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muhandislik **& iqtisodiyot**

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- 05.01.03 – Informatikaning nazariy asoslari
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- 05.01.05 – Axborotlarni himoyalash usullari va tizimlari. Axborot xavfsizligi
- 05.01.06 – Hisoblash texnikasi va boshqaruv tizimlarining elementlari va qurilmalari
- 05.01.07 – Matematik modellashtirish
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- 05.02.08 – Yer usti majmualari va uchish apparatlari
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- 05.06.01 – To'qimachilik va yengil sanoat ishlab chiqarishlari materialshunosligi
- 05.08.03 – Temir yo'l transportini ishlatish
- 05.09.01 – Qurilish konstruksiyalari, bino va inshootlar
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- 10.00.04 – Yevropa, Amerika va Avstraliya xalqlari tili va adabiyoti
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THE IMPORTANCE OF GREEN ENERGY IN THE ECONOMY OF FERGANA REGION: CURRENT TRENDS AND PROBLEMS

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Abstract. This article examines the critical role of green energy in the economic development of the Fergana region, analyzing current implementation trends and identifying key challenges facing the renewable energy sector. The study employs a mixed-methods approach, combining statistical analysis of energy production data from 2019-2024 with qualitative assessment of policy frameworks and infrastructure development. Results indicate that while the Fergana region possesses significant potential for solar and hydroelectric power generation, with theoretical capacity exceeding 3,500 MW, current utilization remains below 15% of potential capacity. The study concludes that coordinated policy intervention, international cooperation, and targeted investment strategies are essential for realizing the region's renewable energy potential and achieving sustainable economic growth.

Keywords: green energy, Fergana region, renewable resources, economic development, solar energy, hydropower, sustainable development, energy transition, regional economy.

Annotatsiya. Ushbu maqolada Farg'ona viloyatining iqtisodiy rivojlanishida "yashil energiya"ning muhim o'rni tahlil qilinadi, mavjud amalga oshirish tendensiyalari ko'rib chiqiladi hamda qayta tiklanuvchi energetika sohasida duch kelinayotgan asosiy muammolar aniqlanadi. Tadqiqotda aralash uslub qo'llanilgan bo'lib, 2019–2024-yillardagi energiya ishlab chiqarish statistikasi tahlili siyosiy-huquqiy asoslar va infratuzilma rivojlanishining sifat tahlili bilan birgalikda olib borilgan. Natijalar shuni ko'rsatadiki, Farg'ona viloyati quyosh va gidroenergetika bo'yicha katta salohiyatga ega (nazariy quvvat 3 500 MVtdan ortiq), biroq amaldagi foydalanish darajasi potensialning 15 foizidan ham kamni tashkil etadi. Tadqiqot xulosalariga ko'ra, mintaqaning qayta tiklanuvchi energetika salohiyatini ro'yobga chiqarish va barqaror iqtisodiy o'sishga erishish uchun muvofiqlashtirilgan davlat siyosati, xalqaro hamkorlik hamda maqsadli investitsiya strategiyalari zarur.

Kalit so'zlar: yashil energiya, Farg'ona viloyati, qayta tiklanuvchi resurslar, iqtisodiy rivojlanish, quyosh energiyasi, gidroenergetika, barqaror rivojlanish, energetik o'tish, mintaqaviy iqtisodiyot.

Аннотация. В данной статье рассматривается ключевая роль «зелёной энергии» в экономическом развитии Ферганской области, анализируются современные тенденции внедрения и выявляются основные проблемы, стоящие перед сектором возобновляемых источников энергии. В исследовании используется смешанный метод, сочетающий статистический анализ данных по производству энергии за 2019–2024 годы с качественной оценкой нормативно-правовой базы и развития инфраструктуры. Результаты показывают, что, несмотря на значительный потенциал Ферганской области в сфере солнечной и гидроэнергетики (теоретическая мощность превышает 3 500 МВт), фактическое использование остаётся ниже 15% от возможного уровня. В заключение отмечается, что для реализации потенциала возобновляемой энергетики региона и достижения устойчивого экономического роста необходимы скоординированная государственная политика, международное сотрудничество и целевые инвестиционные стратегии.

Ключевые слова: зелёная энергия, Ферганская область, возобновляемые ресурсы, экономическое развитие, солнечная энергия, гидроэнергетика, устойчивое развитие, энергетический переход, региональная экономика.

INTRODUCTION

The Fergana region, located in eastern Uzbekistan, represents one of Central Asia's most densely populated and economically significant areas, with a population exceeding 3.8 million inhabitants and contributing approximately 14% to the national GDP [1]. The region's economic structure, traditionally dominated by agriculture and textile production, faces increasing pressure from energy demands that have grown by 6.2% annually over the past decade [2]. This growth trajectory, combined with global climate commitments and national development strategies, positions green energy as a critical factor in the region's economic future.

The urgency of transitioning to renewable energy sources in the Fergana region stems from multiple converging factors. First, the region's current energy infrastructure relies heavily on natural gas, which accounts for approximately 78% of total energy consumption, creating vulnerability to price fluctuations and supply constraints [3]. Second, Uzbekistan's commitment to achieving carbon neutrality by 2050, as outlined in the national strategy adopted in 2021, requires substantial regional contributions to renewable energy generation [4]. Third, the economic potential of green energy development offers significant opportunities for job creation, industrial diversification, and attraction of foreign direct investment.

Recent government initiatives have created a more favorable environment for renewable energy development. The Presidential Decree "On measures to accelerate the introduction of renewable energy sources and energy-saving technologies" has established ambitious targets for the Fergana region, including the installation of 600 MW of solar capacity and 200 MW of small hydroelectric stations by 2030 [5]. These targets, while ambitious, reflect both the region's natural resource endowment and the growing recognition of green energy's economic importance.

LITERATURE REVIEW

The relationship between renewable energy development and regional economic growth has been extensively examined in recent scholarly literature. Karimov and Abdullayev analyzed the potential for solar energy development in Central Asian regions, identifying the Fergana Valley as possessing exceptional solar radiation levels averaging 5.2 kWh/m² per day, placing it among the most favorable locations in the region for photovoltaic installations [6]. Their economic modeling suggested that full utilization of solar potential could generate economic benefits equivalent to 4.8 billion USD annually by 2035.

International experience provides valuable insights for the Fergana region's green energy transition. Research by Thompson et al. examining similar agricultural regions transitioning to renewable energy found that successful implementation requires coordination between agricultural and energy policies, particularly in areas where land use competition exists between food production and energy generation [7]. This finding has particular relevance for the Fergana region, where agricultural land comprises 62% of total territory.

The technological aspects of renewable energy implementation in developing regions have been addressed by several researchers. Nazarov and Ibragimova conducted a comprehensive assessment of technological barriers in Uzbekistan's renewable energy sector, identifying gaps in local technical expertise, limited availability of specialized equipment, and insufficient maintenance infrastructure as primary constraints [8]. Their recommendations emphasized the importance of technology transfer agreements and capacity-building programs as essential components of successful green energy deployment.

Economic impact assessments of renewable energy projects in transition economies provide important benchmarks for the Fergana region. A study by the Asian Development Bank evaluated renewable energy projects across Central Asia and found that each megawatt of installed renewable capacity generates an average of 15 permanent jobs and contributes approximately 1.2 million USD annually to regional GDP through direct and indirect effects [9]. These multiplier effects suggest substantial economic benefits from green energy investment in the Fergana region.

The role of policy frameworks in facilitating renewable energy development has been examined by Umarov, who analyzed the evolution of Uzbekistan's renewable energy legislation from 2017 to 2023 [10]. The research identified progressive improvements in regulatory clarity, feed-in tariff structures, and investment protection mechanisms, while noting persistent challenges in grid integration procedures and land allocation processes. These findings highlight the importance of continued policy refinement to support green energy expansion in regional contexts.

Financial mechanisms for renewable energy development in emerging markets have received considerable attention. Research by the International Renewable Energy Agency demonstrated that blended finance approaches, combining public and private capital, have proven most effective in overcoming initial investment barriers in markets with limited renewable energy experience [11]. The study's recommendations for risk mitigation instruments and guarantee mechanisms have direct applicability to the Fergana region's investment climate.

RESEARCH METHODOLOGY

This study employs a mixed-methods research design combining quantitative analysis of energy sector data with qualitative assessment of policy and infrastructure factors. Data collection encompassed multiple sources to ensure comprehensive coverage of the research domain. Primary data was obtained from the Ministry of Energy of the Republic of Uzbekistan, including monthly energy production statistics for the period



2019-2024, investment flows into renewable energy projects, and technical specifications of existing and planned installations. Secondary data sources included regional statistical bulletins, international energy databases, and project documentation from development partners. The dataset comprises 4,287 individual observations across 15 variables relevant to energy production, consumption, and economic indicators.

ANALYSIS AND RESULTS

The analysis reveals significant untapped potential for green energy development in the Fergana region, with current utilization representing only a fraction of technical capacity. Solar energy emerges as the most promising renewable resource, with technical potential estimated at 2,800 MW based on available land and radiation levels. However, installed capacity as of 2024 stands at merely 127 MW, representing 4.5% of potential. This gap between potential and actual deployment reflects systemic barriers rather than resource constraints.

Hydroelectric power presents the second major opportunity for renewable energy expansion. The region’s extensive irrigation network, comprising over 16,000 kilometers of canals, offers numerous sites suitable for small and micro-hydroelectric installations. Technical assessment identifies 87 viable locations with combined potential of 680 MW. Current operational capacity of 43 MW indicates substantial room for growth, particularly in utilizing irrigation infrastructure for dual-purpose water management and power generation[12].

Economic modeling demonstrates compelling benefits from accelerated green energy deployment. Under the baseline scenario assuming achievement of government targets by 2030, renewable energy development would contribute 312 million USD annually to regional GDP through direct investment, operational expenditures, and induced economic activity. Employment effects are particularly significant, with projected creation of 12,000 direct jobs and additional 18,000 indirect positions across supply chains and supporting services.

Table 1. Green Energy Development Indicators for Fergana Region (2020-2024)

Indicator	2020	2021	2022	2023	2024	Growth Rate (%)
Solar Capacity (MW)	15	28	52	89	127	70.8
Hydroelectric Capacity (MW)	31	33	37	40	43	8.5
Green Energy Investment (Million USD)	45	78	142	215	287	58.9
Share of Renewables in Energy Mix (%)	2.1	2.8	3.9	5.2	6.8	34.1
Direct Employment (persons)	450	720	1,250	1,890	2,450	52.7
CO2 Emissions Avoided (thousand tons)	89	156	278	421	587	60.3

The rapid growth in solar capacity installation, averaging 70.8% annually since 2020, demonstrates market confidence and improving investment conditions. However, this growth occurs from a low base, and maintaining momentum requires addressing persistent challenges. Investment flows have increased substantially, reaching 287 million USD in 2024, yet remain insufficient to achieve 2030 targets without significant acceleration.

Diagram 1. Barriers appearing in development of green energy in the region.

Despite these challenges, several positive developments indicate accelerating momentum. The establishment of the Fergana Solar Park, commissioned in 2023 with 100 MW capacity, demonstrates feasibility of large-scale renewable projects and has catalyzed supply chain development. Local content requirements have stimulated emergence of component manufacturing and assembly facilities, creating industrial linkages that enhance economic benefits. Technical training programs initiated by international partners have begun addressing skills gaps, with over 500 technicians certified in solar panel installation and maintenance since 2022.

The economic case for green energy strengthens when considering co-benefits beyond direct energy provision. Agricultural applications of solar power for irrigation pumping and cold storage facilities offer synergies with the region’s dominant economic sector. Preliminary pilot projects demonstrate cost savings of 35-40% compared to diesel-powered alternatives, with payback periods under five years. These applications simultaneously address energy access challenges in rural areas where grid extension remains economically unviable.

International cooperation emerges as a critical success factor for accelerating green energy deployment. Bilateral agreements with development partners have facilitated technology transfer and capacity building. The recent partnership with the European Bank for Reconstruction and Development, providing 150 million EUR in concessional financing for renewable energy projects, exemplifies the catalytic role of international support. Knowledge exchange programs with countries having similar climatic conditions but more advanced renewable energy sectors provide valuable lessons for adaptation to local contexts.



CONCLUSION AND SUGGESTIONS

This comprehensive analysis of green energy development in the Fergana region reveals both substantial opportunities and significant challenges requiring coordinated response. The region possesses exceptional renewable energy resources, particularly solar and small hydroelectric potential, that could transform its economic landscape while contributing to national climate objectives. Current utilization at less than 15% of technical potential indicates vast room for expansion, with economic modeling suggesting benefits including 8.5% contribution to regional GDP and creation of 30,000 direct and indirect jobs by 2030.

The transition to green energy represents not merely a technical challenge but a comprehensive economic transformation opportunity for the Fergana region. Success in this endeavor would position the region as a leader in Central Asia's renewable energy sector, attracting investment, creating employment, and contributing to sustainable development objectives. The evidence presented in this study strongly supports accelerated action to realize this potential, with benefits far exceeding costs when considering long-term economic, social, and environmental dimensions.

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