditions for its development concentrated in the desert regions of Karakalpakstan and the Navoi region.

The implementation of this potential is rapidly accelerating. By October 2025, the country had built 12 solar and 5 wind power plants with a total installed capacity of approximately 4,682 MW. Since the beginning of 2025, electricity generation from solar and wind plants has reached 9 billion kWh. Taking hydropower plants into account, the total electricity production from renewable sources amounted to 14.52 billion kWh, representing 23% of total electricity generation.

The achieved results have a significant positive impact on the country's economy and environment:

Resource savings: Since the beginning of 2025, the use of renewable energy sources has saved 2.73 billion cubic meters of natural gas. This figure is of great significance for a country where up to 75% of electricity has historically been generated from gas [5].

Environmental impact: In addition, approximately 4 million tons of harmful substances, including greenhouse gases, were avoided. This directly contributes to Uzbekistan's fulfillment of its commitments under the Paris Agreement, which provides for a 35% reduction in greenhouse gas emissions by 2030 compared to the baseline scenario. [1].

Energy supply for the population: Since the beginning of the year, the produced volume of "green" energy has been equivalent to the consumption of 7.5 million households over 10 months, demonstrating a significant contribution of renewable energy sources to the country's energy security.

The government has set ambitious targets for further expansion of renewable energy capacity. According to the updated strategy, by 2030 the share of renewables in electricity generation is expected to reach 54%. This will be made possible through the commissioning of 19 gigawatts (GW) of new "green" generation capacity, including 10 GW of solar power plants and 7 GW of wind power plants.

3. Technological Innovations and Digital Transformation Analysis of the Current State of Energy Efficiency in Uzbekistan Key issue: instability of the power system due to the integration of renewable energy sources.

For power systems with a high share of renewable energy sources, such as solar and wind energy, the main challenge is their intermittent and unstable nature. To address this issue, Uzbekistan is actively implementing

innovative technologies, in particular, **Battery Energy Storage Systems (BESS)**. One of the pilot projects is a 250 MW solar power plant in the Bukhara region, which includes a BESS with a capacity of 100 MWh. This is the first initiative of its kind in Central Asia.

These energy storage systems perform several critical functions: they store excess energy during periods of peak generation (during the day for solar power plants) and feed it back into the grid during peak demand periods (evening), as well as provide frequency regulation and reserve power. The technical characteristics of modern BESS allow them to respond in less than 100 milliseconds, significantly enhancing the stability and reliability of the power system.

At the international exhibition “Power Uzbekistan 2025”, leading global companies presented energy storage solutions designed for the region’s climatic conditions. Among these innovative products are energy storage systems with liquid and air cooling for commercial, industrial, and distributed applications, as well as mobile energy storage systems to supply electricity to remote areas.

In parallel, a large-scale project is underway to implement an Automated Electricity Metering and Control System (AMR/Smart Grid). As part of this system, smart meters will be installed, a data processing center will be created, and software will be deployed to monitor energy consumption in real time. According to expert estimates, the full implementation of the AMR system will reduce commercial losses from the current 10–12% to 4–5% and increase the efficiency of electricity network management.

4. International Cooperation and Investment Mechanisms. International cooperation and the attraction of foreign direct investment are key catalysts for Uzbekistan’s energy transition. The government actively utilizes the public-private partnership (PPP) mechanism, which has proven effective in implementing capital-intensive projects in the energy sector.

Companies from the UAE (Masdar), Saudi Arabia (ACWA Power), China, and France, as well as international financial institutions, play a crucial role in the development of renewable energy. Masdar is implementing several major projects, including the construction of solar power plants with a total capacity of 900 MW in the Jizzakh and Samarkand regions. The agreements involve investments exceeding USD 800 million and the transfer of advanced technologies.

With the support of the International Finance Corporation (IFC) and the World Bank, large-scale projects are being implemented, such as the construction of a 500 MW wind power plant in the Navoi region, which will become the largest in Central Asia. The project includes the development of a wind farm, turbine installation, and the creation of the necessary infrastructure for integration into the unified power system.

In 2025, the World Bank approved a financial assistance program of USD 800 million to support reforms in Uzbekistan’s energy sector. These funds will be directed toward implementing a plan that provides for the opening of the electricity distribution market to private companies, increasing energy efficiency in industry and the residential sector, and creating risk insurance mechanisms for private investors.

These measures will contribute to the creation of a competitive environment, the attraction of advanced technologies and know-how, and the strengthening of local specialists’ capacities through technical assistance and training programs.

5. Challenges and Issues in the Development of Innovative Electric Power. Despite impressive achievements, the development of innovative electric power in Uzbekistan still faces a number of systemic problems that require comprehensive solutions.

Power system instability: The integration of a large number of intermittent renewable energy sources creates serious difficulties for grid management. The existing power grid infrastructure, largely built during the Soviet era, does not always meet modern requirements for flexibility and maneuverability. The situation is further complicated by the uneven geographic distribution of renewable energy facilities: most solar and wind power plants are concentrated in a few regions with the best resource conditions, creating a risk of overloading certain network sections.

Investment requirements: To implement all the projects planned until 2030, as outlined in the “Concept,” more than USD 25 billion in investments will be required. Such a volume of financing will put significant pressure on the state budget and necessitate further improvements in the investment climate. It will be especially challenging to attract funds for projects with uncertain demand or related to the modernization of network infrastructure.

Human capital and skills gap: Operating and managing modern technologies, such as Battery Energy Storage Systems (BESS), Distributed Energy Resource Management Systems (DERMS), and digital substations, requires highly qualified specialists. The current vocational education system does not yet fully meet the needs of the rapidly developing sector. In the field of power grids, there is a particularly acute shortage of specialists such as design engineers, complex equipment operation experts, and data analysts.

Regulatory challenges: Despite significant progress in improving legislation and regulatory frameworks, administrative barriers still exist. These include lengthy project approval procedures, difficulties in obtaining land-use permits for renewable energy projects, and the need to further refine pricing and tariff mechanisms.

Addressing these challenges requires coordinated efforts from the government, the private sector, and international partners, as well as the implementation of comprehensive development plans that take into account the technological, economic, and social aspects of the energy transition.

1. Institutional and Legal Reforms. In 2019, the Ministry of Energy was established in Uzbekistan to coordinate the entire fuel and energy sector, marking the beginning of a new era of transformation.

A key step was the deep reorganization of the joint-stock company "Uzbekenergo," resulting in the creation of three specialized joint-stock companies: “Thermal Power Plants,” “National Electric Networks of Uzbekistan,” and “Regional Electric Networks.” This restructuring enabled the implementation of modern management methods and improved operational efficiency.

The laws adopted in 2019, **“On the Use of Renewable Energy Sources”** and **“On Public-Private Partnership,”** laid a solid legal foundation for attracting private investment in the renewable energy sector.

The Electricity Supply Concept of the Republic of Uzbekistan for 2020–2030 serves as a strategic guideline, according to which the installed capacity of power plants is expected to increase from 12.9 GW to 29.3 GW, and electricity generation is projected to grow from 63.6 billion kWh to 120.8 billion kWh by 2030.

3.2. Development of Renewable Energy and Its Impact. Uzbekistan possesses a unique potential for the development of solar energy. The country’s average global horizontal irradiance (GHI) is 4.52 kWh/m² per day, exceeding the levels of some Southern European countries. This potential is being actively and rapidly realized.

Table 1. Key Indicators of Renewable Energy Development in Uzbekistan (as of October 2025)

Indicator	Value
Number of solar power plants	12
Number of wind power plants	5
Total installed capacity of solar and wind power plants	~4,682 MW
Electricity generation from solar and wind power plants since the beginning of 2025	9 billion kWh
Total generation including hydropower plants	14.52 billion kWh
Share of renewables in total generation	23%

The achieved results have had a significant positive impact on the economy and the environment.

Resource savings: Since the beginning of 2025, the use of renewable energy sources has saved 2.73 billion cubic meters of natural gas, which is crucial for a country historically dependent on gas for 75% of its electricity generation.

Environmental benefits: Approximately 4 million tons of harmful emissions were avoided. This directly contributes to Uzbekistan’s fulfillment of its commitments under the Paris Agreement to reduce greenhouse gas emissions by 35% by 2030..

Energy supply: Since the beginning of the year, the “green” energy produced has been equivalent to the 10-month electricity consumption of 7.5 million households.

The government has set ambitious targets for further capacity expansion: by 2030, the share of renewable energy in electricity generation is expected to reach 54% through the commissioning of 19 gigawatts of new “green” generation capacity.

3. Technological Innovations and Integration

In power systems with a high share of renewable energy sources, their inherent intermittency poses a significant challenge.

To address this issue, Uzbekistan is actively implementing innovative technologies, particularly Battery Energy Storage Systems (BESS). One of the pilot projects is a 250 MW solar power plant in the Bukhara region, which includes a BESS — the first of its kind in Central Asia.

These systems store excess energy during periods of peak generation and feed it back into the grid during peak demand, thereby enhancing the stability and reliability of the entire system.

At the international exhibition “Power Uzbekistan 2025,” companies presented energy storage solutions adapted to the regional conditions, including liquid-cooled and air-cooled systems.

Cooling systems for commercial, industrial, and distributed applications.

In parallel, a large-scale program is being implemented to deploy an **Automated Electricity Metering and Control System (AMR/Smart Grid)**, which will help reduce commercial losses and improve the efficiency of electricity network management.

4. International Cooperation and Investments

International cooperation and the attraction of foreign direct investment are key catalysts of Uzbekistan's energy transition. The government actively employs public–private partnership mechanisms. Companies from the UAE (Masdar), Saudi Arabia, China, and France, as well as international financial institutions, play a central role.

With the support of the International Finance Corporation (IFC) and the World Bank, large-scale projects are being implemented, including a 500 MW wind power plant in the Navoi region, which will become the largest in Central Asia. In 2025, the World Bank approved a financial package of USD 800 million to support reforms, including the opening of the electricity distribution market to private companies and improvements in energy efficiency. These measures help create a competitive environment and facilitate the introduction of advanced technologies and expertise.

Challenges and Prospects

Despite the impressive progress achieved, the development of innovative electric power in Uzbekistan still faces a number of challenges:

1. Grid instability: The integration of a large number of renewable energy sources with variable output requires large-scale modernization of the grid infrastructure and the deployment of flexible generation capacities.

2. Need for investment: The implementation of all planned projects requires multi-billion investments, which places a burden on the state budget and necessitates further improvement of the investment climate.

3. Shortage of technologies and skilled personnel:

To operate and manage modern technologies such as battery energy storage systems (BESS) and digital grids, it is necessary to train highly qualified specialists.

Prospective Directions

For further development, it is planned to:

Actively expand distributed generation, particularly rooftop solar panel installation projects, with the goal of achieving 1 gigawatt of generated capacity. Explore and adopt new energy sources, such as shallow geothermal energy for heating and cooling buildings. Continue promoting market liberalization by creating a wholesale electricity market and attracting private operators to distribution networks to improve efficiency.

CONCLUSION

1. The implementation of these measures will enable Uzbekistan not only to ensure its own energy security but also to strengthen its position as a regional leader in "green" energy.

2. Accelerating the modernization of power grids: prioritizing investment in smart grids and the creation of flexible generation capacities to ensure stability while integrating a large number of renewable energy sources.

3. Promoting localization, research and development: encouraging local production of components for renewable energy systems and energy storage, as well as strengthening cooperation between universities and industry for workforce development.

4. Deepening market reforms: consistently implementing plans for the development of a wholesale electricity market and attracting private investors into the distribution sector to enhance operational efficiency.

5. Developing energy efficiency programs:** actively promoting energy service contracts and energy-efficiency standards for industrial and municipal enterprises to reduce overall energy consumption.

REFERENCES

1. M. Abdullaeva, "Green energy in Uzbekistan: Climate problems and prospects for sustainable development," *Innovative Research in Science* **3**(12), 94–101 (2024).

2. Ministry of Energy of the Republic of Uzbekistan, *Goals, objectives, plans and achievements* (Tashkent, 2025). Available at: https://gov.uz/ru/minenergy/pages/about

3. International Finance Corporation (IFC), *Development of renewable energy sources in Uzbekistan* (2025). Available at: https://energyforum.uz/ru/novosti/razvitie-vozobnovlqemh-istochnikov-nergii-v-uzbekistane

4. World Bank Group, *World Bank supports Uzbekistan in implementing policy reforms to spur job creation and private sector growth*, Press release (Washington, 2025). Available at: https://www.worldbank.org/en/news/press-

release/2025/10/16/first-advancing-global-integration-and-market-transition-uzbekistan-programmatic-development-policy-operation
5. G. Shpitsen, "Uzbekistan optimizes hydrocarbon consumption," *Nezavisimaya Gazeta* (September 8, 2025). Available at: https://www.ng.ru/energy/2025-09-08/14_9333_uzbekistan.html
6. G. Allaeva, G. Yusupkhodjaeva, and K. Mukhitdinova, "Methodology for calculating sustainable development of fuel and energy complex enterprises based on consolidated integral indices," *AIP Conf. Proc.* **3331**, 030006 (2025). https://doi.org/10.1063/5.0308133
7. G. Yusupkhodjaeva, G. Allaeva, and K. Mukhitdinova, "Sustainable development of transport enterprises in the context of the formation of the digital economy," *AIP Conf. Proc.* **3331**, 030087 (2025). https://doi.org/10.1063/5.0306872
8. K. Mukhitdinova, G. Yusupkhodjaeva, and G. Allaeva, "Econometric modeling of investment potential of industrial enterprises," *AIP Conf. Proc.* **3331**, 050026 (2025). https://doi.org/10.1063/5.0308123
9. G. Allaeva, "Main directions of sustainable development of fuel and energy enterprises," *AIP Conf. Proc.* **3152**, 050012 (2024). https://doi.org/10.1063/5.0220851
10. G. Allaeva, "The role of energy security in forming the foundations for sustainable development of fuel and energy complex enterprises," *E3S Web Conf.* **461**, 01061 (2023). https://doi.org/10.1051/e3sconf/202346101061
11. G. Allaeva, "Sustainable development methodology of the fuel-energy complex of the Republic of Uzbekistan," *E3S Web Conf.* **289**, 07033 (2021). https://doi.org/10.1051/e3sconf/202128907033
12. G. Allaeva, "Fiscal instruments of taxation improvement as a factor of sustainable development of enterprises of the fuel and energy sector," *E3S Web Conf.* **216**, 01173 (2020). https://doi.org/10.1051/e3sconf/202021601173
13. G. Allaeva, "Priority directions of development of Uzbekneftegas JSC in the conditions of globalization of the world economy," *E3S Web Conf.* **139**, 01008 (2019). https://doi.org/10.1051/e3sconf/201913901008
14. S. Ibragimova and K. Bakhodirova, "Formation of investment activities of energy enterprises," *E3S Web Conf.* **461**, 01074 (2023). https://doi.org/10.1051/e3sconf/202346101074
15. R. Xusainov and O. Begmullaev, "Problems of ensuring the electricity supply system in Uzbekistan," *AIP Conf. Proc.* **3331**, 030002 (2025). https://doi.org/10.1063/5.0305927
16. R. Xusainov, B. Tillayeva, and N. Sayfutdinova, "Development of ecology and energy in Uzbekistan," *AIP Conf. Proc.* **3331**, 030010 (2025). https://doi.org/10.1063/5.0306384
17. G. Yusupkhodjaeva, "Development of a unified digital transport and logistics intelligent platform based on the national operator," *E3S Web Conf.* **461**, 01055 (2023). https://doi.org/10.1051/e3sconf/202346101055
18. K. Mukhitdinova and G. Tarakhtieva, "Ensuring sustainable future: The interconnectedness of food safety and environmental health," *E3S Web Conf.* **497**, 03037 (2024). https://doi.org/10.1051/e3sconf/202449703037
19. S. Hashimova, D. Yakubova, and N. Tursunova, "Possibilities of expanding the mineral resource as a base of ferrous metallurgy," *Lect. Notes Netw. Syst.* **733**, 879–888 (2024). https://doi.org/10.1007/978-3-031-37978-9_70
20. S. Salomova *et al.*, "Improving the efficiency of energy enterprises," *AIP Conf. Proc.* **3331**, 040076 (2025). https://doi.org/10.1063/5.0305987
21. O. Begmullaev, S. Nabieva, and S. Mirsaidova, "Classification of energy efficiency policies and their implementation," *AIP Conf. Proc.* **3331**, 030053 (2025). https://doi.org/10.1063/5.0305929
22. A. Otabek and O. Begmullaev, "Alternative energy and its place in ensuring the energy balance of the Republic of Uzbekistan," *AIP Conf. Proc.* **2552**, 050030 (2023). https://doi.org/10.1063/5.0117633
23. O. Akhmedov and O. Begmullaev, "Ways of ensuring energy balance in Uzbekistan," *E3S Web Conf.* **216**, 01137 (2020). https://doi.org/10.1051/e3sconf/202021601137
24. S. Nabieva and S. Atakhanova, "Modern methods of investment activity in the development of industrial enterprises," *AIP Conf. Proc.* **3331**, 050010 (2025). https://doi.org/10.1063/5.0308119
25. S. Salomova, "Increasing the efficiency of oil and gas industry enterprises in Uzbekistan," *AIP Conf. Proc.* **3331**, 040075 (2025). https://doi.org/10.1063/5.0305986
26. K. A. Mukhitdinova and L. A. Vildanova, "Transport improvement of the method of assessing the attractiveness of investment in automotive enterprises," *J. Crit. Rev.* **7**(5), 171–176 (2020). https://doi.org/10.31838/jcr.07.05