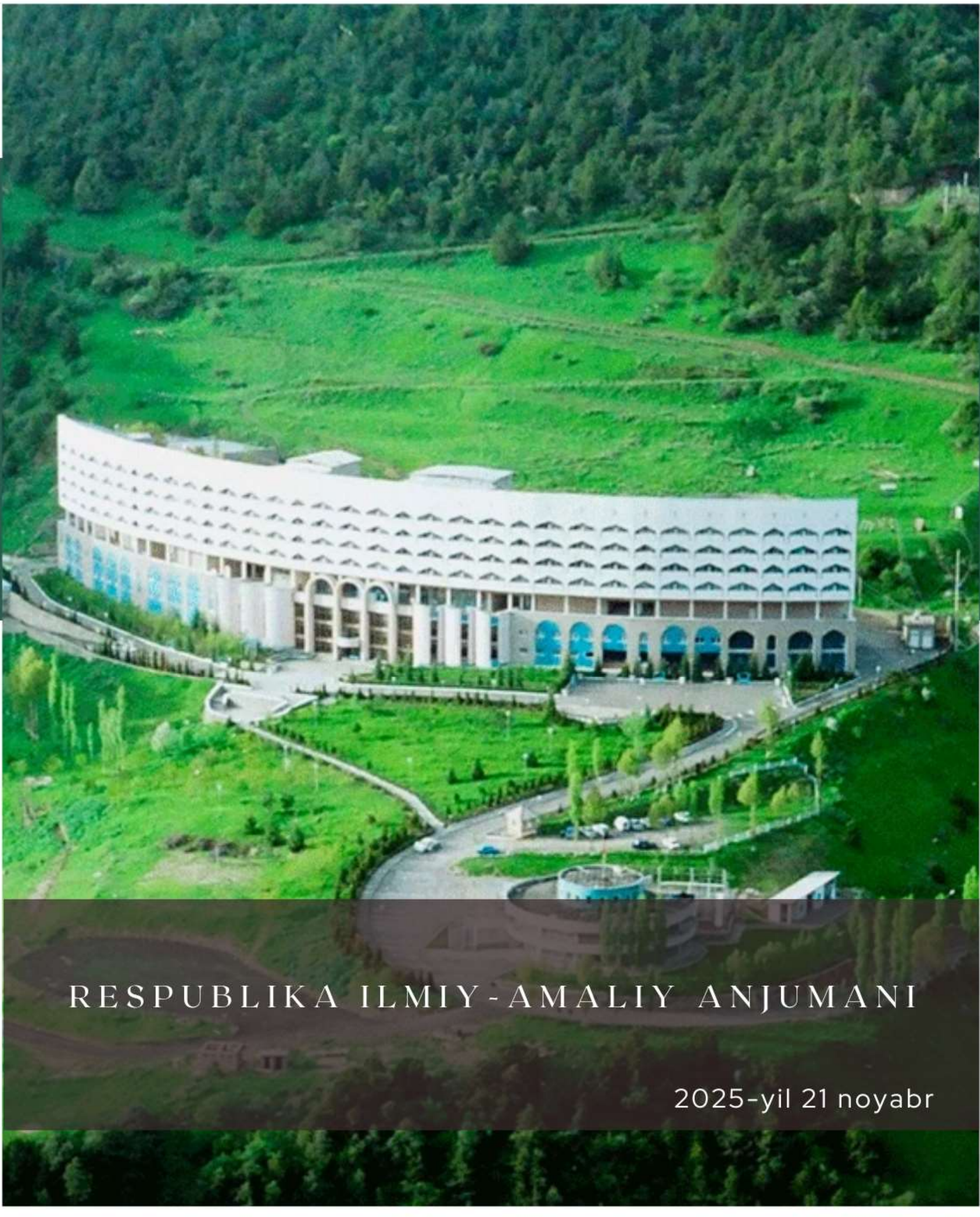
KONFERENSIYA

"JIZZAX VILOYATI IJTIMOIY-IQTISODIY RIVOJLANISHINING ASOSIY YO'NALISHLARI: MUAMMO VA YECHIMLAR"



RESPUBLIKA ILMIY-AMALIY ANJUMANI

2025-yil 21 noyabr

O‘ZBEKISTON RESPUBLIKASI OLIY TA’LIM, FAN VA INNOVATSIYALAR VAZIRLIGI

MIRZO ULUG‘BEK NOMIDAGI O‘ZBEKISTON MILLIY UNIVERSITETINING JIZZAX FILIALI

JIZZAX VILOYATI IJTIMOIY-IQTISODIY RIVOJLANISHINING ASOSIY YO‘NALISHLARI: MUAMMO VA YECHIMLAR

mavzusidagi Respublika ilmiy-texnik anjuman materiallari to‘plami

(2025-yil 21-22-noyabr)

JIZZAX-2025

Jizzax viloyati ijtimoiy-iqtisodiy rivojlanishining asosiy yo‘nalishlari: muammo va yechimlar. Respublika ilmiy-texnik anjuman materiallari to‘plami – Jizzax: O‘zMU Jizzax filiali Iqtisodiyot va turizm kafedrasi, 2025-yil 21-22-noyabr. 557-bet.

Respublika miqyosidagi ilmiy-texnik anjuman materiallarida zamonaviy kompyuter ilmlari va muhandislik texnologiyalari sohasidagi innovatsion tadqiqotlar aks etgan.

Globallashuv sharoitida davlatimizni yanada barqaror va jadal sur’atlar bilan rivojlantirish bo‘yicha amalga oshirilayotgan islohotlar samarasini yaxshilash sohasidagi ilmiy-tadqiqot ishlariga alohida e’tibor qaratilgan. Zero iqtisodiyotning, ijtimoiy sohalarni qamrab olgan modernizatsiya jarayonlari, hayotning barcha sohalarini liberallashtirishni talab qilmoqda.

Ushbu ilmiy ma’ruza tezislari to‘plamida mamlakatimiz va xorijlik turli yo‘nalishlarda faoliyat olib borayotgan mutaxassislar, olimlar, professor-o‘qituvchilar, ilmiy tadqiqot institutlari va markazlarining ilmiy xodimlari, tadqiqotchilari, magistr va talabalarning ilmiy-tadqiqot ishlari natijalari mujassamlashgan.

Mazkur to‘plamga kiritilgan ma’ruza tezislarining mazmuni, undagi statistik ma’lumotlar va me’yoriy hujjatlarning to‘g‘riligi hamda tanqidiy fikr-mulohazalar, keltirilgan takliflarga mualliflarning o‘zlari mas’uldirlar.

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PROSPECTS FOR THE DEVELOPMENT OF MATHEMATICS IN THE GREEN ECONOMY

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Annotation: This article explores the critical role of mathematics in advancing the green economy across Central Asian countries—Kazakhstan, Uzbekistan, Kyrgyzstan, Tajikistan, and Turkmenistan. Emphasizing that mathematics remains indispensable in areas such as renewable energy optimization, climate modeling, and economic forecasting, the article highlights how mathematical tools support sustainable policy design and energy infrastructure planning. It analyzes recent statistical data and historical developments while referencing global and regional best practices. The article also discusses educational reforms in Central Asia that aim to build the mathematical capacity needed for a green transition. The analysis concludes that fostering mathematical education and research is essential to achieving long-term environmental and economic resilience in the region.

Keywords: Mathematics, green economy, Central Asia, renewable energy, sustainability, modeling, education reform, climate policy, optimization, energy transition.

The transition to a green economy - one that balances economic growth, social inclusion and environmental sustainability has never been more urgent. In 2023 alone, global annual renewable capacity additions surged by nearly 50%, reaching almost 510 GW, the highest rate in two decades. This unprecedented expansion has been underpinned by sophisticated mathematical modelling ranging from time-series forecasting of energy yields to optimization of grid integration and resource allocation. In Central Asia, where countries from Kazakhstan to Tajikistan seek to diversify away from fossil fuels, mathematics remains the indispensable key to designing resilient, efficient and cost-effective green infrastructures.

From a historical standpoint, mathematics and economy have been intertwined since the origins of calculus in the seventeenth century, when Newton and Leibniz’s work laid the groundwork for modelling continuous change. The rise of linear programming in the mid-twentieth century—Dantzig’s simplex algorithm (1947)—revolutionized resource allocation problems, directly informing modern energy dispatch and investment planning. In parallel, the development of numerical weather prediction and Lorenz’s chaos theory in the 1960s ushered in the era of climate modelling, which today informs national commitments to emission reductions and adaptation strategies. These milestones underscore how advances in pure and applied mathematics have repeatedly catalyzed leaps in our capacity to understand and optimize complex economic and environmental systems. At the global level, landmark initiatives like the European Green Deal rely heavily on large-scale econometric models and partial differential equation frameworks to simulate land-use changes, carbon budgets and socio-economic impacts across sectors. In the United States, proposals for a “Green New Deal” similarly draw on machine-learning algorithms to forecast job creation in renewable industries and to optimize supply chains for critical minerals. Even in small island developing states, stochastic optimization models guide the integration of solar and battery storage, minimizing both costs and greenhouse gas emissions.

Central Asia—comprising Kazakhstan, Uzbekistan, Kyrgyzstan, Tajikistan and Turkmenistan—boasts vast renewable potentials but faces steep deployment barriers. According to a ScienceDirect overview, the region’s hydrocarbon-poor countries (Kyrgyzstan, Tajikistan) rely heavily on hydropower, while fuel-rich economies lag in wind and solar adoption. Nonetheless, the World Bank’s 2024 “Net Zero Energy” report outlines concrete pathways for emerging Europe and Central Asia to decarbonize through renewables, energy-efficiency investments and grid modernization. In Kazakhstan, solar and wind capacity now account for 23% and 22% respectively of the country’s total renewable installed base, just three years after meeting its interim target of 3% renewables by 2020. Meanwhile, UNDP-supported projects in the Ferghana Valley are deploying climate-resilient, community-scale renewables and strengthening resilience across Kyrgyzstan, Tajikistan and Uzbekistan. Mathematics underpins every stage of this transformation. In hydropower-dominated systems, differential equations and numerical methods model reservoir dynamics and optimize water release for energy versus agricultural needs. In wind and solar integration, graph-theoretic algorithms ensure stable power flows across long-distance interconnections, while integer programming schedules maintenance and dispatch. Risk-analysis frameworks—rooted in probability theory—quantify uncertainties in demand forecasts, commodity prices and weather variability, guiding hedging strategies and insurance designs. Machine-learning techniques, from neural networks to ensemble methods, extract patterns from vast meteorological and load-profile datasets, enabling real-time control and predictive maintenance that boost reliability and lower costs.

The statistical trends underscore the indispensability of these mathematical tools. In Europe & Central Asia, renewable energy consumption reached only 15.14% of total final energy consumption in 2020, lagging behind global peers. Yet countries that have deployed advanced modelling and optimization frameworks—such as Hungary’s load-balancing algorithms and Poland’s district-heating network simulations—have seen annual efficiency gains of 5–8%, translating into significant emission reductions and cost savings. By contrast, where mathematical capacity is limited, project delays and budget overruns are commonplace.

Looking ahead, the prospects for mathematics in the green economy of Central Asia are bright but contingent upon strategic investments in human capital and institutional frameworks. Since 2013, the UN’s Partnership for Action on Green Economy (PAGE) has fostered South-South cooperation, strengthening national capacities to integrate green accounting, economic modelling and sustainability indicators into policy-making. Universities in Tashkent, Almaty and Bishkek are establishing interdisciplinary centres where mathematicians collaborate with economists, engineers and environmental scientists on renewable-energy forecasting, water-resource modelling and climate risk assessment. Such initiatives not only build local expertise but also create data ecosystems essential for continuous model refinement and scenario analysis.

Ultimately, the green economy does not diminish the role of mathematics—it amplifies it. From designing optimal renewable portfolios and evaluating investment risks to simulating socio-economic impacts of decarbonization policies, mathematics is the language in which the future of sustainable development is written. As Central Asia embarks on its green transition, robust mathematical frameworks will be the compass that guides policymakers, investors and communities toward a resilient, prosperous and low-carbon tomorrow.

Kazakhstan has made significant strides in renewable energy, with 148 renewable energy facilities totaling 2,903 MW, including 59 wind power plants (1,409 MW) and 46 solar power plants (1,222 MW). In the first half of 2024, these facilities generated 3.896 billion kWh, accounting for 6.47% of the country’s electricity production. The country’s commitment to increasing the share of renewables in its energy mix to 50% by 2050 necessitates advanced mathematical modeling for grid integration, resource allocation, and predictive maintenance.

Uzbekistan is actively pursuing renewable energy development, with solar and wind power plants generating 4.5 billion kWh in December 2024 alone, saving 1.36 billion cubic meters of natural gas and preventing 1.89 million tons of harmful emissions. The country’s goal to have 40% of its electricity come from renewable sources by 2030 underscores the need for mathematical tools in optimizing energy production, forecasting demand, and managing the integration of diverse energy sources.

Tajikistan and Turkmenistan, while currently lagging in renewable energy adoption, possess significant potential. Tajikistan’s solar energy potential is estimated at about 25 billion kWh per year , and Turkmenistan’s vast desert areas offer substantial opportunities for solar power development. Realizing this potential will require mathematical expertise in modeling energy systems, assessing feasibility, and planning infrastructure investments.

Educational reforms across Central Asia are pivotal in building the human capital necessary for a green economy. Uzbekistan’s higher education coverage increased from 9% in 2016 to 42% in 2023, with the number of universities rising from 77 to 213. The introduction of the credit-modular system based on the European Credit Transfer and Accumulation System (ECTS) has enhanced the flexibility of educational programs, promoting interdisciplinary studies essential for addressing complex environmental challenges. Kazakhstan has also reformed its higher education system, with over 120 universities and more than 600,000 students. The adoption of the Bologna Process and the establishment of institutions like Nazarbayev University, which combines teaching and research on an American model, reflect a commitment to fostering innovation and research capacity. Regional cooperation is further bolstered by initiatives such as the World Bank-supported conference in Tashkent, which emphasized the importance of unified regional accreditation standards, regional labor market forecasting, and the development of incentives for quality research. These collaborative efforts are crucial for harmonizing educational standards and facilitating the mobility of students and professionals across Central Asia.

In summary, mathematics serves as the backbone of Central Asia’s transition to a green economy, underpinning advancements in renewable energy and educational reform. The integration of mathematical modeling, data analysis, and optimization techniques is essential for efficient energy planning, infrastructure development, and policy formulation. As Central Asian countries continue to invest in renewable energy and transform their educational systems, the cultivation of mathematical expertise will be vital in achieving sustainable development goals and fostering regional cooperation.

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